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Development of an instructional package on woodland management for Iowa high school vocational agriculture instructors

Reinee Eshelman Hildebrandt

Iowa State University

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Hildebrandt, Reinee Eshelman, Ph.D.
Iowa State University, 1987

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Development of an instructional package on woodland management for Iowa high school vocational agriculture instructors

by

Reinee Eshelman Hildebrandt

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major: Forestry

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For the Graduate College

Iowa State University
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1987

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INTRODUCTION

Iowa is faced with the problem of diminishing forest resources. Educating people about proper woodland management is one means of reducing this problem.

The intent of this dissertation is to develop an instructional package on woodland management for Iowa vocational agriculture classes. The instructional package will inform the students about Iowa's diminishing woodland problem and about woodland management alternatives. Study of woodland management will provide students with practical knowledge on "how to" manage a woodland to achieve desired land management objectives. Most high school students have not developed and practiced land use strategies. Therefore, this knowledge may motivate future farmers to incorporate woodland management into their farm operations. If more young farmers incorporate woodland management into their farm operations, it is possible that their action could develop into a family tradition of woodland stewardship.
LITERATURE REVIEW

Model Development - Introduction

Almost all educators will agree that effective instruction requires forethought and planning. However, educators vary their instruction from theoretical to applied.

In his presidential address to the American Psychological Association in 1899, John Dewey [in 1900] called for the development of a 'linking science' between learning theory and educational practice. Ralph Tyler has also stated the need for such a body of knowledge. Instructional design is this linking science - a body of knowledge that prescribes instructional actions to optimize desired instructional outcomes, such as achievement and affects (Reigeluth, 1983).

There is no single best approach to the development of instructional systems.

Montemerlo and Tennyson, found more than 100 manuals containing models published since 1951. Andrews and Goodson identified over 60 models for small- and large-scale development efforts. Logan examined approximately sixty systems-based authoring tools and procedures for one particular component of one particular model (Logan, 1982).

One commonly used instructional development model is the "systems approach" model. The terms systems approach, instructional design, and instructional systems design have become common place and synonymous labels in the vocabulary of education professionals.

All systems models share most of the same basic components. "At minimum this means that objectives, methods, and evaluation procedures can be designed to support each
other" (Briggs, 1977). An instructional systems approach implies there is a process of planning that follows an orderly, but flexible sequence. In developing an instructional systems approach, research data is used to help maximize the effectiveness of the system.

Analysis of Instructional Systems Models

Instructional systems can be analyzed within three categories: pre-instructional systems development, systems development, and post-instructional systems development.

Pre-instructional Systems Development

The following pre-instructional systems development steps have been suggested by various systems authors:

1. Analyze and determine needs,
2. Identify instructional goal,
3. Identify learning tasks,
4. Analyze instruction (subject matter and learning content),
5. Identify entry behaviors, and
6. Develop learning objectives.

Analyze and determine needs

There is substantial evidence that needs assessment is an important part of the instructional development process (Briggs, 1977; Gagné and Briggs, 1974; Merrill and Tennyson, 1977; Romiszowski, 1981; and Sherman, 1980). There is some discrepancy in terms of what constitutes a needs assessment.
In the past, for educational purposes, needs often referred to determining what should be taught. Today, educators assess needs in more detail.

Burton and Merrill (1977) suggest, "Needs assessment is the process of determining what ought to be (goals) and measuring the amount of discrepancy between what ought to be and what actually is (needs)." Gagné and Briggs (1974) conclude that needs assessments look at two factors 1) societal needs and 2) learner's needs. "These two kinds of needs are surely to be viewed together in order that relevant instruction be systematically developed for the students who will be tomorrow's adults" (Gagné and Briggs, 1974). Burton and Merrill (1977) further divide societal needs and individual needs into the following five types of needs:

1. Normative need - a discrepancy between an individual's or group's present state and a given norm or standard;

2. Felt need - is what a person "wants" verses what he/she has;

3. Expressed need - is created when an individual has taken action to remove the discrepancy;

4. Comparative need - is a discrepancy between what one group has and what a similar group has; and

5. Anticipated need or Future need - is a discrepancy between present supplies and projected future demands.
They also indicate that, in educational assessment, all five types of needs should be considered. This is achieved by involving as many people as possible in the process.

Bartel (1976) and Dick and Carey (1978) add a pragmatic consideration. They state that needs assessment should determine whether or not an instructional unit has already been developed. If so, efforts should not be duplicated.

Sherman (1980) provides a procedure for performing a needs assessment. His first suggestion is to state the intentions. Refer to the identified discrepancy or need. Then write a broadly framed purpose statement to define the limits of instructional activity. Next, assess the situation by gathering decision-making information. Techniques for data collection include: formal and informal observations, interviews, and questionnaires. Guidelines for conducting a needs assessment include: involving as many people as practical and sharing intentions or goals statements with others who may have information to contribute.

Identify instructional goal

There is some discrepancy among authors as to the differences between assessment and goals. Bartel (1976), Briggs (1977), and Dick and Carey (1985) had instructional goal development as the first step in the model. Bartel (1976) and Briggs (1977) use goals as an element of the needs assessment. Although Dick and Carey (1985) do not formally
include a needs assessment step within their model, they state, "Instructional goals are ideally derived through the process of needs assessment." Gagné and Briggs (1974); Romiszowski (1981); and Sherman (1980) had the instructional goal step after the needs assessment step.

In general, goals are relatively broad statements that describe the gap between intentions and assessment results (Dick and Carey, 1985; Gagné and Briggs, 1974; and Sherman, 1980). "A goal is a statement of what ought to be" (Briggs, 1977). In an educational setting two basic classifications of goals can be identified - educational goals and instructional goals. "Educational goals refer to broad statements of the ultimate outcome of our educational enterprises, and frequently reflect social, political, and economic philosophies" (Burton and Merrill, 1977). The instructional goal is a broad statement describing the major culminating or synthesizing behavior that results from studying the unit (Dick and Carey, 1978). They are developed to define the content of the instruction and to provide a structural framework for content and process analysis (Sherman, 1980).

Instructional goals can come from upper administrative levels, expert opinion, or needs assessment results. Many times, they are derived from educational goals. Broad instructional goals are needed to introduce school boards,
instructors, superintendents, and principals to the potential of the system.

Goal development is a deductive process beginning with general outcomes and continuing with refinement into more specific components. Goals and objectives can be put into four classes related to types of learning:

1. Knowledge goals specify the accumulation of knowledge, facts, and concepts to be included in the discipline.

2. Customary goals define outcomes ordinarily stressed by the school system by custom or mandate.

3. Affective goals work toward developing attitudes and feelings about what is to be taught.

4. Process goals teach ways of responding to situations or thinking strategies (Sherman, 1980).

Sherman (1980) suggests an approach to goals development with four phases. Phase 1: Identify a broad range of needs using old syllabi, school goals, entry level behaviors, relevant literature, and Magers Goal analysis; Phase 2: identify discrepancies between expected and actual performance; Phase 3: write goals and rank them in order of importance; and Phase 4: set priorities for action.

Identify learning tasks

A learning task is a specific activity or skill that needs to be accomplished in order to achieve learning (Banathy, 1970; Bartel, 1976; Butler, 1972; Dick and Carey, 1978; and
Sherman, 1980). There is some variation among approaches at this point in the models. Some instructional systems designers focus on objectives rather than learning tasks. They suggest if an objective is stated specifically enough, it informs us about the expected skill to be completed. Therefore, learning task identification and analysis is not needed.

There is also some variation as to when learning tasks need to be identified. Banathy feels that learning tasks should be developed after the behavioral objectives have been developed. "Once the specific performance expected of the learner has been identified, we can consider what [the student] has to learn in order to be able to perform successfully" (Banathy, 1970). Bartel (1976), and Butler (1972) feel that the learning tasks should be developed before the specific learning objectives have been identified.

"Learning tasks can be identified by subtracting whatever is already known to the learner (input competence) from a specific set of learning tasks (inventory of learning tasks). This information can be used to determine the time allotment and to help estimate the amount of content needed to successfully teach a given content" (Banathy, 1970; Bartel, 1976).

The method for determining learning tasks vary from Bartel's (1976) six step process to Sherman's (1980) two step
process. Sherman suggests, first identify initial learning tasks needed to carry out specified output performance. To achieve this, examine human capabilities - skills, knowledge, and attitudes. Second, analyze and characterize the skills, information, and attitudes the learner brings with him/her. A questionnaire can be used to help verify and determine learning tasks.

Bartel (1976) suggests, the six essential steps in determining initial learning tasks are: 1) identify scope and limitations; 2) review resource materials; 3) develop preliminary duty/division and task list; 4) conduct observations; 5) review by experts; and 6) revise inventory. The initial selection of the tasks should be done without regard to existing information, such as, lack of facilities, personnel, time, and funds (Bartel, 1976).

Once the initial task inventory has been developed, task selection is required. To be included in the final program, the task must meet the following twelve criteria:

1. Frequency of performance and use
2. Importance and need
3. Basic and required
4. Complexity and difficulty
5. Immediacy
6. Time element
7. Appropriateness for setting
8. Duplication
9. Meet task statement criteria
10. Instructor's ability to instruct
11. Student's experience, interest and motivation
12. Availability of facilities and equipment (Bartel, 1976)
After final tasks have been selected, sequencing is based on early use, frequency of use, complexity, and timing. The final step is to detail tasks in the following way.

1. Verify the task
2. Select appropriate format
3. Write tentative steps/elements
4. Identify and write appropriate key points
5. Perform or observe task being performed
6. Have detailed task reviewed by experts
7. Revise detailed task (Bartel, 1976)

Analyze instruction (subject matter and learning content)

An instructional analysis is a procedure to identify relevant subordinate skills or subject matter topics required for a student to achieve the goal. This step is similar to the previous step of learning task identification. A subordinate skill must be achieved in order to learn some higher skill. Dick and Carey (1985) refer to both a hierarchical and a procedural approach to analyzing instructional skills. The procedural approach is used when behavior can be described in a linear sequence. The hierarchical approach is used when there are a number of levels of learning events required to reach the instructional goal. Within each level, it may not make any difference which learning event is done first or last as long as they are all completed. Completion of one level means the learner is ready to advance to the next hierarchical level. Hierarchical information is presented in flow chart form. In developing these flow charts, the instructional designer must identify
entry behaviors and characteristics that the student must have prior to instruction (Dick and Carey, 1985).

Sherman (1980) suggests an analysis of learning content. "The content of learning involves the analysis [division] of goals and sub-goals into separate components to determine the kinds of competencies which are taught." He also suggests to first divide learning outcomes into content components or subject matter areas. Second, identify and order content components. The instructional designer determines what must be taught first in order to enable learners to achieve higher level goals. Sherman's (1980) procedure is similar to Dick and Carey's (1985) hierarchical approach to instructional analysis.

Learning taxonomies can be used to analyze instruction. Two of the more renowned taxonomies are Bloom's Taxonomies (1956) and Gagné (1975). Bloom developed taxonomies for the cognitive domain, affective domain, and the psychomotor domain. Use of taxonomies during the classification procedure helps identify prerequisite learning. The following are the major categories of the cognitive domain ranked from lower levels to higher levels.

1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation (Bloom, Hasting, and Madaus, 1971)
The following categories can be used for the affective domain taxonomy.

1. Receiving (attending)
2. Responding
3. Valuing
4. Organization
5. Characterization by a value (Krathwohl, Bloom, and Masia, 1964)

Gagné (1974) developed a taxonomy with five categories. They are:

1. Verbal Information - "Knowing that"
   a. Labels - attaching a label or name to an object,
   b. Facts - an expression of a relationship between two or more objects or events, and
   c. Bodies of Knowledge - interconnected facts.

2. Intellectual Skills - "Knowing how"
   a. Discrimination - distinguishing one object/symbol from another,
   b. Concrete concepts - identifying an object property or object attribute,
   c. Defined concepts - demonstrate the meaning of some particular class of objects, events, or relations,
   d. Rules - demonstrate a class of relationships among classes of objects and events, and
   e. Higher-Order Rules (problem solving) - invented rules for the purpose of solving a practical problem or class of problems.
4. Attitudes - complex states of the human organism that affect his behavior toward people, things, and events.
5. Motor skills - learned capabilities that underlie performances whose outcomes are reflected in the rapidity, accuracy, force, or smoothness of bodily movement.

Identify entry behaviors

Entry behaviors are skills or knowledge that must be mastered by the learner prior to beginning the developed instruction. Dick and Carey (1985) were the only authors to include this step in their instructional model. Many of the authors mention this step within other components of their models.

To determine entry behaviors, first describe the target population in terms of age, grade level, and general characteristics. Information "about the physical and emotional characteristics of the target population can be used to draw implications about possible interests and skills" (Dick and Carey, 1985). However, caution must be used to ensure that the characteristics describe the target group, rather than provide stereotypical misconceptions.

Second, refer to the instructional analysis previously developed. Examine the hierarchy and identify those skills
obtained by the majority of the population. Draw a line above those skills in the analysis chart. The skills below the line are called entry behaviors.

Dick and Carey (1985) provided words of caution in using entry level behaviors. "The identification of entry behaviors is one of the real danger spots in the instructional process. [A colleague of Dick and Carey pointed out] that the designer is making assumptions about both what the learner must know and should already know."

Develop performance objectives

All of the models included this step in their instructional system. "Perhaps the best-known [and most agreed upon] component of the instructional design model is the writing of performance objectives or behavioral objectives" (Dick and Carey, 1985). Disagreement occurs only with respect to where this step fits into the instructional systems development process. Some feel objectives should be developed after the goals are determined. Others feel that identification of learning tasks and analysis of subject matter comes first.

A number of forces contribute to the development of performance objectives. Bobbitt [in 1918, 1924] and Charters [in 1923, 1929] were probably responsible for formulating a method for determining educational objectives on a scientific basis. It was Tyler [in 1934, 1950], however, who is most often credited as being the 'father' of today's performance objectives. The work of Kearney [in 1953], French [in 1957], Bloom et al. [in 1959] and Krathwohl et
al. [in 1964] followed closely to provide early frameworks for classifying objectives. It was the contributions from systems analysis by scholars like Gagné [in 1962, 1970], Miller [in 1962], and Briggs [in 1970] that have an impact on the systems approach to instruction. It was Mager's 1961 book that diffused the concept and use of performance objectives across all education (Briggs, 1977).

Objectives communicate specific outcomes that are short-range (Kibler and Bassett, 1977). Performance objectives are specific statements of what students will be able to do or how they will be expected to behave after completing a prescribed lesson or unit (Kibler and Bassett, 1977; Sherman, 1980). They must be specific enough to avoid misunderstanding and they must represent small components of behavior that are focused on specific lessons. Performance objectives identify the end product or terminal performance of instruction in terms of observable, measurable behavior. There is no fixed number of levels of such goals and sub-goals or objectives (Gagné and Briggs, 1974).

There seems to be relatively wide spread agreement on the format of and purpose for developing behavioral objectives. Sherman cites the following authors as being in agreement: Duchastel and Merrill; Gronlund; Hernandez; Kibler, Barker, and Miles; Mager; Plowman; Sherman; Vargas. The three main purposes are to:

1. Communicate to the learner (facilitate learning),
2. Provide guidance for evaluation, and
3. Provide guidance for instructional development.
For the students, the objectives tend to motivate more effective learning, allow for greater communications with the instructor, and allow for more independent study and unstructured learning (Bartel, 1976).

For the teacher, benefits provided by developing objectives include: 1) having a prepared document showing content selection and instructional strategy development, (Bartel, 1976; and Dick and Carey, 1978); 2) motivating the teacher to closely relate teaching techniques with teaching methods (Bartel, 1976); 3) requiring the teachers to specify the behaviors they will teach, determine the strategies for instruction, and establish criteria for evaluating student performance upon completion of instruction (Bartel, 1976; and Dick and Carey, 1978); 4) making the teacher more organized, therefore, increasing the teachers credibility (Bartel, 1976); 5) serving as a basis for developing criterion testing instruments to evaluate the effectiveness of instruction (Bartel, 1976; and Dick and Carey, 1978); and 6) helping the teacher emphasize the end product rather than the means of arriving there (Bartel, 1976). Behavioral objectives provide the student and instructor with a more organized presentation approach and evaluation procedure (Bartel, 1976).

There are also some disadvantages. Performance objectives tend to: concentrate on the lower levels of objectives, over emphasize informational content, and under emphasize the
attitudinal content. For the instructors, the major
disadvantage is spending extra time writing performance
objectives. It is also difficult to objectively evaluate
performance objectives for higher levels of learning.

To write an objective statement, identify the students
involved, the condition under which the behavior takes place,
and a performance standard (Bartel, 1976; Dick and Carey,
1978). In more detail, a statement of objectives should
specify:

1. What is the learner expected to be able to do?
   a) use verbs that denote observable action,
   b) indicate the stimulus that is to evoke the
      behavior, and
   c) specify resources to be used by the learner
      and persons the learner should interact with.

2. How well is the behavior expected to be
   performed?
   a) identify accuracy or correctness of response,
   and
   b) identify response length, speed, and rate.

3. Under what circumstances is the learner expected
to perform?
   a) specify physical or situational
      circumstances, and
   b) specify psychological conditions
      (Banathy, 1970).

Avoid words such as know, understand, like, appreciate,
learn, grasp, comprehend, want, taste, and feel. They have
different meanings to different people. Action-oriented words
such as compute, define, estimate, list, measure, describe,
identify, and state should be used (Bartel, 1976; and Mager,
1962).
The following nine criteria can be used to evaluate performance objectives:

1. The level of writing must match the intended learners;
2. The objective should deal with the end product and not the process to achieve that product;
3. The action expected must be observable;
4. The objective should be stated using action verbs;
5. Performance objectives should be specific and narrow or limited in scope;
6. The objective must be realistic in terms of the student's abilities, aspirations, and interests;
7. The students must feel the objectives are worthy of accomplishing to reach his or her long or short range goals;
8. The objective must be financially feasible; and
9. The objectives must be consistent or within the framework of the institution, department, instructional area, subject and course goals (Bartel, 1976).

Systems Development

The following systems development steps were suggested by various authors:

1. Develop criterion-referenced tests,
2. Develop instructional strategies,
3. Evaluate and select instructional materials/media, and
4. Develop an instructional schedule.

Develop criterion-referenced tests

Criterion-referenced tests are considered a breakthrough in education and training methodology.

One of the most dramatic advances in the area of educational measurement and evaluation during the past decade has been the shift from norm-referenced to criterion-referenced testing. Although the
concept of an absolute versus relative standard of measurement was first introduced through the work of Thorndike in 1913, and further studied by Flanagan, Nedelsky, and Edel during the 1950s and early 1960s, the term "criterion-referenced measurement" was not used until 1962 when Glaser and Klaus coined the term [from Berk, 1980] (Montag, 1984).

In criterion-referenced tests, the student's proficiency is measured against a predetermined set of absolute criteria. Glaser (1963) referred to this set of criterion as "an absolute standard of quality." Norm referenced tests measure individual performance as compared to other students.

Criterion-referenced tests are used to determine whether the instructional goals and objectives have been met. They are used to evaluate the behavioral objectives, individual lessons, and the complete system both before and after implementation (Gagné and Briggs, 1974; Briggs, 1977; and Butler, 1972). Their use is strongly recommended for vocational and technical training programs (Butler, 1972).

Four types of criterion tests need to be developed. They are:

1. Entry behavior tests - to determine if students have the skills that are prerequisite to beginning the unit materials.

2. Pre-tests - used to diagnose student knowledge of the skills and objectives presented in the materials, then to prescribe appropriate materials.

3. Embedded tests - used to assess the learning process and provide the student with a chance to implement what they've learned. They are used within lesson assessment for testing student achievement.
4. End-of-lesson and end-of-unit tests - used to determine if remedial work is needed and used to assess transfer of knowledge (Dick and Carey, 1985).

Criterion-referenced tests have many advantages. Tests employed prior to instruction, have diagnostic value. Tests employed during instruction are useful for monitoring pupil progress. The test results show when a learner needs more study or when he/she is ready to go on to a new objective. They also show where remedial study should be focused. End-of-lesson tests focus on the planned instructional goals and objectives. They help make a "yes" or "no" decision as to whether the desired criterion level of performance has been reached on an objective (Briggs, 1977).

Montag (1984) indicates that Hambleton et al. in 1978 developed a model very similar to Fremer's 1974 outline for the construction of criterion-referenced tests. This has become a generally accepted procedure for the development of criterion-referenced tests.

Steps for Developing Criterion-Referenced Tests and Validating Test Score Uses (Hambleton, 1980, p. 83, as cited in Montag, 1984)

1. Preparation and/or selection of objectives or domain specifications.

2. Preparation of test specifications (for example, available time, selection of objectives to be measured by the test, number of test items/domain specification, appropriate vocabulary, method of scoring).

3. Writing test items "matched" to objectives.
4. Preliminary review of test items.

5. Determination of content validity of the test items.
   a. Involvement of content specialists.
   b. Collection and analysis of examinee response data (field test-item analysis).

6. Additional editing of test items.

7. Test assembly.
   a. Determination of number of test items/domain specification.
   b. Test item selection.
   c. Preparation of directions and sample questions.
   d. Layout and test booklet preparation.
   e. Preparation of scoring keys.
   f. Preparation of answer sheets.


9. Test administration.

The test questions are derived from the performance objectives. If the performance objective is clearly written using all five components of an objective statement, the testing situation should be already designed.

**Develop instructional strategies**

"The instructional strategy describes the general components of a set of instructional materials and the procedures that will be used with those materials to elicit particular learning outcomes" (Dick and Carey, 1985). Sherman (1980) defines instructional strategies as, "specific actions taken by the teacher to bring about productive interaction of students and content."
Dick and Carey (1985); Gagné and Briggs (1979); and Sherman (1980) recommend the development of instructional strategies in their models. Many instructional designers develop instructional strategies at the same time they are developing instructional schedules.

Dick and Carey (1985) include five major components in their instructional strategies.

1. Pre-instructional activities
2. Informational presentation
3. Student participation
4. Testing
5. Follow through

Pre-instructional strategies are used to set the stage for the lesson. They should motivate the learner, inform the learner of the objectives, and identify prerequisite skills needed. Gagné and Briggs (1979) suggest the following pre-instructional strategies: assess the events of instruction, gain the attention of the student, inform the learner of the objectives, and begin the lesson. Informational presentation includes: a sequence of lesson topics, size of lesson, and a list of concepts, rules and principles learned in the lesson. Within the lesson, Gagné (1968); Gagné and Briggs (1974); and Gagné (1977) suggest stimulating recall of prerequisite learning, presenting the stimulus material, and providing "learning guidance". Student participation is provided by
including practice and feedback activities. Strategies for student participation include: eliciting the performance and providing feedback about performance correctness (Gagné, 1968; Gagné and Briggs, 1974; and Gagné, 1977). Criterion-referenced tests are included and follow-through activities are suggested. Follow-through activities include enrichment materials and remediation options. Gagné and Briggs (1974) refer to this as "enhancing retention and transfer."

A good pre-planned lesson provides the teacher with multiple communication options designed to gain attention. The technique for gaining attention depends upon the age of the learner. One technique for gaining attention is to start with a known interest of the learners (Briggs, 1977). Once the teacher has the students attention, it must be maintained. Maintaining attention may require still other techniques. Ways of gaining or maintaining focus include: informing the student of the objectives, using break periods between lengthy sessions, using humor, changing plans suddenly, or changing the type of activity. For films, using fast or slow motion, animation, and time lapse photography help maintain attention.

**Evaluate and select instructional materials/media**

Media are defined by Romiszowski (1981) as "the carriers of messages from some transmitting source (which may be human or an inanimate object), to the receiver of the message (which is the learner)."
"One of the important uses of media is to make possible alternative modes of communication in the delivery of instruction" (Gagné, 1975). Sherman (1980) suggests the message channel can be varied to utilize the form of communication that best facilitates learning for the individual student. "In combination, the different media gain more capability by taking advantage of the special attributes of each, and thus becomes more effective than any one medium by itself" (Butler, 1972).

Instructional materials/media may be classified into three broad categories: printed matter, audio-visual materials, and manipulative aids (Finch and Crunkilton, 1979). Printed matter includes: manuals, workbooks, pamphlets, study guides, reference books, standard textbooks, magazines, newspapers, and modules. Audio-visual materials include: pictures, graphics, posters, audiotapes, records, films, transparencies, filmstrips, film loops, slide series, television, video tapes, computers, and video disks. Manipulative aids include: puzzles, games, models, specimens, puppets/figures, learning kits, experiments, trainers, simulations, and dramatizations.

The relative amount of use within each of the three categories has changed over time. Originally, printed materials were the primary instructional materials used. With advancements in technology and the invention of audio-visuals, emphasis has changed. More audio-visual materials are being
included in instruction. The method of using these audiovisual materials has also changed with time.

In conventional educational programs, audiovisual materials are typically used as supplements to instruction for enrichment purposes. As such, they make only limited contributions to improvement in learning. Under these traditional conditions, audio-visual materials are costly additions to the usual instructional materials the teacher may select and use. Media are not supplementary to, or in support of instruction, but are the instructional input itself. In this light, the old concept of audio-visual aids as supplements to the teaching can no longer be accepted (Kemp, 1980).

Today, there are few educators who have not used some form of audio-visuals in their teaching efforts. The question facing all educators is how to utilize audio-visuals, and other instructional material, to provide the best possible learning experience. Romiszowski (1981) states, "the traditional approach to selecting media for instruction has often been based on a search for applications for a new item of equipment which has come on the market." This is no longer a valid criteria for selecting instructional materials.

Guidelines and flowcharts have been developed to help individuals make media selections. The most commonly used guidelines include:

1. Select a communication form which conforms to the purpose and objectives of the instruction (Butler, 1972; Dick and Carey, 1985; Finch and Crunkilton, 1979; Kemp, 1980; Romiszowski, 1981; Sherman, 1980; and Simonson and Volker, 1984).
2. The media selected should match the intended audience's age and reading ability (Dick and Carey, 1985; Finch and Crunkilton, 1979; Romiszowski, 1981; Sherman, 1980; Simonson and Volker, 1984).

3. The content of the media needs to be considered for suitability and for quality (Butler, 1972; Finch and Crunkilton, 1979; Kemp, 1980; Romiszowski, 1981; Sherman, 1980; Simonson and Volker, 1984).

4. The cost of the appropriate media should be considered. The least costly and least elaborate medium that will enable the learners to acquire the desired capabilities should be used (Butler, 1972; Finch and Crunkilton, 1979; Romiszowski, 1981; Simonson and Volker, 1984).

5. The medium should not be too complex (Butler, 1972; Simonson and Volker, 1984).

6. The previous experiences of the learners should be considered (Dale, 1947; Sherman, 1980).

7. The learning environment (formal vs. informal) and the instructional method (individual, small group, or large group) needs to be considered to match the type of media with the instruction (Butler, 1972; Dick and Carey, 1985; Finch and Crunkilton, 1979; Gagné, 1974; Kemp, 1980). See Figures 1 and 2.

8. Practical factors such as adaptability of medium to a teaching location (temperature, humidity, power source,
STEP 1
Determine size of target population

Is message intended for large target population? (difficult to reach everyone at one time)

yes

no

Is exact message content critical? (locked-in)

yes

no

STEP 2: (small group)
Determine message characteristics

Is face-to-face communication feasible?

no

yes

Does message deal with objects not familiar to target population?

no

yes

no

yes

Does message deal with objects not familiar to target population?

no

yes

no

yes
STEP 3
Select medium

**with objects not familiar to target population?**

- **no**
  - Consider distribution of:
    - Printed materials (support with simple drawings, photos)
    - Audiotapes (support with drawings, photos)

- **yes**
  - Consider:
    - Conference or individual calls
    - Distribution of printed material (memos, letter, etc.)

**with objects not familiar to target population?**

- **no**
  - Consider:
    - Small-group meetings (2-way communication)
    - Individual meetings
    - Conference calls
    - Distribution of printed material

- **yes**
  - Consider:
    - Printed material
    - Conference calls
    - Audiotapes
    - Distribution of printed material

**with objects not familiar to target population?**

- **no**
  - Consider:
    - Group meeting—entire group at one time
    - Distribution of printed materials
    - Audiotapes
    - Distribution of printed material

- **yes**
  - Consider:
    - Group meeting—entire group at one time
    - Distribution of printed material
    - Audiotapes
    - Distribution of printed material

*Individual media listed in suggested order of priority

Figure 1. Media selection information - Chart 1 (Simonson and Volker, 1984)
STEP 2 (large group)
Determine characteristics of message

Is exact message content critical? (locked-in)

- no
  - Does message deal with objects not familiar to target population?
    - no
      - Is attitude change critical?
        - yes
    - yes

- yes
  - Does message deal with objects not familiar to target population?
    - no
      - Is attitude change critical?
        - yes
    - yes
      - Is attitude change critical?
        - yes
Figure 2. Media selection information - Chart 2 (Simonson and Volker, 1984)
transportation); b) environment (space, layout, acoustics, facilities available); c) potential damaging sources (students, careless handling); d) working life of the medium for subject matter, physical/biological deterioration (Dick and Carey, 1985; Romiszowski, 1981).

9. The relationship between media and the objectives potential learning domain (cognitive, affective, psychomotor) should be considered. See Table 1. (Simonson and Volker, 1984)

Romiszowski (1981) has taken a number of these guidelines and developed a two stage process for selecting media. In the first stage, he considers factors that influence effective communication. These factors include: learner characteristics, content orientation, and lesson objectives. At this stage, all media that do not fit the learning situation are rejected. In the second stage, cost, practical factors, and human factors are considered.

Romiszowski (1981) has also provided flow charts to aid the instructional developer or teacher in selecting media. See Figures 3-5.

Vocational programs add a special consideration in selecting media.
Table 1. Media selection according to learning domain
(Simonson and Volker, 1984)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Media that could be used</th>
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| Cognitive       | Print – duplicated handouts, worksheets, short readings, copies of articles, textbooks  
Slide sets – narrated live or combined with audiotape for self-instruction  
Transparencies – used by the teacher to speed up problem solving or to explain complex ideas that require nonverbal illustrations  
Individualized instruction – computer programs, workbook/audiotape sets, filmstrips  
Live instruction – effective, but wasteful (students learn as much from mediated instruction where lower-level cognitive information is concerned) |
| Affective       | Live instruction – quite effective and necessary here. Since attitude change can occur during discussions, it is important that a teacher assist in the orderly and systematic process of conducting a discussion  
Film/ videotape – these media may portray contrived events, but the viewer experiences real emotions. Film and videotape are presently our most effective media for representing events in the world.  
Audiotape – where only sound is involved in the realism of a situation  
Print – books, magazines, and other print |
| Psychomotor     | Audiotape – instructions can provide a step-by-step recipe for accomplishing a task, freeing students from having to read as they perform  
Film/television – demonstrations of processes that students can then perform are particularly effective if shown in motion  
Live instruction – the familiar lecture/demonstration provides an example for students to follow as they practice the same process on their own  
Print – using stepwise procedures or recipes, students can follow the instructions to perform a task |
Figure 3. Decisions for selecting visual media (Romiszowski, 1981)
Figure 4. Decisions for matching of learning task to media characteristics (Romiszowski, 1981)
Figure 5. Decisions for selecting verbal and sound media (Romiszowski, 1981)
Vocational and technical training places two important limitations on the use of printed materials. First of all, the instruction should be conducted under workshop, on-the-job conditions as opposed to a classroom, textbook, and lecture situation; thus complete dependence on printed materials should be avoided. Second, low verbal aptitude and skill on the part of some students can interfere drastically with the learning process. Particular care must be taken to keep printed materials at the right comprehension level for the students. Frequently, though, a student with a low-level reading comprehension has surprisingly high listening comprehension. This is one reason why step-by-step slide-tape (teaching machine) presentation and systematized lecture-demonstrations are often more effective than printed material (Butler, 1972).

Develop an instructional schedule

Development of an instructional schedule is the outcome of the previous systems development steps. The instructional schedule provides the instructor with a listing of logically sequenced learning tasks/activities. The schedule should show timing and sequence between materials, aids, support materials, and devices used during the teaching session. This permits the instructor to secure materials and visual aids in sufficient time.

The schedule should be flexible enough to permit changes as technology and methodology become available. It should be designed to meet the demands of the course or training program offerings. Administration should be able to use the schedule to quickly evaluate the course offering.
Mager (1968) provides the following guidelines for instructional schedule development.

1. Where am I going? (in this lesson)  
   1. State the performance objective that explain what the students will be able to do after they have mastered the lesson.

2. How will I get there? (how to achieve the objectives)  
   2. Select methods, materials, activities, and instructional events that provide the best learning conditions for each performance objective.

3. How will I know when I've arrived? (achieved success)  
   3. Administer an appropriate test or other appraisal of student performance to determine when students have achieved the objective.

Mager (1968) used these three questions to the design the following expanded set of actions:

1. Organize the course into major units and topics, and define lesson objectives for each.

2. Identify the human capabilities represented in the lesson's objectives.

3. Design a teaching sequence to take account of prerequisite learnings.

4. Identify the type of capability represented in each subordinate lesson objective.

5. Choose a single "target" objective to fit available lesson time.

6. Design a teaching plan for each objective, considering the appropriateness of instructional events and the effective learning conditions associated with them.

7. Identify a medium of instruction that can best achieve the effective conditions of learning for each event; and choose the medium or media combination that will best do the job.
8. Assess learning outcomes in terms of student performance and make the revisions that are implied, until a satisfactory degree of effectiveness is attained (Gagné and Briggs, 1974).

Banathy (1970) follows a similar approach to developing an instructional schedule. He uses the following steps: 1) select content, 2) organize content, 3) select and organize learning experiences, 4) develop learners management strategies, 5) analyze components, and 6) schedule the lesson.

To select content, the designer should consider the possible characteristics of the learning group and the individual differences of the learners. The content selected should be relevant to the academic achievement, aptitude, and style of learning.

Content can be organized by determining the type of learning a task represents or by developing a logical sequence. Information about conditions of learning and degree of difficulty can be used as guidelines. For presentation, the content is integrated into specific learning sequences of specific learning units.

Banathy (1970) suggests including a variety of learning experiences, in order, to cope with the great variation in the way people learn. The learning experiences should vary in time needed, interest, need, aptitude, and achievement.

Management of learners "is the process of identifying and carrying out those functions that will keep the student
productively participating in the learning activity" (Smith, 1966, cited in Banathy, 1970). This step has also been referred to as planning for instructional events or developing instructional strategies. Some of the events of instruction may be built into the instructional material; others are supplied by the teacher, by the learner, or by planned activities (Briggs, 1977).

Component Analysis defines how specific functions should be carried out. Criteria for selecting components consists of: 1) potential to accomplish a particular function, 2) ability to integrate with other components, 3) relevancy to learner, 4) practicality, and 5) economy.

In component analysis the designer must first line up alternative means or components which have the potential of meeting the purpose of the instruction. The system designer will choose the human resources, means, and tools that will best carry out the function and optimize the attainment of the predetermined performance (Banathy, 1970).

Distribution refers to the assigning of specific functions to specific components. It considers effectiveness and cost of each component.

Finally, scheduling refers to the final "plan of action". It should specify the time, place, and teaching function. The designer decides when and where each function should take place (Banathy, 1970).

Bartel (1976) suggests the final instructional schedule should include the following components:
1. Course/training title
2. Division/duty
3. Tasks
4. Time allotment
5. Methods
6. Audio/visual aids
7. Activities
8. Written instruction sheets
9. Text and reference
10. Evaluative devices

Post-Instructional Systems Development

Once an instructional system has been developed, a number of post-instructional development steps need to be completed. The following post-instructional development steps have been identified by various authors:

1. Evaluation,
2. Degree of revision, and
3. Implementation.

Evaluation

There are three ways to utilize an evaluation process within the instructional systems process. The first method is within the model where each step is evaluated to determine the quality of the materials. In this case, evaluation is not the last step in the system development process but rather it is
implicit in every step of the process (Butler, 1972; and Gagné and Briggs, 1974). The other two roles of evaluation occur after a draft of the materials have been prepared. "It has become customary, since the appearance of a definitive article by Scriven [in 1967], to refer to the two roles of formative evaluation and summative evaluation" (Gagné and Briggs, 1974). Those two forms of evaluation will be discussed below.

**Formative evaluation**

Formative evaluation involves systematically trying out instructional materials with the learners, in order, to obtain information and data for revising and strengthening the materials (Briggs, 1977; Butler, 1972; Dick and Carey, 1985; Gagné and Briggs, 1974; and Sherman, 1980).

Formative evaluation occurs when data are collected and interpreted during the phase of development and are used to "form" the instruction (Gagné and Briggs, 1974). The formative evaluation should indicate how to effectively improve the instructional materials. The evaluation is used to compare actual outcomes with intended outcomes (Sherman, 1980). There are no simple rules for the extent of student, teacher, or classroom involvement in formative evaluation efforts. Evaluation is a matter of seeking convincing evidence.

There are three major stages of formative evaluation. They are one-to-one evaluation, small group evaluation, and
field evaluation (Banathy, 1970; Briggs, 1977; Butler, 1972; and Dick and Carey, 1985). Before beginning the three major steps a preliminary edit is recommended. Dick and Carey (1978) and Gagné and Briggs (1974), combine the preliminary edit with the one-to-one formative evaluations.

The first preliminary editing, made by subject matter experts, is to check the technical accuracy of the materials (Butler, 1972; Gagné and Briggs, 1974). This process is called technical editing. The second preliminary editing is for composition. This helps assure that the material will communicate with its expected audience. The third preliminary editing is to review teaching procedure. The second and third editing are completed by the instructional designer.

**One-to-One evaluation**  The purpose of one-to-one formative evaluation is to identify and eliminate the major problems in the preliminary draft of instructional materials. One to three students should be used (Briggs, 1977; Butler, 1972; Dick and Carey, 1985).

Some discrepancy exists concerning which students should be used. Briggs (1977) suggests, "If only one student can be used, select a student who is slightly below average in ability. If two or three can be identified, then an average and an above average student should also be selected." Butler (1972) suggests using a student from the upper twenty-five percent in aptitude and background because they are the
brighter students who can point out weak spots. Also, if better students cannot learn from the materials, the lower aptitude students will not be able to either. Dick and Carey (1985) suggest selecting at least one student from the target population who is slightly above average in general ability and at least one student who is below average.

During the evaluation, the designer should sit with the students and interact with them as they study the materials (Briggs, 1977). Guidelines for the procedure include:

1. Encouraging students to relax and talk freely about the materials (Dick and Carey, 1985; and Briggs, 1977).

2. Explaining that you are designing a new set of instructional materials and that you would like their reactions to the materials (Dick and Carey, 1985).

3. Pointing out that any mistakes the students make are probably due to deficiencies in the materials and not their intellectual abilities (Dick and Carey, 1978).

4. Pointing out that the observer is not evaluating the student; but the student is evaluating the instructional materials (Butler, 1972).

The designer should try to understand the problems the student is having and try to help the student overcome those problems (Briggs, 1977). At this point in the evaluation process, the post test should not be used as a means of evaluation.
Small group evaluation

The second phase of the formative evaluation is a small group evaluation. Its purpose is to determine if the revisions from the one-to-one evaluations were effective. It should identify the more subtle difficulties that may still exist in the materials and begin to determine the administrative feasibility of using the materials in the desired environment (Briggs, 1977). The appearance of the package should be upgraded and near classroom conditions should be used (Butler, 1972).

The number of people to include in the small group evaluation ranges from six to twenty-four students (Briggs, 1977; Butler, 1972; and Dick and Carey, 1985). They should be representative of the target population and encompass a range of target population abilities. The group should contain low-, average- and high-achievement students; students who are familiar with the subject matter; students who are not familiar with the subject matter; both male and female students; and both younger students and older students (Dick and Carey, 1978).

The procedure begins with the evaluator explaining that the materials are in a formative stage of development and feedback is needed to improved them (Dick and Carey, 1985). The students are provided with all tests and instructional materials. They are asked to study the materials as if they were in the actual classroom situation (Butler, 1972).
Criterion test scores can be used to identify strengths and weaknesses of the materials. Students should be encouraged to work at their own pace. The teacher should provide assistance only when major problems arise.

According to Dick and Carey (1985), once the learning session and testing session is complete, students should be given a questionnaire to fill out. A debriefing session is used so students can describe their reactions to the learning materials. The student reactions will help to identify weaknesses and strengths in the instructional materials.

The following questions should be discussed:

1. Was the instruction interesting?
2. Did you understand what you were supposed to learn?
3. Were the materials directly related to stated objectives?
4. Were sufficient practice exercises included?
5. Were practice exercises appropriate?
6. Did the tests really measure your performance on stated objectives?
7. Did you receive sufficient feedback on practice exercises?
8. Did you receive sufficient feedback on test results?

**Field trial evaluation** The purpose of the field trial phase of formative evaluation is to determine if the previous revisions have been effective. This evaluation will determine the administrative feasibility of using the instructional materials under actual classroom conditions. It is critical that the materials be used in actual classroom conditions
(Briggs, 1977). Materials should closely resemble the final product. The regular instructor and not the instructional designer administers the materials (Briggs, 1977; and Dick and Carey, 1985).

From thirty to fifty students should be used for this step (Briggs, 1977; Butler, 1972; Dick and Carey, 1978). Data to be collected include: 1) test results on pretests, embedded tests, and post-tests; 2) student comment or notation concerning difficulties encountered with the materials; and 3) the students overall reactions obtained from attitude questionnaires. Data that do not suggest ways to revise the materials should not be collected. The information obtained will be used to make final revisions in the instructional system.

The types of data obtained from a formative evaluation are listed below.

From the observer:

1. In what respects are (are not) the materials and media employed in the manner intended by the designer?
2. In what respects does (does not) the teacher carry out the procedures and make the decisions intended?
3. In what respects do (do not) the students follow the general procedures specified?
From the teacher:

1. What practical difficulties are encountered in conducting the lesson?
2. Estimate the degree of interest or absorption of the students in the lesson.
3. What difficulties were encountered in carrying out the intended teacher procedures?
4. How much time will the unit take?

From the student:

1. How likely are you to choose to do the things you learned in this lesson?
2. How likely are you to recommend this lesson to your friends?
3. Results of a test of performance of the lesson's objectives.
4. How much time did it take you to complete the lesson?" (Gagné and Briggs, 1974).

Analysis of the data from the formative evaluation can be done in a number of ways. The first technique is an analysis of individual student achievement. Dick and Carey (1985) analyze data using a table to list the student's name, the entry behavior score, pre-test score, and the post test score. The scores are representative of the percent of the objectives which the student mastered.
The second more detailed method is to use a table containing the student's names on one axis and all the objectives on the other axis. An X is placed under each objective the student is able to achieve. A final percent of the objectives is given by student and by objective. This analysis can help the instructional developer determine if a faulty link exists in the learning hierarchy or task analysis.

Dick and Carey's (1985) third analysis technique is to determine the overall group achievement. Data are displayed graphically with the performance percentage on the vertical axis and the objectives on the horizontal axis. The average percentage ranking for the groups pre-test and post-test are shown for each objective. Once charted, the data should be analyzed to determine entry level behaviors of the students. Pre-test scores should be observed to determine if the group had previously mastered the prerequisite skills necessary to complete the instruction (Dick and Carey, 1978).

**Summative evaluation** In contrast to a formative evaluation, a summative evaluation may be defined as the design, collection, and interpretation of data and information for a given set of instructional materials for the purpose of determining the value or worth of those materials (Dick and Carey, 1978). "Summative evaluation is usually undertaken when development of an instructional entity is in some sense completed, rather than on-going. Its purpose is to permit
conclusions to be drawn about how well the instruction has worked" (Gagné and Briggs, 1974). "The evaluation is called summative because it is intended to obtain evidence about the 'summed' effects to a set of lessons making up a larger unit of instruction" (Gagné and Briggs, 1974).

The summative evaluation process is not an integral component of the systems approach to instructional design, and does not necessarily involve the instructional designer. Therefore, the instructors would analyze the materials in terms of content coverage, statements of objectives, and the relationship of the test instrument to the objectives.

Gagné and Briggs (1974) identified five basic steps in the summative evaluation. They are: identification of intended outcomes, identification of target population and design for the evaluation study, development of evaluation instruments, documentation of instructional process, and preparation of the summative evaluation report.

The following questions would be answered in the summative evaluation.

1. What are comparative costs of the two sets of materials?
2. How much time do students spend studying the materials?
3. Is any special teacher training required for the materials?
4. What are side effects of using any of the materials?
5. What are the long-term effects of using the materials?
6. Will the materials be quickly out-dated or has a system been established for updating them?

Butler (1972) suggests the instructors evaluate high school graduates to determine the qualitative success of the instruction. He states, "Like all productive systems, an instructional system is judged finally by the quality of its product - by weighing output against input."

Degree of revision

Briggs (1977), suggested a standard should be used for determining when the materials no longer need to be revised. "The military decided to establish an 80/80 criterion for determining when materials no longer need to be revised. The 80/80 criterion simply means that when 80 percent of the students achieve 80 percent of the objectives for the unit, then the product is ready for use in the field" (Briggs, 1977). Butler (1972) suggested that each item on the test should be performed with 100 percent accuracy by at least 85 percent of the students. Once this standard is achieved, a final revision is made.

Research findings Komoski (1974) estimated that only about one percent of the materials used in United States public schools in 1974 had undergone formative evaluation. He argued that designers (and commercial publishers) should try
out their materials with at least one student and revise based on information that is obtained. Dick and Carey (1985) state, "Studies have demonstrated that simply trying out materials with a single learner and revising the materials on the basis of that data can make a significant difference in the effectiveness of the materials."

Robeck (1965), found revised instruction produced better results than the original. In his study, he chose one instructional package and had it revised by one student and then the revised version was revised again by another student to create three instructional packages that were then tested. The results indicated, the first single student revision was not significantly better than the original and the second revision was not significantly better than the first revision. Yet, the final revision was significantly better than the original instructional package.

Rosen (1968) involved twenty designers in a study of the formative evaluation process. His results indicated that both sets of revised materials were superior to the original set, and that, in addition, the materials revised on an empirical test data basis were significantly better than the materials revised on the basis of intuition.

"Other studies similar to that of Rosen have been conducted by Baker and Sulzen. Both these studies used a group of instructional designers and both obtained the same
results, namely, the revised instruction produced significantly better learning outcomes than did the original, unrevised instruction" (Briggs, 1972).

Implementation

Bartel (1976) provides a checklist of instructional systems content. He suggests the developer make sure all segments are included before implementation of the system. The checklist is given below.

1. Cover page
2. Table of contents
3. Introduction
   A. Course/program goals and purposes
   B. Nature and scope of the course/program
   C. Length and credit or unit to be earned
   D. Grade level and type of students to be served
   E. Prerequisite and other entrance requirements
4. Division performance objectives
5. Instructional schedule
   A. Sequential and classified listing of tasks
      (manipulative, informational, attitudinal)
   B. Sequential listing of jobs, projects, problems, experiments and/or activities.
   C. Sequential listing of support materials (texts, references, films, instructional sheets)
6. Prepared lesson or session plans
7. Prepared visual aids
8. Prepared instructional sheets
9. Prepared evaluation devices
10. List and sources of texts, references, films . . . 
11. Prepared progress records and charts
12. Other support materials.

During implementation and use of the system, it is continually evaluated.

According to Banathy (1970), the strategies for continual effectiveness are "1) systems monitoring to evaluate continual effectiveness of the system, and 2) performance testing to measure the progressive achievement and terminal proficiency of the learner." Those portions of the system that fall short may need some redesigning and revision (Butler, 1972).

Adoption-diffusion Model

Introduction

The adoption-diffusion model deals with sociological change, overt behavior changes, and communication strategies. Instructional models focus on communications with the learner; the psychological basis for those communications; and knowledge or attitudinal changes (Rogers and Shoemaker, 1971).

The adoption-diffusion concept focuses on the diffusion of innovations into a community with the hope of bringing about social change. An innovation is an idea, practice, or object
that is perceived as new, regardless of the lapse of time since its first use or discovery. Social change is the process of altering the structure and function of a social system. A social system is a collection of units (individuals, informal groups, complex organizations, or sub-systems) that are functionally different but engaged in joint problem solving with respect to a common goal (Rogers and Shoemaker, 1971).

The characteristics of an innovation contribute to different rates of that innovation's adoption. Characteristics that increase the rate of adoption include: 1) relative advantage in economic returns; 2) compatibility with existing practices, values, past experiences, and needs of the receiver; 3) complexity or ease of understanding and utilization; 4) trialability or degree to which the idea can be experimented with on a limited basis; and 5) observability or degree to which the results of an innovation are visible to others (Rogers and Shoemaker, 1971).

People can be categorized according to their rate of innovation adoption. Categories include: innovators, early adopters, early majority, late majority, and laggards. Table 2 summarizes adopter characteristics and communication behavior.

Rogers and Shoemaker (1971) outlined a paradigm of types of social change (Table 3). They identified two types of
<table>
<thead>
<tr>
<th>Characteristic or Behavior</th>
<th>Innovators</th>
<th>Early Adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Time of adoption</td>
<td>First 2.5 percent to adopt new ideas</td>
<td>Next 13.5 percent to adopt</td>
</tr>
<tr>
<td>2. Attitudes and values</td>
<td>Scientific and venturesome</td>
<td>Progressive</td>
</tr>
<tr>
<td>3. Abilities</td>
<td>High level of education; ability to deal with abstractions</td>
<td>Above average education</td>
</tr>
<tr>
<td>4. Group memberships</td>
<td>Leaders in county wide or state organizations; travel widely</td>
<td>Leaders in organizations within the community</td>
</tr>
<tr>
<td>5. Social status</td>
<td>Highest social status, but their farming practices may not be accepted</td>
<td>High social status; looked to be neighbors as &quot;good farmer&quot;</td>
</tr>
<tr>
<td>6. Farm businesses</td>
<td>Largest, most specialized, and most efficient</td>
<td>Large farms; slightly less specialized and efficient</td>
</tr>
<tr>
<td>7. Sources of information</td>
<td>Scientists; other innovators; research bulletins</td>
<td>Highest contact with local change agents; farm magazines; Extension bulletins</td>
</tr>
<tr>
<td>Early Majority</td>
<td>Late Majority</td>
<td>Laggards or Late adopters</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Next 34 percent to adopt</td>
<td>Next 34 percent to adopt</td>
<td>Last 16 percent to adopt</td>
</tr>
<tr>
<td>More conservative and traditional</td>
<td>Skeptical of new ideas</td>
<td>Agricultural magic and folk beliefs; fear of debt</td>
</tr>
<tr>
<td>Slightly above average education</td>
<td>Slightly below average education</td>
<td>Low level of education; have difficulty dealing with abstractions and relationships</td>
</tr>
<tr>
<td>Many informal contacts within the community</td>
<td>Little travel out of community; little activity in formal organizations</td>
<td>Few memberships in formal organizations other than church; semi-isolates</td>
</tr>
<tr>
<td>About average social status</td>
<td>About average social status</td>
<td>Lowest social status</td>
</tr>
<tr>
<td>Slightly larger than average sized farms</td>
<td>Slightly smaller than averaged sized farms</td>
<td>Small farms; low incomes; seldom farm owners</td>
</tr>
<tr>
<td>Farm magazines; Friends and neighbors</td>
<td>Mainly friends and neighbors; radio farm shows</td>
<td></td>
</tr>
</tbody>
</table>

- Early Majority
- Late Majority
- Laggards or Late adopters
Table 3. Paradigm of types of social change (Rogers and Shoemaker, 1971)

<table>
<thead>
<tr>
<th>Recognition of the Need for Change</th>
<th>Origin of the New Idea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal to the Social System</td>
</tr>
<tr>
<td>Internal: Recognition is by members of the social system</td>
<td>I. Immanent change</td>
</tr>
<tr>
<td>External: Recognition may be by change agents outside the social system</td>
<td>III. Induced immanent change</td>
</tr>
</tbody>
</table>

social change - immanent and contact. Immanent change occurs when members of a social system, with minimal external influences, create and develop a new idea. Contact change occurs when sources external to the social system introduce a new idea. Contact change may be selective or directed. Selective contact change results when members of a social system are exposed to external influences and adopt or reject the idea. Directed contact change, or planned change, is caused by outsiders who, on their own or as a representative of a change agency, intentionally seek to introduce new ideas in order to achieve goals they have defined. These people are identified as social change agents.

"There are three sequential steps to social change: 1) invention, 2) diffusion, and 3) consequences. Invention is
the process of developing new ideas. Diffusion is the process of communicating new ideas to members of a social system. Consequences are the changes that occur within a social system over time as a result of the adoption or rejection of the innovation. Social change is, therefore, an effect of communication" (Rogers and Shoemaker, 1971).

Innovation diffusion involves the steps of disseminating information, maximizing interaction, facilitating behavioral action/change, and providing support or service for integration of the innovation. Havelock (1979) saw diffusion as a two-step process that involved dissemination and demonstration. Dissemination would create a widespread awareness of the invention among practitioners while demonstration would provide an opportunity to examine and assess operating qualities of the innovation.

**Adoption-diffusion model**

The traditional view of the innovation-decision process, called the "adoption process," was postulated by a committee of rural sociologist in 1955, as consisting of five stages:

1. **Awareness stage.** The individual learns of the existence of the new idea but lacks information about it.

2. **Interest stage.** The individual develops interest in the innovation and seeks additional information about it.

3. **Evaluation stage.** The individual makes mental application of the new idea to his [her] present
and anticipated future situation and decides whether or not to use it.

4. Trial stage. The individual actually applies the new idea on a small scale in order to determine its utility in his [her] own situation.

5. Adoption stage. The individual uses the new idea continuously on a full scale. (Rogers and Shoemaker, 1971)

These stages do not always occur in the above order. The only exception is that awareness must occur before the innovation can be adopted.

Recent diffusion researchers have come up with a new adoption-diffusion model (Figure 6).

The steps for this model are:

1. Knowledge. The individual is exposed to the innovation's existence and gains some understanding of how it functions.

2. Persuasion. The individual forms a favorable or unfavorable attitude toward the innovation.

3. Decision. The individual engages in activities leading to a choice to adopt or reject the innovation.

4. Confirmation. The individual seeks reinforcement for the innovation-decision he [she] has made, but he [she] may reverse the decision if exposed to conflicting messages about the innovation.

This model contains three major divisions; antecedents, process, and consequences. Antecedents are those variables present in the situation prior to the introduction of an
Paradigm of the innovation-decision process.

(ANTECEDENTS)

Receiver Variables
1. Personality characteristics (e.g., general attitude toward change)
2. Social characteristics (e.g., cosmopolitanism)
3. Perceived need for the innovation
4. Etcetera

Social System Variables
1. Social System Norms
2. Tolerance of Deviancy
3. Communication Integration
4. Etcetera

(PROCESS)

Communication Sources

(KNOWLEDGE) → (PERSUASION) → (DECISION) → (CONFIRMATION)

(Channels)

Perceived Characteristics of Innovations
1. Relative Advantage
2. Compatibility
3. Complexity
4. Trialability
5. Observability

(CONSEQUENCES)*

Adoption → Continued Adoption
Discontinuance → 1. Replacement
2. Disenchantment

Later Adoption → Continued Adoption
Rejection → Continued Rejection

*For the sake of simplicity we have not shown the consequences of the innovation in this paradigm but only the consequences of the process.

Figure 6. Paradigm of the innovation-decision process (Rogers and Shoemaker, 1971)
innovation. Antecedents consist of: the individual's personality characteristics (such as general attitude toward change); social characteristics (such as cosmopolitanism); and the strength of his [her] perceived need for the innovation (Rogers and Shoemaker, 1971). The process refers to the communication strategies used. The consequences include individual decisions to adopt the innovation and the overall effect of innovation adoption on the community.
THE ADOPTION-DIFFUSION INSTRUCTIONAL MODEL

An adoption-diffusion instructional model was developed to serve as a guideline for development of the instructional package on woodland management. This model incorporates the adoption-diffusion process with instructional systems models.

The adoption-diffusion process is built around the social change process. It deals with overt behavior changes and communication strategies to bring about sociological change. Determining societal needs and finding solutions for those needs is a part of the adoption-diffusion process.

Instructional systems models emphasize the importance of carefully structured instructional materials defining what the student will learn. They focus on communications with the learner, the psychological basis for those communications, and knowledge or attitudinal changes.

As opposed to the adoption-diffusion model, many instructional models only implicitly consider societal needs. The purpose for developing this model was to incorporate adoption-diffusion components into an instructional systems model to encourage deliberate inclusion of social change strategies. Those strategies include identifying societal needs, considering innovation characteristics, developing adoption strategies, and implementing diffusion strategies.

The formal school system has a tremendous potential for initiating social change. Teachers serve as role models and
potential change agents. The adoption-diffusion instructional model was developed to utilize the social change potential provided by the formal school setting.

There are twelve components to the model. They are:

1. Conduct a needs assessment;
2. Identify the instructional goal;
3. Consider the innovation;
4. Analyze subject matter to determine topic/subtopic hierarchy;
5. Identify unit goal and unit objectives for each topic area;
6. Develop performance objectives for the sub-topic areas;
7. Develop criterion-referenced tests;
8. Consider adoption strategies;
9. Evaluate and select instructional materials;
10. Develop instructional schedules and educational strategies;
11. Conduct formative evaluations and revisions; and
12. Implement system using diffusion strategies (See Figure 7).

Conduct a Needs Assessment

The first step in the adoption-diffusion instructional systems model is needs assessment. Normative, comparative, anticipated, felt, and expressed needs are considered in the
Figure 7. Adoption-diffusion instructional model
needs assessment. It contains four parts. They are: clarifying the problem; reviewing past and existing problem-solving strategies; searching for duplicate efforts; and assessing target audience needs. Collectively, these segments assure the need for development of an instructional system and provide information for developing a useful product.

**Clarify the problem**

The first step in the needs assessment was problem clarification to indicate "what is" and "what ought to be." Future needs, anticipated needs, and comparative needs were identified using a literature review and informal conversations with professional foresters.

Iowa is faced with diminishing woodland quality and quantity. According to the 1832-1859 Surveyors Notes, Iowa originally had 6.68 million acres of timber. In 1954, there were 2.3 million acres of commercial forest land in the state. The last tally in 1974 indicated Iowa had 1.56 million acres of timber (Spencer and Jakes, 1980). This represents a decline of 5.12 million acres of timber since 1832. If the present rate of decline continues, Iowa will have virtually no forest cover by the year 2017.

The quality of Iowa's woodlands has also deteriorated. Highgrading of Iowa's woodlands has drastically reduced the quality of the timber resources. In the past, landowners have harvested timber using primarily a "select the best and leave
the rest" harvesting technique. This harvesting of the superior quality trees has left the poorer quality trees to regenerate the forests.

Grazing of Iowa's woodlands has also decreased woodland quality. It is estimated that about three-fourths of Iowa's woodland owners allow grazing in their woodlands (Wray and Hildebrandt, 1985). Grazing animals compact the soil, eliminate most understory vegetation, and thus, increase the rate of surface water runoff. They also trample and consume seedlings. Continued heavy grazing converts the woodland area to pasture within 50 to 100 years.

The diminishing quality and quantity of Iowa's woodlands have contributed to increased soil erosion. An average annual rate of 9.9 tons of soil is lost for each acre of cropland in Iowa per year. This rate is almost double the allowable rate set by the Soil Conservation Service. According to the Field Office Technical Guide for Soil Conservation Society in March 1985, the 718,000 acres of ungrazed Iowa timber lost about one ton of soil per acre, while 796,000 acres of grazed timber lost an average of almost 4.3 tons of soil per acre (Soil Conservation Service, 1985). Converting marginal farm lands into properly managed ungrazed woodlands, could reduce the amount of annual soil erosion.

In Iowa, lands that are sensitive to soil erosion problems include: steep slopes, many forest derived soils, and United
States Department of Agriculture Soil Conservation Service Land Capability Classes Ve, VIe, and VII. Areas containing the above land capability classes should be maintained as grassland or timber. According to the 1982 Natural Resource Inventory, 2,364,200 acres of Iowa's lands fall into these categories (Soil Conservation Service, 1982). Of those acres 1,718,500 are in woodlands or pasture.

The Department of Natural Resources - Forestry Division has a goal of increasing the amount of woodland in Iowa by three million acres. State Forester, Gene Hertel, estimated that converting eighty-four percent of the areas in land capability classes V, VI, and VII to forest land would satisfy this goal and at the same time protect the basic soil resources and yield products and amenities for all Iowans on a continuing basis (Iowa Conservation Commission, 1984).

Woodland management can provide numerous economic and non-economic benefits to the landowner and the public. Woodlands can increase the aesthetic beauty of Iowa's landscape and help the state's tourism industry. Woodlands provide habitat for wildlife. This, in turn, provides a setting for recreational activities such as picnicking, hiking, birdwatching, and camping for landowners and others.

Benefits from Iowa's woodlands take many forms and can provide economic returns from: firewood production, nut production, trees for recreation areas, Christmas trees, and
sawlogs and veneer logs. Recreation and wildlife can also provide economic returns. The Iowa Department of Natural Resources (formerly the Iowa Conservation Commission) has sold over 138,000 general hunting licenses annually for the past five years (Iowa Conservation Commission, 1986). By maintaining appropriate woodland habitat and wild areas, landowners can increase game species. By marketing these areas as private hunting resorts, landowners can obtain a seasonal income.

For the needs assessment, the problem statement should indicate the current situation and future desired directions. Presently, in Iowa many landowners are not managing their woodlands for any given objective or benefit. As a result Iowa's woodlands are not reaching their full potential for yielding products and amenities. In the future, woodland stewardship and woodland management need to become a part of the traditional farm operations. More emphasis needs to be placed on the economic and non-economic benefits that are provided by proper woodland management. This can be accomplished, in part, by the development and implementation of instructional materials on woodland management for high school youth.

Review past and existing problem-solving strategies

Existing approaches to solving the woodland management problem were reviewed. Information was gathered using
existing literature and communications with forestry and agriculture professionals. The merits of developing an instructional system were also reviewed, at this point.

Programs, services, and incentives aimed at encouraging proper woodland management are presently being offered by: Iowa State University Forestry Department, Forestry Extension at Iowa State University, County Extension Staff, County Conservation Boards, the Department of Natural Resources - Forestry Division, private organizations, and government legislation. The majority of these efforts are provided for the adult population.

These organizations and agencies provide a variety of problem-solving strategies. Those strategies include: written communications, field demonstrations, media presentations, inservice training for professionals, workshops for landowners, free technical forestry assistance, tax incentives, land preservation/donation services, support organizations, and youth programs.

Various youth organizations provide forestry-related programs. However, youth programs, including Forestry Extension programs, 4-H Extension programs, scouting programs, school curricula and related activities, and vocational agriculture programs, typically do not focus on proper woodland management. Many youth programs tend to focus on forest
ecology, tree identification, and general environmental awareness.

**Written communications** Publications on forestry related topics are provided by U.S.D.A Forest Service, Society of American Forester, Forestry Extension, and Iowa Department of Natural Resources - Forestry Division. Forestry Extension provides the majority of written communications. They have developed over 100 publications available on the topics of Christmas tree production, firewood production, plantation establishment, timber harvesting and marketing, wood product utilization, urban forestry, and house construction and maintenance. These materials are available to the public, free of charge. They also distribute the *Woodland Owners Newsletter* to about 13,000 people biannually. The newsletter includes seasonal forestry topics, information on upcoming forestry field days and other forestry-related events.

**Field demonstrations** The Iowa State University Extension Service in cooperation with the Iowa Department of Natural Resources - Forestry Division and Wildlife Division, and the Soil Conservation Commission provide forestry field days. During the 1985-86 program year Forestry Extension provided subject matter expertise for 18 forestry field days.

County Extension Staff are responsible for promoting and organizing field days. According to documentation in "Staff Days Expended for Fiscal Year 1984 For October 1, 1983, to
September 30, 1984," county extension professionals and para-professionals expended 194.75 days or 1558 hours on woodland management topics (Iowa State University Extension Service, 1984). The average number of hours per region ranged from 1 hour per county per year in the northwestern part of the state to 42 hours per county per year in the southeastern part of the state. The majority of that time is spent on planning and organization of forestry field days.

Forestry field days are used to demonstrate woodland management strategies applicable to Iowa. Topics include: tree plantation establishment and care, Christmas tree production, silvicultural treatments, harvesting and marketing, and chainsaw safety.

Forestry Extension Staff and the County Extension Staff also provided 13 windbreak schools.

**Media presentations** Since 1980, the Department of Natural Resources - Forestry Division has developed a slide presentation on woodland management. Presently, the Iowa Chapter of the Society of American Foresters has established a task force for promoting forestry in Iowa. Their initial proposal is for the development of a video-taped presentation on the economics of woodland management. The intended audience would be local bankers and investors.

**Inservice training for professional foresters** The Iowa State University Forestry Department provides various work-
shops for professional foresters in Iowa. Since 1980 workshops have included: Timber Tax Management, a Computer Shortcourse for Natural Resource Managers, the 1985 Northeastern Nurserymens Workshop, and the Midwest Forest Economist Meeting. Both Iowa State University Forestry Department and the Forestry Division of the Iowa Department of Natural Resources provide inservice training and staff improvement opportunities for their employees.

**Free technical forestry assistance** The majority of free technical assistance is provided by the Department of Natural Resources - Forestry Division. District foresters are available to visit landowners and provide technical forestry assistance on woodland management options. They work one-to-one with the landowner. Typically, a management plan is developed for the landowner. Forestry Extension also provides technical information.

**Tax incentives** Tax incentives are available to woodland owners. A recent change in the tax laws will not be as favorable as past tax incentives. Prior to December 31, 1986, tax incentives included: capital gains benefits for the sale of stumpage; tree planting tax incentives to help landowners regain some of the costs of tree planting; and forest reserve to eliminate property tax on qualified forest land. After December 31, 1986, the capital gains rate has
been made the same as the ordinary income rate. Also the concepts of active and passive income were implemented.

Private support organizations Iowa Tree Farm Committee, Iowa Christmas Tree Growers Association, Iowa Wood-Using Industries Association, Iowa Nut Growers Association, Iowa Natural Heritage Foundation, state and local level recreation agencies, and a variety of environmental groups have an interest in maintaining Iowa's woodlands. The Iowa Tree Farm Committee is primarily interested in woodland management. The participants must follow a management plan. This organization provides incentives in the form of awards and recognition. The Iowa Christmas Tree Growers Association, Iowa Wood-Using Industries Association, and the Nut Growers Association provide a support group for those individuals interested in the associated forestry areas. In 1986, a grant was provided by the U.S.D.A. Forest Service to the Iowa Department of Natural Resources - Forestry Division for the development of an "Iowa Woodland Owners Association." This association is being developed to promote woodlands in Iowa from the multiple use aspect - erosion control, recreation, wildlife, water quality, and timber production.

Land preservation/donation services Of the groups mentioned above, the environmental groups, recreation area managers, and the Iowa Natural Heritage Foundation are concerned with establishing preservation or conservation
areas. Many such areas include forest resources. The Iowa Natural Heritage Foundation has helped set aside over 5,200 acres of forest land for recreation or preservation. The Nature Conservancy has been instrumental in protecting 31,364 acres of natural areas. Iowa Natural Heritage Foundation, Nature Conservancy, and many County Conservation Boards have had land donated or willed to them as "Life Income Gifts" because of the tax advantages.

**Youth programs** The Iowa State University Cooperative Extension Service provides forestry-related youth programs and services. Conservation education sessions have been provided to schools, 4-H groups, and scout groups. State-wide activities include Trees For Tomorrow Workshop - a career exploration workshop, Trees for Schools Program and the Forestry Consortium Awards at the Hawkeye Science Fair. A "Trees for Schools" program was established in 1986 as a part of the "Year of the Tree" state-wide effort. The program was developed to promote resource conservation, providing opportunities for learning experiences, and enhancing the beauty and utility of school grounds. Forestry extension staff at Iowa State University are responsible for administering the program.

County extension staff organize many of the county-wide environmental day camps for schools. They rely heavily on
university extension subject matter specialist to provide the sessions.

The Extension Service's 4-H program offers a Forestry project to its members. Since 1983, the National 4-H Forestry Materials have been used for the Forestry project. Iowa does not have a large enrollment in forestry projects. Each summer the 4-H program also provides a camp called the "Iowa Youth Conservation Leadership Workshop." A half day session on tree measurements and forest ecology is provided at this workshop. Approximately seventy-five young people are reached each year.

Scouting programs include a forestry badge in their program. The scout must complete a list of tasks in order to get the badge. The requirement includes learning about tree identification, forest fire control, forest ecology, and types of forest communities in Iowa. Some scouting programs also include forestry in their careers materials.

Forestry is most often included in elementary school curricula. Most often it is included as one topic within a science or environmental camp outing. The most common topic taught is tree identification. Teachers also have "Project Learning Tree" activity materials available to them.

Vocational agriculture programs are provided for both adult and youth populations. Although no recent data is available, "in 1970-1971 data revealed that vocational agriculture departments in Iowa provided a mean of twenty
hours per year of instruction to high school students and adult farmers on horticulture-forestry and landscaping. Instructors providing the most instruction in horticulture-forestry were in the western livestock area (24 hours) and northeast dairy area (23 hours). Variation in the amounts of instruction in horticulture-forestry provided in the other areas and within these two economic areas did not signify wide differences among the economic areas" (Severance, 1972).

Iowa Department of Natural Resources - Forestry Division also provides youth programs on forest ecology, biology, and management. These programs are provided on an "as requested" basis.

**Summary - development of a new instructional package**
Since Iowa continues to have a problem of diminishing forest resources, program efforts need to continue. In the past, the majority of these programs have been provided to adults. Typically, the adults who participate in the programs already have an interest in managing their woodlands. Some are already actively managing their woodlands. An approach needs to be developed to reach those woodland owners who are not already advocates of proper woodland management.

Developing an instructional package on woodland management would work toward this goal. This package would reach the younger population before they develop land use strategies. The instructional package would provide information about
woodland management so young adults could incorporate woodland management strategies into their future agriculture operations. This approach, in the long run, may help bring about both attitudinal and behavioral changes.

Iowa high school vocational agriculture students make up a large percentage of the population of future landowners and managers of Iowa's woodlands. Implementation of the woodland management unit into Iowa's high school vocational agriculture programs would give future landowners working knowledge of woodland management. This knowledge could encourage prudent land use practices including woodland management and stewardship.

Search for duplicate efforts

To avoid duplication of efforts, a literature search was conducted to locate existing instructional materials. Those materials were reviewed to determine if they could be adopted or modified to fit the situation. The data based searches are listed below.

1. Iowa State University Parks Library
   b) Master's Theses in Arts and Social Sciences vol. 1-5 (1976-1981)
   c) Master's Theses in Education vol. 25-31 (1975-1982)
Thirty-four sets of instructional materials were located as a result of these searches. Twenty of the thirty-four sets focused on forestry occupations or careers. Six of the instructional materials related to large-scale forestry. One set of instructional materials focused on harvesting forest products. One set of instructional materials addressed chainsaw safety.

Six sets of instructional materials related to woodland management. One vocational agriculture instructional package
was entitled, "Forestry Curriculum Guide" (Curtis, 1974). These materials focus on tree identification, and timber measurements, pine and hardwood log grading, and silvicultural systems. While isolated sections of this package could be modified for use, it does not address Iowa's woodland situation nor Iowa's biotic or climatic conditions. Wisconsin State Vocational Agriculture Departments have the following instructional unit: "Forestry Manual for Vocational Agriculture Instructors," (Wisconsin Association of Vocational Agriculture Instructors, 1976). This unit focused on small- and medium-scale forest industry operations and potential career opportunities more than woodland management. The New York unit was entitled, "Modules in Agriculture Education Forestry" (New York State Education Department, 1975). Topics include: forest fire control, harvesting timber and pulp, operating timber harvesting equipment, marking timber, timber and log conversion, Christmas tree production and marketing, and maple syrup production. The units on harvesting timber and Christmas tree production would be compatible with Iowa landowner objectives. This unit was developed in the 1970s and focuses on New York's biotic and climatic conditions. Iowa Department of Public Instruction included an eight page outline for Forestry within the "Curriculum Guide In Agriculture Resources and Conservation" (Iowa State University and the Department of Public Instruction, 1973). Ohio
Department of Public Instruction had a teachers handbook entitled "Harvesting Forest Products: A Teachers Handbook." Missouri has a forestry unit entitled, "Forestry For Agriculture Science II" Volume 17, Number 8 (Stewart and Mullinix, 1985). Topics within the unit includes: tree identification, tree planting, tools and equipment, measuring standard timber and logs, timber stand improvement, growing and marketing Christmas trees, and producing walnut timber.

The Agriculture Education Department at Iowa State University has recently begun to develop instructional materials dealing with forestry. In December of 1985, a grant for the Forestry and Agriculture Education Departments at Iowa State University was provided by the Career Education Division of the Iowa Department of Public Instruction to develop instructional units in firewood production and Christmas tree production. These units were developed by Wade Miller, Reinee Hildebrandt and Steve Eckles and are included in the instructional package discussed here.

Another important source of Forestry related materials is the nationally and internationally recognized curriculum guide - "Project Learning Tree" (American Forest Institute and the Western Regional Environmental Education Council, 1977). It consists of a collection of general forestry related educational activities. It does not specifically address Iowa's woodland management problem. Project Learning Tree
does contain activities that could be used by qualified instructors to supplement materials in the proposed instructional package.

In 1983, the University of Northern Iowa's – Institute for Environmental Education in cooperation with the Department of Public Instruction and the Iowa Natural Heritage Foundation developed a packet of environmental education activities entitled, "Project Outlook" (Iowa Natural Heritage Foundation, 1983). Topics related to woodland management include: land use, natural habitat, soils, and heritage. Activities from those topic areas could be used, by qualified instructors, to supplement the woodland management instructional package discussed here.

With the exception of the units developed by Iowa State University Departments of Agriculture Education and Forestry, no suitable materials were located. The materials identified did not address improving small scale woodland management as it relates to Iowa.

Iowan's needs to understand multiple benefits derived from woodland management. Instructional materials need to help students understand how to incorporate woodland management options with more prevalent agriculture options. They need to provide "how-to" information about the multiple benefits of woodlands. Since the other instructional materials do not do
this, the development of an instructional package on woodland management would not be a duplication of efforts.

Assess target audience needs

Needs surveys were conducted to determine the needs of the individuals involved with the instructional package. Vocational agriculture instructors and professional Foresters were surveyed. A literature search was completed to determine student characteristics and needs.

Vocational agriculture instructors survey The first survey was sent to vocational agriculture instructors. They will be implementing the instructional system and will serve as social change agents. The purpose of the survey was to determine if they perceived a problem. The survey was also used to determine their interest in incorporating woodland management into their curriculum. This step focused on normative, expressed, and felt needs.

The survey was sent to all 256 vocational agriculture instructors in the State of Iowa. The list was obtained from the Department of Public Instruction - Vocational Agriculture Section and from a list used to distribute the Forestry Extension's Woodland Owners Newsletter. There were two mailings. One hundred and sixty-one surveys were returned after the first mailing. A second mailing of 107 surveys was sent to people not responding to the first mailing. Fifty-six non-duplicated surveys were returned. Therefore, the total
number of responses was 217 out of 256 or eighty-five percent response.

Background information such as school name, number of vocational agriculture students, number of classes taught, and staff size was obtained. The next question was whether forestry was currently taught as a part of their vocational agriculture curriculum.

If it was not taught, instructors were asked to give reasons why not. Then they were asked if they would use a pre-packaged woodland management unit if one were developed. If they were not interested in using a pre-packaged unit, they were asked for their subject materials source, whether they had any students with forestry projects, and whether they would attend an inservice in forestry. Instructors who would use the instructional package were asked to prioritize the list of instructional materials they would like to use.

Those instructors who presently included forestry as a topic were asked to indicate whether it was taught directly as a separate topic or indirectly through another topic. Regardless of whether they taught forestry directly or indirectly, both groups were asked to prioritize the list of instructional materials and to give their sources for obtaining information. Both were then asked whether they would use a pre-packaged woodland management unit. The remaining questions are the same as mentioned earlier for
those not teaching forestry. The instructors that taught forestry indirectly were asked to list the topic areas or courses in which they included forestry. All categories of respondents were given the opportunity to give additional comments.

Survey results Respondents were categorized into three groups: 1. those who do not teach forestry presently; 2. those who do teach forestry indirectly through another course topic; and 3. those who teach forestry directly as a separate unit.

The total number of respondents who presently do not include forestry is 145, (67 percent) of the total respondents. Of those respondents, 126, (87 percent) would be interested in implementing forestry if a woodland management instructional package were developed. Based on their stated class sizes, this could mean an increase in excess of 5000 youth clientele each year.

When the respondents were asked their reasons for not including forestry in their present curriculum, responses included: lack of background preparation (82 responses), no materials available (75 responses), not applicable to their county (32 responses), they never thought of it (31 responses), and other reasons (17 responses). Of those instructors who felt they lacked background preparations,
sixty respondents, (73 percent) would be interested in attending an inservice training.

Of the group of instructors who do not presently teach forestry, nineteen instructors, (13 percent) were not interested in including forestry in their curriculum even if an instructional package were developed. Of those nineteen, sixteen instructors responded that it was not applicable to their county, two people mentioned lack of materials, five people included lack of background preparation, and one indicated that he/she never thought of it. Figure 8 shows the location of Iowa vocational agriculture instructors who are not interested in including a woodland management unit.

Sixty-three individuals, (29 percent) teach forestry indirectly through other courses. Forestry is included in soil conservation by thirty-eight instructors, in horticulture by thirty-two instructors, in natural resource management by twenty-four instructors, in farm management by eighteen instructors, in landscape architecture by seventeen instructors, in agriculture buildings by eleven instructors, and six instructors indicated other courses including Ag Resources, Pruning, FFA Nursery, Farmstead, Crop Production, and Exploratory Class.

Of this group, fifty-eight instructors indicated an interest in implementing a unit on woodland management if it were developed. Five instructors would not be interested.
Figure 8. Location of vocational agriculture instructors not interested in teaching woodland management
Forestry is presently taught in ten vocational agriculture courses. A total of 545 students are presently being reached with forestry materials. The time spent on this unit ranged from one week to eighteen weeks. The median is four weeks (see Figure 9).

All instructors who indicated they would use a pre-developed instructional package were asked to prioritize the list of instructional materials. Using only the respondents first and second priority choices, a prioritized list was developed. The prioritized list includes: filmstrips/films (77); transparencies (61); slide/tape (59), lectures (42), computer programs (35); group activities (26); experiments/labs (20); individual projects (10); field trips (9); video tapes (7); and posters (1). Additional suggestions included student worksheets, quizzes, learning activities, information sheets, and handout information.

Professional foresters survey results The second survey was sent to professional foresters around Iowa. The purpose of this survey was to gain information on regional woodland management priorities. It was also used to determine if they felt the development of an instructional package would work toward solving Iowa's woodland management problem. Expressed, future, and comparative needs were the basis for subject matter selection by the field foresters.
Figure 9. Time presently spent teaching forestry in Iowa high school vocational agriculture classes.

(Number of Weeks)
Figure 9. Time presently spent teaching forestry in Iowa high school vocational agriculture classes (Teaching Forestry in 1983)
(77); transparencies (61); slide/tape (59), lectures (42), computer programs (35); group activities (26); experiments/labs (20); individual projects (10); field trips (9); video tapes (7); and posters (1). Additional suggestions included student worksheets, quizzes, learning activities, information sheets, and handout information.

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The survey was sent to the twenty-nine professional foresters in the state of Iowa. Twenty-four responses were received. Ninety-one percent of the professional foresters agreed that an instructional unit on woodland management for high school vocational agriculture courses was needed.

All respondents agreed the topics of woodland management and planting/growing trees should be included. Ninety-one percent of the respondents agreed the topics of timber harvest, timber marketing, and fuelwood management should be included. Over seventy-five percent suggested the topics of Christmas tree management, wildlife management, soil
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Responses from Department of Natural Resources District Foresters about regional woodland management concerns were recorded by geographic area (Figure 10). The responses indicate information needs, land owner concerns as expressed to the foresters, and land use problems noticed by the field foresters.
Figure 10. Regional woodland management concerns as noted by Department of Natural Resources District Foresters
Additional comments were as follows. One forester was concerned about schools eliminating vocational agriculture programs due to lack of funding. One survey respondent was concerned about vocational agriculture instructors not having a forestry background. Two foresters were concerned about the approach. They felt there was a need to raise the environmental consciousness rather than teach management. The individuals providing positive comments expressed enthusiastic support for the project.

Overall, the survey respondents expressed an interest in the development of an instructional package for high school vocational agriculture courses.

Learner characteristics The literature search provided little specific information about vocational agriculture students. However, general high school student characteristics were obtained. Appendix A provides a summary of the socio-psychological, physical, and emotional characteristics of high school students.

No formal documents concerning learner aptitudes or learner characteristics were located. Specific characteristics were obtained through verbal communications with professionals in the Agriculture Education Department at Iowa State University and professionals employed with the State Department of Education. The general consensus was that vocational agriculture classes contained students with a range
of aptitudes and abilities. On the average, however, the class would be average to slightly below average in aptitude and ability.

Identify Instructional Goal

The instructional goal provides the overall direction for the instructional unit. It is a broad statement of what the students will be able to do upon completion of the instructional package.

To identify an instructional goal, the agency's, institution's, or organization's philosophy needs to be considered. The philosophy for both the agency developing the instruction and the agency receiving the instruction should be compared. The agencies philosophies must be compatible. The problem statement identified in the needs assessment should also be reviewed to determine if the agencies philosophies and programming efforts would include such a problem.

Given the above considerations, a broadly stated instructional goal is written. The goal statement must be within the scope of the agencies philosophies. It should explain the desired outcome and overall direction of the instructional package. Once the statement is written it should be evaluated to see if it is truly compatible with both agencies philosophies.
Review philosophies

Vocational education, as intended under the Smith-Hughes Act, is to endeavor to develop our system of education so that all may have the opportunity of training for an occupation. "According to the Smith-Hughes Act, the present plan of instruction requires work of less than college grade and is designed to train practical farmers rather than to endeavor to make specialist of a chosen few" (Martin, 1929).

Today, the same basic underlying intent exists. The mission statement has, however, been expanded to include consideration of special populations and existing agricultural administrative focuses. The goal of Iowa's vocational education programs for fiscal years 1986-88 is: "To provide instructional programs and activities that contribute to the economic growth of the state, to provide equity of access to a diversity of quality vocational education programs, so that persons of all ages in all communities of Iowa, those in high school, those who have completed or discontinued their formal education, those who need to upgrade their skills or learn new ones, those with special education handicaps, and those presiding in a merged area school district will have ready access to vocational training or re-training, which is realistic in the light of actual or anticipated opportunities for gainful employment which is suited to their needs,"
Interests, and abilities to benefit from such training" (Iowa State Board of Education, 1985).

Extension's philosophy is to help people identify their own problems or opportunities and then to provide practical, research-based information that will help them overcome the problems or take advantages of opportunities. Community needs help determine research needs, in turn, research results provide curriculum content for Extension programs. The various disciplines within the land grant system collaborate with many people. Collectively, the team can assume a better quality of life, both for Americans and for our neighbors in developing nations (Vines and Anderson, 1976).

The Extension service and the vocational education program have a common underlying concern, that is, to help local community members identify and meet their needs. Extension focuses on disseminating research-based information and providing "hands-on" demonstrations to help meet those needs. The vocational agriculture program focuses on occupation-oriented needs. It typically focus on task-oriented information that is presented in a "learn-by-doing" technique.

Consider the problem statement

Solving the problem of Iowa's declining woodlands is compatible with both the vocational agriculture and extension service philosophies. The instructional unit would make landowners aware of the problem and provide research-based
information on woodland management. This approach complies with the Extension Service philosophy. The unit would focus on future woodland owners. Therefore, it should be occupation-oriented. "Hands-on" learning experiences should be included in the teaching procedure and implicit within the instructional goal.

Instructional goal statement

The goal of this instructional package is: Upon completion of this woodland management instructional package, the students will know the benefits and importance of Iowa's woodlands as they relate to land use. They will be able to manage a woodland area according to the benefit(s) they desire to produce.

Consider the Innovation

The innovation is the development of an instructional package on woodland management for vocational agriculture high school instructors. The instruction provides future landowners with working knowledge of "how to" manage woodlands for multiple benefits. The instruction presents ways to incorporate woodland management into existing farm operations. Exposure to the instruction will provide the student with information for evaluating the viability of woodland management as a part of their farm operation. The desired long-term outcome is to have this knowledge motivate future
farmers to implement woodland management practices into their farm plans.

To consider the innovation, four actions were taken. Innovation attributes that contribute to a faster rate of adoption were compiled from the research materials. These attributes were then modified to this situation and listed. The potential instructional package attributes were identified and listed. The characteristics of woodland management were identified and listed. Finally, the instructional package attributes and woodland management characteristics were compared to innovation attributes. From the comparison, positive attributes that increase the rate of adoption and negative attributes that hinder adoption were identified and listed. Those listings are used as a reference for developing the instructional system. The compatible attributes were considered during the development of the instructional model. During the Adoption Step (discussed on page 116) in the Adoption Diffusion Instructional Model the information generated in the Innovation Step was compared to the final product.

Innovation attributes

Rogers and Shoemaker (1971), identified a list of innovation attributes that help aspire to rapid and successful innovation adoption. The following questions summarize those characteristics:
1. How can the implementors see some economic returns during the four year period?
2. How can the results be observed by the implementor?
3. Can an experimental or trial area be developed on a crop rotation basis?
4. Are the woodland management opportunities easy and understandable for the students to implement?
5. Are the ideas compatible with the existing practices, values, and experiences of the intended user?
6. Is the instructional unit easy to implement and understand how to teach?

Potential instructional package attributes

The following is a listing of desirable instructional package attributes: being well organized, easy to implement, containing readily available written information, containing "hands-on" activity ideas, containing ready made tests and activity sheets, and having a low maintenance (in terms of, time to implement, extra costs, and additional time to organize activities). These attributes were considered during the development of the instructional package.

Woodland management characteristics

Woodland management is a long term investment. To establish a tree plantation or to reforest an area takes an initial dollar investment. This investment does not bring
about immediate cash flow benefits. It can require from forty to eighty years to get a crop from a tree plantation.

There are tree planting tax incentives where landowners can recover the cost of planting trees over a seven to eight year period. However, there is still an opportunity cost associated with plantation establishment. Some farmers can not afford to set aside capital without realizing annual cash flow. Therefore, this characteristic could deter some farmers from plantation establishment.

While existing woodlands may provide immediate income opportunities by marketing woodland products, much of Iowa's timbers are of poor quality. Many existing woodlands would benefit greatly from timber stand conversion or timber stand improvement practices. This again, may require a commitment of time and money without instant monetary return. The exception would be if the landowner could sell the excess timber for firewood.

Most forest management options require periodic labor commitments. Christmas tree production is the exception to the rule. It is labor intensive and requires attention each season. Those options with a minimal labor commitment may be appealing to some landowners.

Finally, woodland communities are more complex than row crop or horticulture systems. To manage these areas, advice of a professional forester may be needed. This list of wood-
land management characteristics was considered in the development of the instructional units.

**Compare instructional package with innovation characteristics**

For the instructional package attributes the following strategies were included:

1. The instructional materials were organized in a format highly recommended by practicing vocational agriculture instructors.

2. The instructional materials included: ready-made handouts, activities, visuals, and tests. These materials will help minimize the amount of preparation time needed by the instructor. They will also make the instruction easy to implement.

3. The materials provided a suggested teaching outline, but were designed in such a way that the instructor could select the sub-topic areas that are compatible with the vocational agriculture curriculum.

4. Field trip ideas and suggestions for media were included. While these options may add extra cost and demand additional preparation time, the instructors have the option whether or not to choose those activities.

In comparing the woodland management strategies, the following ideas were implemented as an attempt to improve the rate of adoption. Four situations were identified.
The first situation deals with the problem that woodland management is a long-term investment. Landowners are concerned about receiving immediate economic returns. This situation provides one of the biggest challenges. Woodland management is a long term project where immediate economic returns are not realized. Incorporating woodland management with traditional agriculture crops operations would continue to provide landowners with annual income while providing periodic woodland incomes during years with poor row crop production. Woodland management can also be incorporated with other non-traditional forms of agriculture. In Creston, Iowa, a local farmer has incorporated forestry with a horticulture "truck farming" operation. Combining slow-return forestry options with other faster-return forestry options is also another non-traditional possibility. Plantation establishment with both fast and slow growing tree species could provide returns for the landowner within ten to fifteen years. Combining nut production with walnut timber production would provide the landowner returns within fifteen years. The above concerns and ideas were addressed in the Sub-topic 6 within the Introduction to Woodland Management Unit. This section encourages a brain-storming session to get students to think of ways of incorporating woodland management into traditional agriculture operations. A list of examples was provided to
serve as a discussion guide for the instructor. Additional suggestions were provided throughout the other units.

The second situation concerns the trialability and observability of implementing woodland management. The long term nature of woodland management limits trialability and observability of the results. Since most forestry options take from 40 to 100 years to obtain results, it is virtually impossible to have a trial run during one person's lifespan. Establishment of "school tree farms" or "woodland demonstration areas" may improve observability. The "Trees for Schools" program, developed in 1985 by the "Year of the Tree" Committee, could be used to establish classroom demonstration areas. Within the instructional package, the "Trees for Schools" Unit was developed to encourage involvement in the Trees For Schools Program. Ultimately, the school could get involved in the "Trees for Schools" program and utilize the remaining woodland management instructional units to learn about managing their school's tree farm.

The third situation focuses on the complexity of woodland management. Woodland management is more complex than row crop production. Background training and education is needed to help people understand its complexity. Several strategies were used to reduce this problem. Within the units, suggestions of guest lecturers and contact persons were provided. In determining the content to be included, it was
assumed that the instructors and students had very little background knowledge. Therefore, both teacher and student information sheets were provided. When discussion activities were included in a unit, a corresponding instructor discussion guide was included. Finally, inservice training was provided prior to dissemination of the materials.

The final characteristic of woodland management is compatibility with practices, past experiences, and needs of the receiver. Professional foresters and other natural resource management officials for a number of years have been trying to encourage landowners to manage woodlands for erosion control, wildlife habitat, recreation, aesthetics, and cash crops. National farm policy is presently aimed at providing incentives for converting poor quality and lower productivity crop lands to timber. Since landowners are presently being encouraged to diversify their farm operations, compatibility might be less of a problem than in the past. This issue is brought to students attention in Sub-topic 6 of the "Introduction to Woodland Management" Unit. However, it can not be solved by a mere exposure to a lesson within an instructional unit. This issue needs to continue to be addressed in national, state, and local farm policies.

Overall, the development of the instructional package incorporated strategies to accent the positive attributes and
characteristic, and to consider the negative attributes and characteristics.

Analyze Subject Matter to Determine Topic/Sub-Topic Hierarchy

Due to the size and complexity of the proposed instructional package, this step was added to provide additional focus and organizational direction. The purpose of this step is to identify woodland management topic areas. The topic and sub-topic areas are then placed into a learning hierarchy.

Major topic areas are identified by reviewing previously developed instructional materials, professional foresters survey summary, and forestry-related publication materials. Other input was provided by various other members of the Forestry Department at Iowa State University. The topics of firewood production, Christmas tree production, and tree planting were repeatedly included in existing vocational agriculture materials. From the survey of professional foresters over 75 percent of the respondents suggested the topics of: timber harvest, timber marketing, fuelwood management, Christmas tree production, wildlife (game) management, soil conservation, tree identification, and wildlife management (non-game).

From this input the following major topic areas were chosen: 1. Trees For Schools Program; 2. Introduction to
Woodland Management; 3. Wood For Energy; 4. Sawlog and Veneer Production; 5. Christmas Tree Production; and 6. Reforesting Iowa (Tree Planting). Below is an outline of the topic and sub-topic areas selected.

Topic 1: Trees for Schools Program
1. Obtain information about the "Trees for Schools" Program
2. Getting financial sponsors or organizing fund raisers
3. Participate in the Trees for School Workshop
4. Choose tree planting unit or units 4-8 and apply to adopted woodland area
5. Write a five year management plan

Topic 2: Overview of Woodland Management
1. Managing Iowa's woodlands—past and present
2. Tree identification
3. The woodland eco-system
4. Benefits from Iowa's woodlands
5. Woodland management techniques

Topic 3: Wood as Energy—Production and Marketing
1. Terminology
2. Pre-cutting activities
   a) Planning a fuelwood cutting
   b) Marketing fuelwood
   c) Chain saw safety
3. Cutting activities
4. Post-cutting activities
   a) Splitting wood
   b) Drying wood
   c) Storing wood
   d) Selling fuelwood

5. Non-traditional wood for energy uses
   a) Biomass production
   b) Energy plantations

6. A firewood business

Topic 4: Sawlog and Veneer Log Production
1. Tree identification
2. Woodland management terms
3. Land management practices affect on woodland quality and quantity
4. Profitable tree species from Iowa woodlands
5. Timber stand improvement
6. Value of individual trees
7. Woodland management plan
8. Timber harvesting and marketing strategies

Topic 5: Christmas Tree Production and Marketing
1. Introduction to Christmas tree production and marketing
2. Starting a Christmas tree plantation
   a) Select marketable species
   b) Select appropriate site
c) Plant trees

3. Maintaining A Christmas tree plantation
   a) Biological problems
   b) Animal damage
   c) Tree shearing

4. Marketing Christmas trees
   a) Marketing survey
   b) Marketing options
   c) Marketing plan

Topic 6: Reforesting Iowa (Tree Planting)

1. Planning a tree planting
   a) Purposes for tree planting
   b) Types of planting stock
   c) Sources of planting stock
   d) Steps in establishing tree plantations
   e) Site preparation

2. Planting Trees
   a) Equipment available for planting trees
   b) Steps in using each type of equipment
   c) Tree planting suggestions for Iowa
   d) Weed control

3. Care and maintenance of tree plantings
   a) Biological problems that affect trees
   b) Controlling animal damage to trees
   c) Weed control
Learning hierarchy

These topic areas were then sub-divided and arranged into the most appropriate teaching order. Dick and Carey's (1985) hierarchical, or combination approach was used to identify and analyze the teaching order for the topics, sub-topics, skills, and objective. Figures 11 and 12 provide an example of the concept for developing the flowcharts.

Establish Unit Goals, Unit Objectives, and Performance Objectives

Each major topic area was developed into an individual unit. A unit goal and unit objectives were developed for each topic. The unit goal is a broad statement of the overall direction of the unit. It tells what overt behavior the student should be able to accomplish upon completion of that particular unit. Table 4 lists the unit goals.

Unit objectives were developed from the sub-topics areas. The unit objective statement was written using action verbs to describe what the student should be able to do upon completion of the associated sub-topic. These objectives form the basis for the individual lessons within the unit. Table 5 lists the unit objectives.

Within each lesson, specific performance objectives were developed to indicate specific tasks, skills, or memorization the student would perform within the unit. The performance
t/o indicates task or objective

Figure 11. Learning hierarchy flowcharts
INTRODUCTION TO WOODLANDS

Goal: Introduce woodland management objectives

- **Topic: Agriculture & Forestry**
  - Discuss how woodland management fits into various operations

- **Topic: History**
  - Inform students of Iowa's woodland history
  - List five benefits derived from our woodlands by early settlers

- **Topic: The Woodland Community**
  - Explain the woodland management role in caring for Iowa's woodlands
  - Describe what a disturbance means for an undisturbed woodland look
  - List the biotic components of the woodland
  - List five benefits derived from our woodlands by present day landowners
  - List the benefits wildlife and insects can provide the landowner

- **Topic: Trees**
  - Provide background information on the function of the individual tree as it relates to the woodland community
  - Explain how a tree grows
  - Identify 20 tree parts
  - List tree functions
  - List parts of a tree
  - Know that a tree is a member of the plant community

Figure 12. Learning hierarchy for "Introduction to Woodland Management"
Introduction to Woodland Management

Introduce the concept of woodland management by objectives.

Agriculture Diversification
Discuss how woodland management integrates traditional agriculture operations.

Woodland Community
Analyze the woodland community.

What a disturbed vs. a well-maintained woodland looks like.

List types of forest communities in Iowa.

Background on the role of the tree as it grows in the community.

Identify at least 20 trees.

List characteristics.

List possible woodland management objectives.

List steps to woodland management.

List woodland management terms.

Explain the pros and cons of various harvesting, regeneration and timberstand improvement strategies.

Define woodland management terms.

Topic: Woodland Management Techniques
4. Given a description, be able to make wise management decisions.

Topic: Introduction to Woodland Management
5. Introduce the concept of woodland management.

Introduction to Woodland Management instructional unit
<table>
<thead>
<tr>
<th>Unit Title</th>
<th>Unit Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees for Schools</td>
<td>Teach students how to be community leaders in the area of natural resources, through their participation in the Trees for Schools Program through Forestry Extension at Iowa State University.</td>
</tr>
<tr>
<td>Introduction to Woodland Management</td>
<td>To introduce the concept of woodland management by landowners objectives.</td>
</tr>
<tr>
<td>Wood As Energy</td>
<td>Manage an existing woodland area or establish a new tree planting for energy production and marketing.</td>
</tr>
<tr>
<td>Managing Woodlands for Sawlog and Veneer Production</td>
<td>Manage an existing woodland area for sustained sawlog and veneer production.</td>
</tr>
<tr>
<td>Christmas Tree - Production and Marketing</td>
<td>Establish and manage a Christmas tree plantation that provides a marketable product.</td>
</tr>
<tr>
<td>Reforesting Iowa - The Establishment and Care of Tree Planting</td>
<td>Plan, implement, and maintain a tree planting.</td>
</tr>
</tbody>
</table>
Table 5. Listing of unit objectives by unit

<table>
<thead>
<tr>
<th>Unit</th>
<th>Unit Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees for Schools</td>
<td>1. General Activities</td>
</tr>
<tr>
<td></td>
<td>2. Tree Planting Activity Suggestions OR Forest Management Suggestions</td>
</tr>
<tr>
<td></td>
<td>3. Developing a Long-term Plan of Action</td>
</tr>
<tr>
<td>Introduction to Woodland Management</td>
<td>1. Inform students of Iowa's woodland management history.</td>
</tr>
<tr>
<td></td>
<td>2. Provide background information on the functions of the individual tree.</td>
</tr>
<tr>
<td></td>
<td>3. Identify at least twenty trees.</td>
</tr>
<tr>
<td></td>
<td>4. Explain the woodland management community.</td>
</tr>
<tr>
<td></td>
<td>5. Introduce the concept of woodland management.</td>
</tr>
<tr>
<td></td>
<td>6. Explain various woodland management techniques and introduce key terminology.</td>
</tr>
<tr>
<td></td>
<td>7. Determine ways woodland management can be a part of traditional farm operations.</td>
</tr>
<tr>
<td>Wood as Energy</td>
<td>1. Explain how wood for energy production can help improve our woodlands.</td>
</tr>
<tr>
<td></td>
<td>2. Explain what a person should know before they begin cutting down trees for fuelwood.</td>
</tr>
<tr>
<td></td>
<td>3. Determine the proper steps to take in cutting down trees for fuelwood.</td>
</tr>
<tr>
<td></td>
<td>4. Explain the post-cutting activities a person should do before marketing or utilizing fuelwood.</td>
</tr>
<tr>
<td></td>
<td>5. Determine strategies for marketing fuelwood.</td>
</tr>
<tr>
<td></td>
<td>6. Explain non-traditional wood for energy options.</td>
</tr>
<tr>
<td></td>
<td>7. Establish a firewood business.</td>
</tr>
<tr>
<td>Managing Woodlands for Sawlog and Veneer Production</td>
<td>1. Know how to identify trees of commercial value in Iowa.</td>
</tr>
<tr>
<td></td>
<td>2. Describe how a tree grows.</td>
</tr>
<tr>
<td></td>
<td>3. Determine potential value of an individual tree.</td>
</tr>
<tr>
<td></td>
<td>4. Explain the complex ecosystem of the woodland.</td>
</tr>
<tr>
<td>Unit</td>
<td>Unit Objectives</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Managing Woodlands for Sawlog and Veneer Production Continued | 5. Explain how land management practices affect timber quality.  
6. Define woodland management terms.  
7. List woodland regeneration strategies.  
8. Develop woodland protection strategies.  
9. List timber harvesting and marketing strategies and describe the benefits and drawbacks of each strategy. |
| Christmas Tree Production and Marketing | 1. List some advantages for Christmas trees in Iowa.  
2. Describe what is involved in starting a Christmas tree plantation.  
3. Explain the key factors in maintaining a Christmas tree plantation.  
4. Know how to determine if a market exists for Christmas trees.  
5. Determine several marketing strategies for Christmas trees. |
| Reforesting Iowa - The Establishment and Care of Tree Plantings | 1. Planning a tree planting, given a specific management objective.  
2. Plant trees correctly.  
3. Care for and maintain a tree planting. |
objectives were written using action verbs. When necessary, the performance objectives specify under what conditions and to what degree of competency the student will be able to complete the objective. A specific degree of performance was not included so that each instructor would have the option of establishing their own standards given the specific group of students they are working with. Table 6 provides an example of the unit objectives.

The performance objectives tell what the learner is expected to be able to do. They use verbs that denote observable action, and they specify resources (objects) to be used by the learner. They tell under what circumstances the learner is expected to perform unless the objective is to be completed by classroom attendance and taking a test. When the circumstance was specified, the physical or situational circumstances and psychological conditions were listed.

Once the list of objectives was completed, each objective was analyzed. The criteria were as follows. How does this objective describe what is expected? Does it use verbs denoting observable action? Does it indicate the stimulus that is to evoke expected behavior? Does it specify resources to be used and the persons with whom to interact? How does the objective state the circumstances under which the learner is expected to perform? Is this circumstance realistic?
Table 6. Performance objectives by sub-topic for the "Introduction to Woodland Management" unit

<table>
<thead>
<tr>
<th>Sub-topic</th>
<th>Performance Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing Iowa's Woodlands - Past, Present, and Future</td>
<td>1. List five benefits derived from our woodlands by the early settlers and present day landowners.</td>
</tr>
<tr>
<td></td>
<td>2. Explain the role of woodland management in caring for Iowa's woodlands.</td>
</tr>
<tr>
<td>The Individual Tree</td>
<td>1. List the three basic parts of a tree.</td>
</tr>
<tr>
<td></td>
<td>2. List the components and function of the three parts of the tree.</td>
</tr>
<tr>
<td></td>
<td>3. Explain how a tree grows.</td>
</tr>
<tr>
<td></td>
<td>4. List leaf and tree characteristics used to identify trees.</td>
</tr>
<tr>
<td></td>
<td>5. Identify at least twenty tree species and list their uses.</td>
</tr>
<tr>
<td>The Woodland Community</td>
<td>1. List the biotic components of the woodland.</td>
</tr>
<tr>
<td></td>
<td>2. Describe the appearance of the forest soil.</td>
</tr>
<tr>
<td></td>
<td>3. List four types of woodland communities in Iowa.</td>
</tr>
<tr>
<td></td>
<td>4. Describe what an undisturbed woodland looks like.</td>
</tr>
<tr>
<td></td>
<td>5. Explain the benefits wildlife and insects can provide landowners.</td>
</tr>
<tr>
<td>Introduction to Woodland Management</td>
<td>1. Define the term woodland management.</td>
</tr>
<tr>
<td></td>
<td>2. List the woodland management steps.</td>
</tr>
<tr>
<td></td>
<td>3. List five woodland management objectives.</td>
</tr>
</tbody>
</table>
Table 6. Continued

<table>
<thead>
<tr>
<th>Sub-topic</th>
<th>Performance Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland Management Techniques</td>
<td>1. Define the terms: timber stand improvement, noncommercial thinning, commercial thinning, weeding, liberation cut, cleaning, improvement cut, silvicultural method, planting, harvesting, weed control, clearcut, selection cut, seed tree, and shelterwood.</td>
</tr>
<tr>
<td></td>
<td>2. List and explain four types of timber stand improvement cuts.</td>
</tr>
<tr>
<td></td>
<td>3. List four types of harvesting techniques and explain the pro's and con's of each.</td>
</tr>
<tr>
<td></td>
<td>4. Given a description of an area, make a decision on appropriate timber management objectives.</td>
</tr>
</tbody>
</table>
Appendices B-G provide a complete listing of unit goals, unit objectives and performance objectives by instructional unit.

Develop Criterion-referenced Tests

The purpose of the criterion-referenced test is to measure the students' ability to achieve the performance objectives. The student assessment instruments should be developed based on performance objectives. There are four types of tests that can be developed. They are:

1. Entry-level behavior tests;
2. Pre-tests for entry level information;
3. Embedded tests to analyze transfer of knowledge;
4. Post tests to determine student achievement and to determine overall success of the unit.

Embedded tests, post tests, and some pre-tests were developed. Pre-test options were provided for subject matter areas that have already been covered in other courses. Pre-test topics included tree growth, tree function, and tree identification. Pre-tests help the teacher determine if other classes have already covered the materials adequately.

Embedded tests were provided with the student information sheets. They can be used by the student as a self-assessment tool to help determine if they understood the main objective of the reading assignment. Student activities also serve as
embedded tests, since they provide students with an opportunity to reinforce mastery of information provided.

One post test was provided for each unit with the exception of the "Trees For Schools" Unit. This test was based on the behavioral objectives. The tests were designed to test transfer of knowledge. Real life situations were used in the test questions to determine how students would synthesize information provided.

Criteria for evaluating test questions include: 1. Does it address the objective? 2. Is it written clearly? 3. Is it written using correct grammar? Once the questions have been developed, they can be used for pre-tests, within lesson assessments, and end-of-lesson tests.

Examples of this step can be observed in Appendices C-G.

Consider Adoption Strategy

Innovation attributes, that lead to innovation adoption, were formally compared to the final product to determine if the innovation characteristics had been appropriately integrated. The results of this formal review have been included previously in the Innovation Section of this dissertation.

Also at this time, the communication strategies for promoting the instructional package were identified. The needs assessment initially communicated the development of a
woodland management instructional package. At this stage, additional communication strategies were considered.

This step also incorporates the strategies of including as many participants as possible in the developmental process. Again, the needs assessment surveys involved participants in the development of the instructional system at an early stage. As the materials are developed the participants were involved in the developmental through informal conversations with survey participants. Finally, a select number of participants were involved in the review process. Potential reviewers were suggested by Iowa State University Agriculture Education professionals. Some reviewers were selected based upon their expressed interest in a specific subject area.

Evaluate and Select Instructional Materials
A search for existing instructional materials was performed. Materials found were entered into a computerized filing system called the Natural Resources Educational Resources File. Private and public educational businesses were contacted to obtain a listing of all forestry-related educational materials. Additional materials were located through formal library searches conducted as a part of the needs assessment, and personal communications with other educational professionals.

After instructional materials were located, appropriate types of media were selected. Romiszowski (1981) and Simonson
and Volker (1984) developed systems for selecting appropriate media. Those systems were used to determine the type of media to use. Once the appropriate type of media was selected, the Natural Resources Educational Resources File was used to locate potential materials. A checklist was then used to make the final selection (see Figure 13).

A variety of media options were included within the instructional system. Written information sheets and transparencies were included for each instructional unit. These forms of media provide the instructor the option of presenting information in lecture style. This teaching method is most efficient and least costly. The information sheets were designed to provide the small segments of subject matter for the students or larger segments of background information for the instructors. The transparencies were designed to communicate complex concepts, to reinforce information transfer, and to emphasize important points.

Guest speakers were recommended for several of the topics within the units. Suggestions included: the Iowa Department of Public Instruction - District Foresters, Iowa State University - Extension Foresters, local Christmas tree producers, local loggers, local nursery operators. These suggestions were made to help instructors who have little or no background in forestry. Local individuals can also serve as examples of people who have successfully ventured into
PART A

1. Is the media adaptable to learning location?
   (If, yes continue. If, no eliminate as a choice.)

PART B

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Compatible with unit objective</td>
<td>30 pts</td>
<td></td>
</tr>
<tr>
<td>(content and learning domain)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Matches audience (age, interests, mental ability, &amp; past experience)</td>
<td>30 pts</td>
<td></td>
</tr>
<tr>
<td>3. Cost (initially, maintenance, and life expectancy)</td>
<td>20 pts</td>
<td></td>
</tr>
<tr>
<td>4. Good quality (not biased, out of date, or prejudice)</td>
<td>8 pts</td>
<td></td>
</tr>
<tr>
<td>5. Fits learning environment (small or large group; individual)</td>
<td>7 pts</td>
<td></td>
</tr>
<tr>
<td>6. Good quality (technical)</td>
<td>5 pts</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL PTS.

Figure 13. Instructional materials evaluation checklist
nontraditional agriculture options. As examples of eminent social change they have a higher degree of potential for influencing social change.

Films and slide shows were recommended for a variety of reasons. First a film on operating a chain saw was suggested because the task involves motor responses. The attribute of motion is utilized to show step-by-step how to perform the task. A line demonstration was suggested as a follow-up activity rather than the initial learning session, because there may be excess "noise" involved. This "noise" would decrease the quality of communication. Several films about woodland ecology were selected. The films will show the class various ecological relationships that could not be seen during the course of a normal field trip. Two of the suggested films weave the concept of land stewardship with the story of woodland ecology. Motion media is effective in dealing with the affective domain, especially when the media portrays contrived events as these films do. The film entitled "Woodlands for Profit" was included because it not only matched the objectives of the unit but it portrays people from around Iowa who have successfully included woodland management as a part of their agriculture operations or lifestyles. Those examples of social change may encourage more individuals to practice woodland management.
Field trips were recommended. Hands on activities such as exploring the woodland community, marking trees for firewood or timber stand improvement, and shearing Christmas trees were suggested. These activities provide very effective learning experiences but are more costly. Because of the extra cost, the instructor may choose not to utilize these suggestions.

Usage of selected instructional materials was prescribed within the teaching procedure. A listing of additional materials available to the vocational agriculture instructors will be provided.

See Appendices B-G to review a copy of the instructional system. Information from this step is located in the "Listing of Suggested References" and within the "Teaching Procedure."

Develop Instructional Schedules and Educational Strategies

The instructional schedule is a teaching procedure showing sequence of activities, visual materials, and informational sessions. It includes suggestions for maintaining student interest. For this instructional package, an interest approach, a teaching procedure, teacher and student information sheets, activity sheets, a list of suggested activities, a list of suggested references, and a list of visual masters were developed. This instructional schedule was selected because Iowa Vocational Agriculture Instructors have voiced a preference for that specific format.
Potential activities and information needed to achieve unit and sub-topic objectives were gathered. Alternative means or components with the potential of meeting the purpose of the instruction were identified. Human resources, means, and tools that optimize the attainment of the predetermined performance objectives were selected. These ideas were included in the teaching procedure. Finally, the instructional strategies were included. These strategies are used to reinforce the lesson and to maintain student interest.

See Appendices B-G to review the instructional system. The results of this step are included in the "Teaching Procedure" of each unit.

Conduct Formative Evaluation/Revisions

The formative evaluation consisted of a preliminary editing for technical accuracy. The preliminary editing was performed by university faculty in forestry, agriculture education, and horticulture; district foresters; and high school vocational agriculture instructors. Copies of the individual units were sent to selected reviewers, and revisions were made based on their comments. The fog index was used to determine the reading level of the information sheets.
Implement System Using Diffusion Strategies

Adoption strategies were implemented at this stage. Communication techniques, such as "Woodland Owners Newsletter" and the Vocational Agriculture Inservice Training, were used to inform clients of the instructional package's availability.

The first diffusion task is to get the change agents or vocational agriculture instructor to adopt the unit. The second diffusion task is to get the client to incorporate woodland management in their land management practices.

**Diffusion of instructional unit**

Steps to get the instructor to adopt the instructional unit within their curriculum include: creating a knowledge of the existence of the unit; persuading the instructor to mentally evaluate the unit; persuading the instructor to try the unit, and lastly to get the instructor to include the unit as a part of their curriculum. Potential avenues for communication of the existence of the instructional unit include the Woodland Owners Newsletter, Vocational Agriculture Inservice, and the Vocational Agriculture Newsletter. Social/professional gatherings of vocational agriculture instructors could be used to get the materials to the instructors. In the future, special programs or awards recognition could be used to get the instructors to adopt the unit.
Diffusion of woodland management into traditional agriculture systems

This task is to get the students to adopt the idea of woodland management in their land use decisions. In part, this task lies in the hands of the vocational agriculture instructor or change agent. The disseminator of the unit should try to encourage the vocational agriculture instructor to follow the implementation strategies suggested in the unit. The fact that the unit is going to be used in the class will ensure that knowledge or awareness is achieved. Persuasion, will depend in part on the instructor talents and the instructional unit's organization, appeal, and understandability. The vocational agriculture instructors and other professionals with forestry and natural resource interests could help with this step by providing extra support to instructors using the units. Students must be persuaded to try woodland management practices. The use of a school forest would provide a "trial" opportunity for students without requiring them to invest capital. Another way to encourage the students to try woodland management is to get them involved in FFA projects related to forestry.

Finally, students must adopt woodland management strategies in their land management decisions. Here, reinforcement and support from the Forestry Department and
Forestry Extension at Iowa State University; the Department of Natural Resources – Forestry Division, and local community leaders would help to encourage and support their decisions.
CONCLUSIONS

Long Term Evaluation of Instructional Package

The dissemination of an instructional package is not the final responsibility of the instructional package designer and the institution disseminating the materials. Periodic feedback and evaluation is necessary. The materials will need to be reviewed every three to five years to determine if the materials are outdated. The vocational agriculture instructors will need to be surveyed to determine if: the materials are meeting their needs, the materials or parts of the materials need to be improved, additional units are desired, and additional instructional materials need to be developed to supplement the existing units.

The survey should ask instructors to indicate which instructional units (or materials therein) they have used in their class. They should then be directed to a separate survey page about each unit. If they are not using the materials, they should be asked why not. This will help determine if they think the materials are: of inferior quality or not applicable to their part of the state. It would also indicate if they did not feel comfortable presenting the materials due to a lack of background in forestry-related topics. If this is the case, then they should be asked if they would be willing to attend an
inservice training or take their class to a forestry field day designed specifically for high school students.

Those who are using the materials should be asked to indicate which sub-topic areas within each unit they are presently using. They should also be asked if they are using segments of the materials in other classes or within other topic areas. Have them specify the class or topic area.

Problem areas within each unit should be identified. Additional suggestions for instructional materials or instructional units should be obtained. Finally, an open ended question asking for additional comments should be included.

Additional Units

The existing materials were developed for vocational agriculture courses. They focus on "how-to" information about forestry and woodland management. This new instructional package focuses mainly on the tangible benefits of woodland management. Several vocational agriculture instructors and agriculture education professionals have expressed the need for instructional information on benefits such as recreation management, wildlife management, soil conservation, and maple syrup production. With the present interest in agriculture diversification, these additional instructional units would make timely additions to the woodland management instructional package.
Other opportunities exist for different school enrichment materials. Within the schools, there are two additional courses where forestry-related materials would be applicable. They include: 1. Industrial Arts Courses for wood products related materials; and 2. Science Courses for tree identification, tree ecology, tree biology, and forestry-related science projects/experiments.

Additional Instructional Materials

Additional instructional materials could also be included in the existing units.

Introduction to woodland management

1. A video or film to show the components of different Iowa woodlands or deciduous woodlands, and the ecological relationships between the wildlife and the plant communities could be included. It could also introduce the concept of land stewardship.

2. A slide/tape presentation to show students the types of trees found in Iowa and to provide additional information about each species could be included. This would be a lower priority suggestion, since learning can be facilitated better in an outdoor environment. However, this medium would be helpful for a rainy day option. It would also reduce the amount of time needed in class to teach the topic of tree identification.
3. Computer assisted instruction that allows students to manage a given area on an acre by acre basis would show students the many different management scenarios possible. It could be used to show how present management practices influence future woodlands and their management.

Reforesting Iowa - the establishment and care of tree plantings

1. A film or video to illustrate how to properly plant trees using a tree bar, shovel, and mechanical tree planter could be included. The steps to tree planting should be included and safety precautions given. This could be used as a rainy day substitute, to introduce the topic, or to reinforce learning.

2. A film or video to encourage a spirit of stewardship and concern for Iowa's diminishing woodlands might be incorporated. The medium could start with native Americans and progress to modern time. It could show the change from a dependence upon forests to the thoughtless clearing of land, an action that contributed to the overproduction of traditional agriculture commodities. A message of land stewardship such as "we are not inheriting land from our parents, but we are borrowing it from our children" could be used within the film or video.
Wood as energy

1. A video or film to illustrate how to cut down trees in a variety of situations would be useful.

2. A film or video to introduce the students through the entire fuelwood production process and to point out safety hazards is also needed. This can also be accomplished through the use of an organized field trip or "hands on" lab experiences. However, to make it a successful outdoor learning experience the instructor would need to spend considerable preparation time to set up the learning environment. The film or video could be used to minimize in-class time. It could be used to make students aware of safety hazards before they attended the "how to" lab experience. Finally, it could also be used to reinforce learning since it could review major points about fuelwood production.

Christmas tree - production and marketing

1. A film or video to demonstrate the shearing options could be helpful. It could be used to introduce the various techniques or to reinforce learning.

2. Written examples of marketing promotions could be helpful.

3. A film or video that provides a case study of one Christmas tree operation during the course of the year. It could illustrate the various types of tasks required and demonstrate how to schedule those tasks in with
traditional farm operations. If the Christmas tree plantation used was managed on a rotation basis, the film could also show the different tasks required during the course of the eight year crop cycle.

**Managing woodlands for sawlog/veneer production**

1. A film or video on timber stand improvement showing how one timbered area was improved over a period of ten to twenty years would be helpful. It could also show the different types of timber stand improvement strategies that were used. Each strategy could be explained and safety information provided. Periodic samples of increased annual growth, as shown by cross sections or increment core samples, could be included. Forestry terms could be defined.

2. Modified computer assisted instructional TIGER program for high school students could be developed.

**Summary**

One means of implementing some of the above ideas, is to use existing extension film footage. According to Tom Hoerner, IVAID coordinator, vocational agriculture instructors have expressed a demand for video cassette materials. By organizing existing segments under appropriate headings (i.e., Christmas tree production, woodland management, ...) a thirty to sixty minute Forestry video could be provided.
Forestry Extension staff could provide future topics and segments that could double as instructional materials.

Other approaches include: contacting national and state natural resource organizations to determine if they would have an interest in developing some of the above ideas.

The adoption diffusion process of encouraging future farmers to incorporate woodland management into traditional agriculture operations does not end with the development and dissemination of an instructional package on woodland management; it merely begins. Follow-up activities and development of additional instructional materials as needed will continue to nurture a spirit of kindredship and cooperation between the natural resource professionals and high school vocational agriculture instructors.
REFERENCES


APPENDIX A - LEARNER CHARACTERISTICS
Vocational Development

1. "Exploration stage"—occupations are explored until entry into a beginning job in an appropriate field.

2. Occupational preferences and considerations are based on needs, values and opportunities in addition to interests and capacities.

3. Occupational preference is an expression of the vocational self-concept.

4. Interested in appraising abilities.

5. Vocational preferences become more realistic—what they want and what they expect to get in an occupation come closer together.

6. Choice of high school subjects is vocationally relevant.

7. May "hold down" a regular part-time job.

8. Vocational preference is crystallized.

9. Choice of college and/or college major is a vocational decision.

10. About the time of high school graduation, the individual realizes preferences are too subjective and adopts an instrumental attitude toward work—working conditions, training required, and financial return are considered.

Physical Development

Interests in physical activity are diverse—there is difficulty in organizing activity that will interest the entire group.
Emotional Development

Feelings of inferiority and inadequacy are common.

Social Development

1. A strong desire to acquire status in and conform to the peer group. Lifelong friendships develop.
2. A common desire is a "place" of their own where they can get together with friends—a place to "hand-out."
3. Interest is high in social skills and activities.
4. Girls are usually more socially advanced than boys—boys close the gap during this stage.
5. Need for increasing freedom from parental control to make decisions and accept the consequences.
6. The peer group assists in the process of gaining independence from the family by providing the support needed. There remains a need for parental support. Status is associated with popularity, leadership and athletic achievement rather than intellectual achievement.
7. Great satisfaction and increases self-identity from performing adult roles.
8. Dating is characterized by more stability, trust depth of feeling and understanding.
9. Conflicts arise as parents focus on behavior and youth on ideals. Deviant behavior may stem from poor relations with parents and other adults.
10. Lives in two worlds—the adolescents behavior, as well as what adults expect of him vacillates between adult and child.

Mental Development

1. Youths have reached adult mental capability.

2. A personal philosophy begins to emerge—they express personal opinions on religion, our political and economic systems, etc. Discussions centering on the activities of adolescents or on the world are enjoyed.

3. Abstract thinking and problem-solving may reach a high level.

4. Adolescents can choose purposes, make plans, carry them out and evaluate the results.

Information was taken from Growth-Development (Yep, 1977).
APPENDIX B - TREES FOR SCHOOLS
TREES FOR SCHOOLS

Written by: Reine Hildebrandt
4-H and Forestry Departments
Iowa State University

Goal: Teach students how to be community leaders in the area of natural resources, through their participation in the Trees for Schools Program sponsored through Forestry Extension at Iowa State University.

Objectives:

Upon completion students will be able to:

1. Explain the Trees for Schools Program.
2. Write letters to potential financial sponsors and explain the Trees For Schools Program and why it is important, OR organize fund raisers that make people more aware of Iowa's woodlands.
3. Contact resource people to assist in developing a five year plan.
4. Develop a Trees for Schools Project plan for their school.

Visual Masters:

1. Trees for Schools (Program Objectives)
2. Trees for Schools (Steps 1-5 for participation in the program)
3. Trees for Schools (Steps 6-10 for participation in the program)
4. Two Ways to Participate
5. Values of Tree Planting

Teaching Procedures:

AN INTERDISCIPLINARY APPROACH CAN BE USED TO TEACH THIS UNIT. APPROPRIATE COURSES HAVE BEEN SUGGESTED.

Topic 1: General Activities

1. Interested Instructor or administrator should introduce the program using visual masters #1-4. Teacher information sheets entitled, "Why Get Involved?" and "The Trees For Schools Program" provide background information.

2. (Vo Ag Class, History Class, or Government Class) Have a guest speaker, such as a district forester or extension forester, talk about Iowa's diminishing woodland situation and explain how involvement in the program will help this
situation. Use visual #5 to summarize values of Iowa's woodlands.

3a. (English/Writing Class, Speech Class or Government Class) Have an English teacher lecture on how to write an informational letter and how to write a persuasive letter. Divide students into groups and write letters to:
   a) Request more information about the "Trees for Schools" program or enroll in the program. Contact: Forestry Extension; 251 Bessey Hall; Iowa State University, Ames, Iowa 50011.
   b) Generate financial support. Contact local business persons or civic organizations.
   c) Get the school board involved and start a trees for schools committee. Contact community leaders, Iowa Department of Natural Resources employees, local nurserymen, local garden clubs or others to get a representative on the committee.
   d) Obtain information on different natural resource programs which recognize work done on projects such as the Trees for Schools program. Contact: Forestry Extension; 251 Bessey Hall, Iowa State University, Ames, IA 50011 or State of Iowa, General Information, Wallace Bldg., Des Moines IA, 50319 or write your congressmen.
   e) Obtain information on tree planting incentives. Contact: Forestry Extension, 251 Bessey Hall, Iowa State University, Ames, Iowa 50011.

3b. Have students report their findings or read the letter they received to the class.

4. (Government class, Vo Ag class, Social Studies class) Have students brainstorm on activities for an Arbor Day or Arbor Week dedication. Have them develop an agenda of learning activities, guest speakers, club activities, etc.

Topic 2: Tree Planting Activity Suggestions

1. Decide on the type of tree planting (wildlife, landscape development, windbreak screens, energy plantation, forest production, etc.) and locate an area for the tree planting.

2. Use the following instructional units available through Forestry Extension at Iowa State University: Christmas Tree Production and Marketing, and Reforesting Iowa - Tree Planting.

OR Topic 2: Forest Management Suggestions

1. (Adopting a Wooded area) Locate an area (county conservation board land, parklands, or private forestland) and secure permission to use the area. Develop a contract between the "Trees for Schools" Committee and the landowner.

2. (Adopting a Wooded area) Talk with the landowner and your district forester about timber stand improvement work and other learning activities that could
be done in the wooded area.

3. Use the following instructional units available through Forestry Extension at Iowa State University: Introduction to Woodland Management, Wood As Energy, and Managing Woodlands for Sawlog and Veneer Production.

Topic 3: Developing a Long-term Plan of Action

1. Have students read the student information sheet entitled, "Developing a Long Term Plan".

2. Have the students list the types of projects they would like to do for their "Trees for Schools" area. Select one of those projects.

3. List specific tasks needed to accomplish that project.

4. Have the students make a list of the equipment and materials these tasks require.

5. Provide a listing of material costs from local sources. Have students develop a budget. They should consider the following costs: plant material, tools, transportation, and labor.

6. Provide students with a calendar and have them mark the appropriate scheduled seasons for those tasks such as planting, pruning, shearing, weed control, etc. Have them determine who and what group or organization should be responsible for each task.

7. Have them develop a maintenance notebook for each species planted. Information can be obtained from the Extension Service, local Nursery, State Forest Nursery, and pesticide or herbicide companies.

8. Have students read information sheet entitled, "Presenting The Trees for Schools Plan".

9. Select a date and organize a meeting for presenting your plan to sponsors and the "Trees for Schools" Committee.

10. Have an English teacher lecture on writing a formal invitation.

11. Have students write invitations to:
   a) school board members
   b) a representative from potential sponsors and support organizations
   c) school grounds keeper (especially if you wish to have him or her help with maintenance)
   d) interested parents

12. Have an English teacher, or local business person provide a lecture on "Giving a Business-Style Presentation". To benefit from what they learn from lecture, students should present: the long range plan of action, the maintenance plan, and cost calculations (planting, materials, tools, labor, transportation) at a later date.
13. Have a mock presentation prior to the actual presentation. Provide suggestions to help improve student's presentation style.

14. Present on designated meeting date.

Extra Suggested Activities

1. Send student representatives and instructors to related workshops sponsored by the local conservation commission or the AEA office. Have workshop representatives report back to entire school or to a specific class.

2. Have the students brainstorm on ideas for using the "Trees for Schools" area for learning. Suggestions might include:
   a. Provide tree planting demonstrations
   b. Have the shop class make interpretation signs such as plant identification signs, benches, picnic tables, etc.
   c. Have the science class study plant and tree identification.
   d. Have the science class study woodland ecology.
   e. Have the art class develop a "Trees for Schools" landscaping plan. Have them sketch how the "Trees for Schools" area will look in five years, ten years, twenty years and/or fifty years.
   f. Teach the vocational agriculture class about weed control.
   g. Before you do any manual labor, have the Physical education class teach about proper lifting techniques and proper posture.

Glossary of Terms

1. Arbor Day - The last Friday in April designated for tree planting
2. Trees for Schools Program - A Program designed to promote conservation of our natural resources.
3. Trees For Schools Workshop - A workshop where participants learn about tree planting, tree care and maintenance, and other forestry topics. They become Arbor Day Ambassadors for their school and community.
Helping Iowa's Woodlands - A Diminishing Resource

Iowa is faced with a diminishing forest resource. According to the 1832-1859 Surveyors Notes, Iowa originally had 6.68 million acres of timber (Thomson, 1980). In 1954, there were 2.3 million acres of commercial forest land in the state (Thornton et.al., 1959). The last tally in 1974 indicated Iowa had 1.56 million acres of timber (Ostrom et.al., 1974). This represents an overall decline of 5.12 million acres or over 76 percent of Iowa's original forest cover.

One reason for Iowa's diminishing forest resource is land use conversion. Iowa's woodlands have been converted to cropland, pastureland, or residential areas. Forestry is just one of the many land use alternatives which compete for Iowa's fertile lands.

Many areas on soil classes V-VIII, which should have been kept in woodland and grasses, have been converted to crops. Severe erosion problems have resulted because of this change in land use. According to the Iowa Forest Resource Plan for 1985, a state goal to increase Iowa's woodland areas to three million acres would be the equivalent of 84% of the lands in the USDA Soil Conservation Service land-capability classes V, VI, and VII. Converting this land to forest land would protect the basic soil resources and yield products and amenities for all Iowans on a continuing basis.

Grazing also contributes to the decline of woodland quality and quantity. Grazing of Iowa's woodlands brings about a slow sometimes inconspicuous decline in our woodlands. It is usually noticeable only when it is too late for the woodlands to rejuvenate. By this process, a woodland area originally characterized by wide plant diversity can be converted to a pastureland after about 100 years of grazing.

A factor that contributes to the diminishing woodland problem is landowners attitudes toward forested areas. Some Iowa landowners seem to dismiss the values and benefits of our woodland areas. These natural areas can provide numerous benefits to the landowners and the general public. Yet, often both the non-economic and economic benefits of forested land are overlooked.

Benefits of Iowa's Woodlands

Woodlands can provide soil protection against both water and wind erosion. Iowa croplands lose an average of 9.4 tons of soil per acre per year. On our ungrazed woodlands only 1.02 tons of soil are lost per acre per year. On grazed woodlands 4.42 acres of soil are lost per acre per year (Natural Resource Inventory, 1982). This is an increase of 3.4 tons per acre per year because of grazing.

Woodlands provide wildlife habitat, which in turn provides recreational opportunities to landowners and others. The Iowa Department of Natural Resources has sold over 225,000 hunting licenses per year since 1982 (Iowa Conservation Commission, 1986). This income helps support wildlife habitat
improvement in Iowa. Woodlands also help maintain better water quality for fish
habitat. Trees along streams provide shade and cooler water conditions needed
by fish such as trout.

Woodlands provide an aesthetic quality to an otherwise monotonous landscape.
Trees aid in the purification and enhancement of our air quality. They take in
carbon dioxide and release oxygen.

Our woodlands also add to Iowa's economy. Since 1982, Iowa has been one of the
top three states in the nation for exporting top quality (veneer) walnut logs.
We have 224 wood using industries, 87 sawmills, 1 veneer mill, and 1 pulp mill.
There are 400 tree farms containing 29,126 acres of timber land. Iowa's woodland
industry contributes to Iowa's economy. According to the Annual Survey of
Manufacturers, our lumber and wood products industries; pulp, paper, and allied
products; and furniture and fixtures industries employ 14,300 Iowans annually
which represents $3.73 million dollars of taxable income per year and 5.8% of
the 246,000 people employed in Iowa's industries.
The Trees For Schools Program

Teacher Information Sheet

The "Trees for Schools" program is designed to promote resource conservation, to provide opportunities for learning experiences, and to enhance the beauty and utility of school grounds.

There are two ways to become involved in the program. Schools can choose to do a tree planting or they can adopt a wooded area nearby and work with the owner to improve the area.

Choosing the Tree Planting Option

Tree plantings can be developed on school lands or lands adjacent to the school property. Hilly or wet areas of the school grounds, which aren't used for other activities, can benefit from establishment of woody plants. Plantings may be for landscaping, windbreaks, erosion control, or wildlife habitat. These areas do not need to be large or continuous. For example, small areas of less than 500 square feet can be planted for songbird habitat. Tree plantings can also be developed on larger tracts of woodland or open land located away from the school grounds. These areas can be publically or privately owned and can be used for a variety of field trips.

Tree plantings projects should function as outdoor classrooms, and provide students with opportunities to learn how they depend upon natural resources and how human activities affect the woodland environment. By observing, classifying, measuring, analyzing, and interpreting, young people gain essential learning skills and develop an individual relationship with the natural world. As they acquire knowledge about the environment, they also develop some competence in the management of woody plants.

There are a number of different types of tree plantings the school could develop. Some suggestions include:

1. Production of black walnut sawlogs and veneer logs
2. Traditional forest plantings of oak, ash, maple and other species
3. Christmas tree production
4. Energy or fuelwood production
5. Wildlife habitat
6. Recreation or picnic area
7. Soil conservation
8. Windbreaks
9. Visual or sound screens
10. Arboretum
11. Fruit or nut production
12. Timberland conversion or improvement

Choosing the Existing Woodland Option

The second way to become involved in the "Trees for Schools" program is to adopt an existing tract of timber. These areas can be publically or privately owned. They can be used for field trips that address a wide variety of topics.

For this option, the major goal is to manage the woodland area. Woodland
management involves performing cultural practices to produce more of the desired products from the forest. Usually more than one product can be produced from a tract of woodland at the same time.

To develop a woodland management plan, work with the landowner and your district forester. The plan should include a set of goals for the area, a general inventory of the existing resources on the woodland, and the procedures or activities for obtaining the management goals.

Activities necessary for the management of a forest are:

1. Mapping and surveying the woodland,
2. Conducting an inventory of the various woodland resources,
3. Harvesting mature timber for lumber and considering regeneration strategies (or how do we keep the area in forest land),
4. Thinning the stand to obtain maximum growth rates,
5. Thinning a stand for fuelwood production,
6. Pruning high quality trees especially black walnut,
7. Controlling unwanted vegetation,
8. Tapping maple trees for syrup,
9. Improving the wildlife habitat,
10. Planting trees in wooded areas where there is not adequate regeneration, and
11. Developing an area for recreation.

Getting Involved in the Program

There are ten steps to getting involved in the Trees for Schools program. They are:

Step 1. Decide to participate

Any interested instructor and or group of students can decide to try and initiate interest in the program. All participating schools will receive a reference notebook from Iowa State University.

Step 2. Obtain approval and support from school board and administrators

Approval and support of the school board and administrators must be obtained before beginning the project.

Step 3. Organize a Trees for School Committee

The project plan and ideas should be developed by a Tree for Schools Committee consisting of at least two teachers, a member of the school administration, and a core of interested students, plus representatives from any of the following groups: county extension staff, county conservation boards or staff, wildlife biologist, local nursery operators, parents, school maintenance staff, and other community groups or private individuals with an interest in woodland development.
Step 4. Elect a committee chairperson

Step 5. Select a tree planting site or existing forest site

Step 6. Develop a five year planting plan including care and maintenance.

First, develop a broad plan of projects and activities. After the project has received the required approvals, the School Tree Committee should begin to develop a specific 5-year plan listing specific projects for this time period including what is to be done, who is to do it, and a time schedule for completion of the projects, educational objectives, students benefits, both immediate and potential costs (including maintenance), and future needs for the project.

Step 7. Keep a record of your progress

Maintain both written and pictorial evidence of the progress you have made. This will help strengthen awards applications.

Step 8. Consider recognition and awards

Apply for recognition and awards at the local, state, and national levels.

Step 9. Evaluate your progress yearly

Additional Technical Support

Forestry Extension at Iowa State University is available to provide further technical assistance. The Extension Foresters provide Forestry Field Days, which are open to both school groups and the general public. As time permits, the extension staff may be able to visit your school and provide project idea suggestions.

Instructional Units on forestry topics are also being available at Iowa State University Department of Forestry. Topics include: Introduction to Woodland Management, Reforesting Iowa - Tree Planting, Firewood Marketing and Production, Christmas Tree Marketing and Production, and Managing Woodlands for Sawlog and Veneer Production.

The Iowa Department of Natural Resources, Forestry Division, can also participate in field experiences with the class and provide demonstrations. This will assist you with the Trees For Schools Program.

Literature Cited

Developing a Long-term Plan

You will also want to develop a Trees For School Plan. This plan should include: a long-term plan of action, an itemized list of costs, and a maintenance plan.

Plan of Action In your plan of action, you need to determine what work will be done each year, by whom, and how much that work will cost. Be very specific. Include not only information on the tree planting and establishment but information on maintenance. Remember, the vegetation you plant may need watering, pruning, and mulching. Many tree planting fail because people do not to maintain the trees.

Itemized List of Costs To determine costs get price lists from local sources. Include the cost of the plant materials, the cost of transporting the materials, the cost of equipment needed to do the tree planting and any labor costs there might be. Develop a record keeping system.

Maintenance Plan Your maintenance plan should include information on general tree care and maintenance plus information on the specific species which have been planted. Collect information on disease and insect problems, pruning suggestions. Since you are planting trees around an area where people recreate you will need to find out if any of the plants might be poisonous to touch or consume. Make sure poisonous plants are not in areas where younger children might play.
Presenting the "Trees for Schools" Plan
Student Information Sheet

If you were a potential "Trees For Schools" sponsor, what sort of information would you need? Remember, you would be deciding whether or not to fund the project? What about the school superintendent? How can you convince him that this program is a good educational experience? Write out your thoughts.

Once you decide what information you need to include, ask yourself this question. How should that information be organized? Again, write out your thoughts.

Have your English teacher provide suggestions on how to give a persuasive speech. Make sure that you:

1. Present information in a logical order,
2. Look professional,
3. Avoid a wordy presentation - Stick to the most important information,
4. Prepare effective visuals,
5. Tell the audience "Why this project is important",
6. Provide handouts to let them know you're prepared,
7. Allow for a question and answer period.

An example of a possible "Trees for Schools" presentation is shown below.

I. Explain what the Trees for Schools program is.
   A. Sponsored by Iowa State University
   B. Objectives of the program
      1. promote resource conservation
      2. provide opportunities for learning experiences
      3. enhance the beauty and utility of the school grounds
   C. Benefits for the Trees for Schools program
      1. For the State
      2. For your School
         a) educational experience
         b) extra revenue or dollar expenditures saved
         c) improvement of aesthetic quality
   D. Ways to get involved in the program
   E. How your school group has decided to get involved.

II. Your Proposed Plan
   A. Plan of Action
   B. Proposed Budget
   C. Maintenance

III. Question and Answer Period
Trees for Schools Program

- Promoting resource conservation
- Providing opportunities for learning experiences
- Enhancing the beauty and utility of school grounds
GETTING INVOLVED
IN THE
TREES FOR SCHOOLS
HIGH SCHOOL PROGRAM

1. Decide to participate
2. Obtain approval and support from school board and administrators
3. Organize a School Trees Committee
4. Elect a committee chairperson
5. Select a tree planting site or existing forest site
6. Develop a 5 year planting plan including care & maintenance
   a. what needs to be done
   b. when it needs to be done
   c. done by whom

7. Send a teacher and/or administrator plus student representatives to the Arbor Day Jamboree in April

8. Keep a record of your progress
   a. written
   b. photographs

9. Consider recognition & awards (local, state and national)

10. Evaluate your progress yearly
TREES for SCHOOLS

Start a Tree Planting

Improve an Existing Forest
PRESENT USES OF IOWA WOODLANDS

OTHER USES:
- NUT PRODUCTION
- MAPLE SYRUP
- CHRISTMAS TREES
- WILDLINGS

SOIL CONSERVATION

WILDLIFE HABITAT

WINDBREAKS

RECREATION, EDUCATION & NATURAL BEAUTY

LUMBER & VENEER

FIREWOOD
APPENDIX C - INTRODUCTION TO WOODLAND MANAGEMENT
INTRODUCTION TO
WOODLAND MANAGEMENT

Reince Hildebrandt
4-H and Forestry Departments
Iowa State University

Goal:
To introduce the concept of woodland management by objectives

Unit Objectives:
1. Inform students of Iowa's woodland history.
2. Provide background information on the functions of the individual tree.
3. Have students identify at least 20 trees.
4. Explain the woodland community.
5. Introduce the concept of woodland management.
6. Explain various woodland management techniques and introduce key terminology.
7. Have students determine ways woodlands can be a part of their traditional farm operations.

Visual Masters:
1. Iowa's Forest Cover - GLO Survey 1832-59
2. Iowa's Forest Cover - U.S.F.S. Survey 1976
3. Iowa's Forest Cover (graph)
4. Woodlands of Iowa - Settlement Period Uses
5. Woodlands of Iowa - Present Day Uses (overlay)
6. Present Uses of Iowa Woodlands
7. Acreage of Iowa Tree Farms
8. Number of Iowa Tree Farms
10. Parts of a Tree
11. Leaf Identification Characteristics - Leaf Shape
12. Leaf Identification Characteristics - Leaf Arrangement
13. Leaf Identification Characteristics - Leaf Margins
14. Leaf Identification Characteristics - Leaf Type
15. Other Tree Identification Characteristics - Bark
16. Other Tree Identification Characteristics - Twigs
17. Other Tree Identification Characteristics - Winter Buds
18. Other Tree Identification Characteristics - Location
19. The Woodland Community
20. Disturbed vs. Undisturbed Woodland
21. Practices that Affect Timber Value
22. Steps to Woodland Management
23. Silviculture Strategies
24. Timber Stand Improvement - Before Cutting
25. Timber Stand Improvement - After Cutting
26. Four Timber Harvesting Techniques
27. Pro's and Con's of Timber Harvesting (overlay)
Activity Handouts:

1. Woodland Benefits Survey
2. Identifying Parts of a Tree
3. How A Tree Grows
4. Name That Tree/ Tree Identification Trivia
5. Tree Identification Information Cards
6. "Conserving Soils" Activity Master; #1 Soils What Are They?
7. "Micro-Plot" Activities Information Sheet
8. "Micro-Plot" Activity #1 Recording Worksheet
9. "Micro-Plot" Activity #2 Land Profile Worksheet
10. Definitions of Terms
11. Woodland Management Terminology Crossword Puzzle
12. Land Descriptions - How would you manage the area (Student Worksheet)
13. Land Descriptions - How would you manage the area (Teachers Help Guide)

Topic 1: Managing Iowa's Woodlands—Past, Present, and Future

Objectives:

1. List five benefits derived from our woodlands by both the early settlers and present day landowners.
2. Explain the role of woodland management in caring for Iowa's woodlands.

Teaching Procedure:

1. Have students read the enclosed article titled, "Iowa Forests: A History of Value."
2. Have a guest speaker, such as a district forester or extension forester, talk about Iowa's diminishing woodland situation and the importance of woodlands past and present. OR Instructor could lead discussion using the information provided in the Teacher Information Handout titled, "Managing Iowa's Woodlands - Past, Present, and Future". Visuals #1-5 will be helpful in summarizing the information.
3. Have the students discuss benefits derived from forest resources within your community. Summarize using visual master #6.
4. Have students go out into the community and do Activity #1 the "Woodland Benefits Survey". Discuss the results. What benefits do landowners think they get from their woodlands? Have each student survey five woodland owners in your school district. Use the survey provided. Record your findings. Add to the data each year until most woodland owners are surveyed.
5. Discuss how landowner's attitudes contribute to Iowa's diminishing woodland problem.
6. Discuss the importance of woodland management. Emphasize the growing interest in woodland management using visual's #7-9.
7. Get involved in the "Trees for Schools" program. For more information contact Paul Wray, Forestry Extension, 251 Bessey Hall, Iowa State University, Ames, IA 50011.
8. (Optional) Suggested Project Learning Tree activities: #16 - The Influence of Forests on Your Region's History; #21 - Pioneers of the Wilderness; #24 Economic Web of Life; #53 The Value of 100 Acres of Forestland; #71 - Biography of a Favorite Thing.
Topic 2: The Individual Tree

Objectives:

1. List three basic parts of a tree.
2. List the components and function of the three basic parts of a tree.
3. Explain how a tree grows.
4. List leaf and tree characteristics that can be used to identify trees.
5. Identify at least twenty tree species and list the uses of identified trees.

Teaching Procedure:

1. Refresh the students’ knowledge of trees. Make sure they know that a tree is in the plant kingdom. Have students list the three major parts of a tree and explain their function. Provide students with Activity Handout #2: "Identifying Parts of a Tree". This can be used as a pre-test or post-test. Use Visual #10 to summarize discussion.

2. Provide students with the Student Information Sheet #2: "The Individual Tree" and the Forestry Extension Publication entitled, F-308 "How a Tree Grows".

3. Give the Students Activity Handout #3: "How A Tree Grows". Discuss their answers. This discussion should lead to a discussion on tree growth.

4. Divide the class up into groups of two or three students. Give each group a cross section from a different tree. Have the students make up a story of that tree's life. To add diversity to the stories use the following cross sections - one with all wide annual rings; one with all very small annual rings; one with annual rings going from small to large; one with annual rings going from large to small; one that has fire damage, and one that had an internal wound.

5. Move onto the topic of tree identification. Have students do Activity Handout #4: "Tree Identification Word Find and Tree Identification Trivia".

6. Show a slide presentation on tree identification. Suggestions include: "Forestry Program: Trees" #S-50 Part #3 Identifying Trees; available through Media Resources Film Booking; Pearson Hall, Iowa State University, Ames, Iowa 50011. (You may wish to skip the first 45 seconds of the presentation. It is aimed toward younger youth.)

7. Show the students characteristics used to identify trees using visuals #11-18.

8. Do an "Adopt A Leaf" Activity. Give each student a twig from a different tree. Tell them that they will be expected to find their twig again. Allow the students three minutes to look at their twig and to observe the leaves. Collect the twigs. Spread the twigs in a circle and have the students come find their twig. Discuss how they could identify their twig. Emphasize the tree identification characteristics when the students refer to them. For example: opposite vs. alternate leaf arrangement, simple vs. compound leaves, leaf margins, etc.

9. (optional) Have the students collect samples from different trees around the school and develop their own tree identification key. Have them teach K-6th grade students to identify the trees using the keys they developed.

10. Take a hike around the community to identify the trees using either the
key they developed or the publication Pm-970: "Key of Iowa Trees" from Forestry Extension at Iowa State University. Before leaving give each student one description about a specific tree. These descriptions have been provided in Activity Handout #5: "Tree Identification Activity Cards". Each student will be responsible for reporting the information on the card when their tree species is identified.

11. Create a "Family Feud" style tree identification quiz show. Use actual leaves, descriptions of tree uses, fruits and berries from the tree, riddles about trees, and drawings of the trees.

Topic 3: Iowa's Woodland Community

Objectives:

1. List the biotic components of the woodland.
2. Describe the appearance of a forest soil.
3. List four types of woodland communities in Iowa.
4. Describe what an undisturbed woodland looks like.
5. Explain the benefits wildlife and insects can provide landowners.

Teaching Procedure:

1. Show a film about woodland ecology. Suggestions include: "Life in the Woodlot" #S-48398 (good story line emphasizing human and wildlife interaction with ecosystem and long-term ownership of woodlands, applicable to Iowa farm youth, color is not of good quality); "Nature's Half Acre" #S-50045 (good general ecology, but is not directed only to woodland areas); or "A Walk in the Forest" #S-57513 (not as specific to Iowa but it does show ecological relationships and emphasize land stewardship). These films can be obtained from Iowa State Media Center, Ross Hall, Iowa State University, Ames, Iowa 50011.

2. Divide the students into three groups. Have each group read one student information sheet on the woodland community sub-topic and report that information to the class. You may want to have your English or Speech teacher give a short lecture or provide a handout on informative speeches.

3. After the students have given their reports, the instructor should summarize the main points. Emphasize the components of a woodland using visual #19. Describe a poorly managed vs. a well managed woodland area using visual #20-21.

4. Summarize the woodland soils topic by:
   A) Reading the soils information from Rachael Carson's "Silent Spring".
   B) Having students do Activity Handout #5 "Conserving Soils" Activity Master; #1-Soils What Are They? Part three can be done in conjunction with the "Micro-plot" activity listed below in step number five.
   C) Having the students read the information sheet titled, "Iowa's Prairie and Forest Soils" from the book "Iowa's Natural Heritage".

5. Take a field trip to a local woodlot. Invite your district forester to come talk about the forest ecosystem. While on the field trip have the students do Handout #7-9 "Micro-Plot" Activities. At each area, the instructor should comment on species composition and plant diversity. Have the students decide what each area will look like in fifty years providing it remains as a woodland area.
6. (Optional) Suggested Project Learning Tree activities: #62 - Food Mobile; #63 - Succession of the School Grounds; #64 How Do You Bury A Pile of Dirt?

Topic 4: Introduction to Woodland Management

Objectives:
1. Define the term woodland management.
2. List the woodland management steps.
3. List five woodland management objectives.

Teaching Procedure:
1. Have the students list five woodland benefits. Discuss the answers. Reinforce the important benefits obtained from Iowa's woodland resources.
2. Discuss the topic of Woodland Management. Ask students to list steps they need to consider to manage a woodland. Discuss their answers. Teach students the steps to proper woodland management listed on visual #22.
3. (Optional) Suggested Project Learning Tree activities: #12 - Local Recreation Preference; #32 - Participating Democracy; #43 - The Value of Wildlife; #44 - Building for the Birds; #45 - Snow Use; #51 - Mining and Renewable Resources; #59 - Endangered Species; #81 - Plan a Trip.

Topic 5: Woodland Management Techniques

Objectives:
1. Define the terms: silviculture, woodland management, timber stand improvement, noncommercial thinning, commercial thinning, weeding, liberation cut, cleaning, improvement cut, planting, harvesting, weed control, clearcut, selection cut, seed tree, shelterwood.
2. List and explain four timber stand improvement methods.
3. List four types of harvesting techniques and explain the pro's and con's of each.
4. Given a description of an area, make a decision on appropriate timber management objectives.

Teaching Procedure
1. Provide students with Handout #10, "Definition of Terms". Have the students do Handout #11, "Woodland Management Terminology Crossword".
2. The instructor should go over the word find or crossword with the students. Reinforce the definition of the terms.
3. Talk about woodland management techniques using visual #23-27. Forestry Extension Publication Pm-718, "Woodland Management in Iowa" can provide background information.
4. Show the slide/tape show developed by the Department of Natural Resources Forestry Division titled, "Woodlands for Profit". Copies can be borrowed free of charge, by writing: Roy Hatcher, State Nursery, 2484 South Duff, Ames, IA 50010; Phone: (515) 233-1161. You will be responsible for the cost of returning the slides/tape show.
5. Have students read Information Handout entitled, "Introduction to Woodland Management". Discuss the information.

6. Have the students do Handout #12, "Land Descriptions - How would you manage the area?". Handout #13 is an answer sheet for the teacher. Divide students into small groups and give each group one land description. Each group should come to a decision on how to manage the area. After the groups have made their decision, have them read the land description to the class and then report their management proposal. They should explain why they chose that management strategy. After each report, have a question answer period for each group.

7. Take the class to a "Forestry Field Day" sponsored by Iowa State University Forestry Extension.

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**Topic 6: Agricultural Diversification - Where Does Woodland Management Fit In?**

**Objective:**

1. Create a list of ways landowners can incorporate woodland management into the agriculture planning systems.

**Teaching Procedure:**

1. Discuss difficulties associated with incorporating woodland management into traditional farm operations. Ex. long term investment, potential risks for weather, insects and disease, loss of annual income... Address the philosophical issue of land stewardship. Also address the issues of water quality, long vs. short term management, and erosion control.

2. Have a brainstorming session/contest. Divide the class into small groups. Require that each group list ten ways to incorporate woodland practices into a farm operation.

3. Summarize their ideas on an overhead. If they have difficulty getting started provide some suggestions from the "List of Ideas for Integrating Woodland Management into Existing Agriculture Systems". The instructor should collect the ideas, type up the ideas, and return a copy to students for future reference.

4. Provide each student with a soils map of a farm (preferably their family farm). Have them locate potential sites for woodland management projects. Discuss their proposals.

**Suggested References:**


NOTE: To obtain material published by Forestry Extension write to: Forestry Extension Service, 251 Bessey Hall, Iowa State University, Ames, IA 50011.
Management was not a word that could be associated with early forest harvesting practices. Early logging was a "take the best and leave the rest then move on" business. Many of Iowa's forests, as well as the rest of the nation's forests, were utilized without a sustained yield management consideration. In the "History of Warren County, Iowa", Rev. W. C. Martin provides a classic example of how both government and private landowners treated their timberlands.

"Indeed, if the timber had been properly husbanded, it would have been sufficient to supply the wants of the entire county. It was in this township [Richland Township] that the Government saw-mill was erected by Captain Allen and John D. Parmelee, and here the first destruction of Warren County timber began that was so ruthlessly carried forward until the native timber has almost entirely disappeared. There were groves of magnificent walnut trees. Some of them were made into rails, and some sawed into boards, and the large limbs were left to rot or be burned to the ground. Many of those trees would today [1909] be worth $100 each possibly more, but they are gone. On the hills there were beautiful oak trees, the value of which now could hardly be estimated, but they too have gone the way of all the earth. Every student of the past of Warren County can but regret the careless manner in which the large groves of excellent timber in Richland township were disposed of and the little profit that was derived from them."

People did not see the importance of managing woodland resources because the acres of timber seemed endless. When the Eastern timbers had been depleted; the Midwestern timbers were used; then the Western forests were used. Timber harvesting was a necessary part of the development of our nation.

Early settlers were dependent upon three basic resources: water, food, and timber. The woodlands were needed for fencing, buildings, fuelwood, urban tree plantings, shelterbelts and windbreaks, and transportation by railroads and steamboats. It took six acres of timber for one mile of railroad. The expanse of our railroad system was one of the most significant uses of our nations woodlands.

With such an intense demand placed upon Iowa's woodlands the original 6.68 million acres of forest land, (recorded in the 1832-1859 Surveyors Notes) were reduced to 2.56 million acres by 1875. Once the timber resources had been picked over many loggers moved westward.

Demands upon Iowa's woodlands changed with the passing of time. One of the biggest influences on the demand for woodland resources was the highway system and the automobile. This new transportation system reduced the settlers dependance upon railroad and steamboat transportation. The automobile and highway system made it possible to transport timber from the west. They made it possible for people to obtain alternate fuel sources and bring new foods to the market place. Settlers no longer had to rely on the woodlands for survival.
This all caused a decrease in demands on Iowa's woodland resources and allowed the acreage of woodland to remain stable for the next 80 years. In 1954, there were 2.3 million acres of commercial forest land in the state. During the next 20 years there was an alarming decrease in Iowa's woodland acreage. The last Forest Service survey in 1974 indicated Iowa had 1.56 million acres of commercial timber.

The decline in acreage of Iowa's woodlands continues today. There are a number of reasons Iowa's woodland resources continue to decline including land use conversion, grazing, and landowners attitudes. Landowners depended upon economic gains for survival and did not feel woodlands added to their economic situation.

Today, forestry is just one of the many land use alternatives which compete for Iowa's fertile lands. Since forestry does not produce an annual income, many of Iowa's woodlands have been converted to cropland, pastureland, or residential areas.

Many landowners fail to realize woodlands can provide economic and non-economic benefits. Economic benefits include: sawlog and veneer log production, firewood, maple syrup, and nut production. Non-economic benefits include: wildlife, recreation, soil conservation, and aesthetics.

Woodlands can provide soil protection against both water and wind erosion. According to the Natural Resources Inventory of 1982, Iowa croplands lose an average of 9.9 tons of soil per acre per year. On ungrazed woodlands only 1.02 tons of soil are lost per acre per year. On grazed woodlands 4.42 acres of soil are lost per acre per year. This is an increase of 3.4 tons per acre per year because of grazing.

Woodlands provide wildlife habitat, which in turn provides recreational opportunities to landowners and others. The Iowa Department of Natural Resources (formerly the Iowa Conservation Commission) sold over 227,000 hunting licenses annually between 1981 and 1986. This income helps support wildlife habitat improvement in Iowa. Woodlands also help maintain better water quality for fish habitat. Trees along streams provide shade and cooler water conditions needed by fish such as trout.

Woodlands provide an aesthetic quality to an otherwise monotonous landscape. Trees aid in the purification and enhancement of our air quality. They take in carbon dioxide and release oxygen.

Our woodlands also add to Iowa's economy. From 1981 to 1986, Iowa has been one of the top five states in the nation for exporting top quality (veneer) walnut logs. We have 224 wood using industries, 87 sawmills, 1 veneer mill, and 1 pulp mill. Iowa's woodland industry adds value to Iowa's economy each year. According to the Annual Survey of Manufacturers, our lumber and wood products industries; pulp, paper, and allied products; and furniture and fixtures industries employ 14,300 Iowans annually representing 5.8% of the 246,000 people employed in Iowa's industries. Their earnings account for $3.73 million dollars of taxable income per year.

Iowa has lost more than three-fourths of its original woodlands. Although we continue to lose woodland acreage, there is an increasing interest in managing
our woodland resources. A growing number of landowners are interested in managing and caring for Iowa's woodlands. The Iowa Tree Farm System is a non-profit organization that promotes proper woodland management. Between 1980 to 1986 the enrollment doubled from 200 to nearly 444 members. The total enrollment of acreage is 30,735.

This new trend toward management is much needed. If landowners continue to ignore woodland benefits, they may not only be losing cash flow potential, but may be contributing to the destruction of Iowa's precious woodland resources. By managing a woodland area, the landowner can actively work to produce the kinds of products and services they desire from the area. They can even improve the quality of the woodland and potentially increase the amount of income they can get from the forest. Without proper woodland management, Iowa's woodlands will continue to diminish in size and quality. With this increasing interest in "wise" management of our woodlands, Iowa's woodlands will have a brighter future.

In 1987, the Iowa Woodland Owners Association (IWOA) was established. It is committed to advance the interests of woodland owners and forestry and to develop public appreciation for the value of Iowa woodlands and their importance in the economy and overall welfare of the state. The association is also charged with fostering and encouraging the wise use and management of woodlands and related resources in Iowa. This organization will act as a voice for the opinions of private woodland owners to legislators and government agencies. It will help members keep current on pertinent tax laws and policies. Members can meet together and share common fellowship and experiences in woodland management. The IWOA can work with other groups and organizations to promote the wise use of our woodland resources.
Parts of a Tree

A tree has three basic parts; a crown, a trunk, and a root system. The crown consists of branches, twigs, buds, and leaves. The trunk consists of one single stem. The root system contains a collection of major roots, secondary roots, tertiary roots down to numerous root hairs.

Each of the major tree parts perform specific tasks. The leaves of the crown produce sugars and oxygen. The trunk is the tree's support and transport system. The root system provides support by anchoring the tree in place. Its numerous root hairs absorb water and nutrients from the soil.

Let's see how these three tree parts work together as a team. In the spring as the ground thaws, the tree absorbs soil nutrients in water solution through numerous hair-like rootlets. This fluid is then transported through the outer part of the wood (sapwood), up the trunk and branches, and into the leaves. There it combines with carbon dioxide absorbed from the air and energy from the sun to make "tree food" (sugars and starches). This process is called photosynthesis. These liquid sugars and starches move through the phloem in the trunk and are stored in the root system or used in the tree growth process.

In the tree growth process this energy is used to develop new rings of annual growth around the trunk and branches. This ring is the diameter growth. When the tree trunk is cut, these "annual rings" look like circles. A tree may gain from one tenth to three inches in diameter growth per year.

A tree also grows in height. Each spring new flushes of leaves and twigs emerge from winter buds. This adds height growth to the tree. A tree may grow one inch to eight feet in total height per year. The amount of growth depends on the tree's growth rate and the suitability of planting site.

The tree is an amazing factory. A 50 feet tall - 24 inches diameter oak tree can absorb up to 100 gallons of water from the soil and release it into the atmosphere each day. Each acre of woodland produces enough oxygen each year to fulfill the requirements of 18 people. Trees also act as natural filters for the air we breathe. The trunk of this factory also provides lumber.

How Trees Grow

Read the Extension Publication F-308, "How A Tree Grows".

Factors Influencing Tree Growth

A woodland owner should know what influences the rate of tree growth. This knowledge can be applied to woodland management.

A number of factors influence tree growth. The first is natural growth rate. Some trees naturally grow faster than others. Fast growing trees include: eastern cottonwood, black willow, silver maple, boxelder, green ash, black
ash, river birch, tree-of-heaven, red mulberry, black cherry, black locust, honeylocust, swamp white oak, catalpa, quaking aspen, and bigtooth aspen. These fast growing trees are typically short lived trees (30-50 years). Slow growing trees typically live 100-300 years. Slow growing trees include: chinkapin oak, bur oak, white oak, eastern red cedar, mockernut hickory, shagbark hickory, shellbark hickory, bitternut hickory, Ohio buckeye, and sugar maple.

Another factor related to tree growth is how well that tree was matched to the site. When a tree is planted in the wrong area it will not grow to its fullest potential and it may even die prematurely. The soil type, topography, flood tolerance, and shade tolerance all need to be considered.

A final factor is competition. Trees in a forest compete with neighboring trees for nutrients, moisture, and sunlight. When favorably situated, trees in young, even aged forests (in which all trees are about the same age) grow fast in height, as if striving to avoid being overshadowed and suppressed. They may obtain their greatest height growth when some competition is present. In an uneven-aged forest (trees varying from small seedlings to mature or overmature) the understory often grows slowly for long periods awaiting release from crowding. When an opening occurs in the forest canopy, the shade tolerant trees in the understory may begin to grow in height and diameter.

Study Questions:

1. List the parts of a tree and explain their function.
2. Explain how a tree grows.
3. List factors that influence how a tree grows.
A forest is not merely a group of trees growing in the same location. It is a community of trees, plants, creatures, and the soil with its many microorganisms. Many ecological relationships exist within the woodland community.

The peaceful appearance of a forest is deceiving. A fierce, though slow and silent, battle is going on constantly. Plants struggle for water and food with their roots, and for light and space with their foliage. Similar trees may be enemies or allies. When trees compete for life, the strongest win. The strongest, however, are not always the most desirable for our needs.

Some of Iowa's woodlands may appear healthy and undisturbed, but actually aren't. There is a big difference between a disturbed and undisturbed woodland community. Read the enclosed information sheet titled, "Forest Structure" taken from the book "Iowa's Natural Heritage". It provides an excellent description of a healthy undisturbed forest.

The main difference between an undisturbed woodland and a disturbed woodland area is the amount of vegetation. An undisturbed woodlot will have many layers of plants from small ground layer to a herb layer to a shrub layer to a layering of trees. A disturbed woodlot will have a park-like appearance (many large trees with only grass or bare ground below). Note however, that an undisturbed woodlot with a dense canopy of leaves could also have a park-like appearance. So you need to look closer. Look for a distinct "browse line". This is the height at which the livestock can not reach any higher to feed on leaves. Look for soils lacking the organic matter layer; soils that are highly compacted; and trees with exposed roots. These conditions indicate the site has been disturbed by grazing.

More than three-fourths of Iowa's woodlands are grazed. Grazing livestock damage the soil by compacting it, injure trees, and reduce the quality and quantity of vegetation. Grazing slowly ruins the site quality. It reduces the growth and quality of the timber. Small seedlings and sapling trees are eliminated and the land eventually is converted to pastureland.

The grazing of woodlands threatens the existence of many understory species. Iowa has many rare and endangered plant species that live in our woodlands. Some of these plants, as well as other plants, have specific site requirements. This means they will only grow in the right place. For example: aconitum or Northern Monks Hood is a plant that only survives on north facing slopes in sink hole-like formations in Northeastern Iowa. Protection of such rare and endangered habitat should be a management priority. Once destroyed, such rare natural treasures can never be replaced.

A woodland community is not stagnant. Natural processes are constantly at work to mold the future of the landscape. The woodland community you see today will look very different fifty years from now. The trees and plants continue to grow. Some plant species will die out and be replaced by other plant species. This natural process is called "succession". Succession is
the naturally occurring change from one plant community to another. A simplified model is as follows: bare ground, to lichen to mosses, to grasses, to conifer trees or fast growing shade intolerant deciduous trees (aspen, cottonwood, willows,...), to slow growing shade tolerant trees (oaks, hickories, sugar maples). Of course, succession is more complex than this. It doesn't always occur exactly in this order. Read the enclosed information sheet on "Forest Succession" from the book, "Iowa's Natural Heritage".

A close look at a woodland community can tell us a lot about the area. Plants can be an indicator of the quality of that site. Forest sites with red and white oak, jack-in-the-pulpit, and orchids are typically good quality sites. Forest sites with bur oak, black oak, black or honey locust, red cedar and multiflora rose are typically poor quality sites or sites that have been abused.

With an understanding of the woodland ecosystem and of proper woodland management, a woodland owner can work within the constraints of the natural environment to grow forests. This management can help the forest continuously yield the desired wood products and services.

Study Question

1. Explain what an ungrazed woodland should look like.
There are five basic types of forest communities in Iowa. The major forest types in Iowa are oak-hickory, or the central hardwoods; silver maple/cottonwood/ash, or bottomland hardwoods; oak-maple-basswood, or northern hardwoods, riparian community, and some northern conifer-hardwoods. The book entitled, "Forest and Shade Trees of Iowa" by Peter van der Linden and Donald Farrar provides a good description of Iowa's forest communities. Those descriptions are given below.

Reprinted by permission from FOREST AND SHADE TREES OF IOWA by Peter van der Linden and Donald R. Farrar (c) 1984 by the Iowa State University Press, 2121 South State Avenue, Ames, Iowa, 50011. All rights are reserved.

Most of the natural forest stands in Iowa can be placed in one of the five following communities.

1. The **oak-hickory** community occurs on dry uplands and on south-and west-facing slopes. Its canopy (uppermost layers of foliage) is usually dominated by one or more of the following trees: white oak, bur oak, black oak, Hill's oak (Northern pin oak), chinkapin oak and shagbark hickory. Other common canopy trees include: white ash, black cherry, quaking and bigtooth aspens, red oak, and basswood and, in southeastern Iowa, post oak, blackjack oak, shingle oak, and mockernut hickory. The understory (lower layers of foliage) is usually dominated by ironwood or chokecherry, though saplings of larger trees such as white ash, hackberry, elms, and hickories may also be abundant. Shrubby, thicket-forming species such as prickly ash, hazelnut, and dogwoods are often common in clearings or in stands with open canopies.

2. The **oak-maple-basswood** community occurs in moist but well-drained uplands, especially on north-and east-facing slopes and terraces in the larger stream valleys. Its canopy is usually dominated by some combination of red oak, hard maple, and basswood, with the maples decreasing and the other two species increasing from east to west. Hard maple drops out entirely in western Iowa and red oak in the extreme northwest. Other large trees frequently encountered in this community are white oak, shagbark and bitternut hickories, black walnut, butternut, white and black ashes, and formerly the American elm. The understory and shrub layers are often sparse, with ironwood and hard maple saplings the usual dominants. Hornbeam, bladdernut, serviceberries, dogwoods, witch hazel, Ohio Buckeye and the saplings of ashes and hickories are also common locally.

3. The **bottomland hardwoods** community occurs on primary floodplains and low-lying terraces in the larger stream valleys. Its canopy dominants are typically one or more of the following species: silver maple; green ash; hackberry; black walnut; cottonwood; and, in certain parts of Eastern Iowa, the river birch. American elm was once a conspicuous feature of this community but the large trees of this species are now scarce because of the Dutch elm disease. Many other species of large trees are also characteristic of this community though they seldom take up more than a minor part of the canopy: sycamore, honeylocust, Kentucky coffee tree, black and peachleaf
willows, bitternut and shellbark hickories, pecan, pin oak, shingle oak, swamp white oak, butternut, rock elm, and black ash. The understory is commonly dense with woody vines and saplings of the canopy species, but where the canopy is fairly open the understory is often replaced by tall herbaceous plants such as jewelweed and nettles.

4. The riparian community forms a narrow belt on lakeshores, stream banks, mud flats, and sandbars. It is usually dominated by one or more of the following: cottonwood; silver maple; boxelder; river birch; and, sandbar, rigid, black and peachleaf willows. Several other species from the adjacent bottomland hardwoods community may also occur to a greater or lesser extent.

5. The northern conifer-hardwoods community occurs on steep, moist, usually north-facing slopes in extreme northeastern Iowa. This community is centered in the Great Lakes states and many of its most characteristic species drop out in Minnesota or Wisconsin. The trees and shrubs that do range into Iowa are more often found as minor constituents of the oak-maple-basswood or oak-hickory communities than as a discrete community. They include white pine, balsam fir, Canada yew, paper and yellow birches, mountain maple, quaking and bigtooth aspens, black ash, speckled alder, highbush cranberry, red elderberry, and red-osier dogwood.

Study Question

1. List the different woodland communities in Iowa.
Soils are the earth's life support system. Rachel Carson's book entitled, "Silent Spring", provides a vivid description of this important substance—soil. Read the enclosed photocopy from her book. (You may not make copies of this document. Permission to use this materials is limited to placing one photocopy in this unit.)

It takes from 30 to 300 years for a soil to develop. The rate of development is influenced by climate, parent materials, topography, vegetation, and organisms within the soil. In Iowa, soils were developed under two major types of vegetation. Read the information from "Iowa's Natural Heritage".

Each year a new layer of dead twigs, leaves, fruits, nuts, and bark are added onto the soil. This layer is called the organic layer. With each passing day and each additional rainfall, these organic materials are broken down and transported into the soil. This process is called weathering. As the soil weathers it begins to develop distinct layers or horizons. These layers have been classified as O1, O2, A1, A2, A3, B1, B2, B3, C, and R (using the old classification system) or O1, OA, A, E, EB, BE, BW, BC, and R (using the new classification system). See Figure #1 for a comparison of the two classification systems.

Figure 1. Comparison of old and new soils classification systems
Forest soils differ from prairie soils in their soil horizons. Prairie soils may have a 20 inch thick A horizon, yet a very small B (or EB & BE) horizon. Forest soils have a four to eight inch A horizon and a very distinct B2 or Bw horizon. Since forest soils have a thin A horizon, soil conservation practices and wise land use practices are important.

Study Question

1. Explain how forest soils differ from prairie soils.
Sixty-nine bird species, thirty-five mammals, and twenty-one reptiles and amphibians depend upon Iowa's woodlands for their existence.

What does wildlife need to survive? Wildlife, like humans, needs food, water, and cover. No two kinds of wildlife have exactly the same requirements for living. For example: the white tailed deer needs forest edge, thicket, and open meadow. Many cavity nesting songbirds need a mature timber with some dead and dying trees within.

Wildlife can provide numerous benefits to landowners. We can not only enjoy observing wildlife, but can obtain economic benefits as well. These economic benefits include: trapping, hunting, fishing, honey gathering, and insect control.

Hunting and trapping of fur bearing animals can bring in extra revenue or help you become more self sufficient. Squirrel, rabbit, pheasants, turkey, and deer can be hunted to provide food. Raccoon, opossum, and beaver could also be eaten but are less popular alternatives.

Wild honey bees can provide honey for home use. Bees and other insects help pollinate fruits and legumes. Some insects can be detrimental to agriculture crops. These insects can be controlled by encouraging the right kind of insects and wildlife. This type of insect management is known as biological control. Several million beneficial insects, more than 400 birds of 40 species, and more than 1000 small mammals are effective destroyers of harmful insects.

Providing for Woodland Wildlife

There are two approaches to managing for woodland wildlife. The first is simply to create a diversity of plants and see what wildlife frequent the area. The second method is management for a specific species.

Creating Diversity  A great variety of animals will be attracted to areas with a diversity of plants that provide food and cover. The key elements to this approach are to create a horizontal and vertical diversity of plants.

Horizontal diversity refers to having a variety of vegetation such as wetlands, grassland, forest edge, and forests. An area with horizontal diversity may have a timber next to a pasture; next to a timbered bottomland area; next to cropland.

If the area does not have a diversity of plant covers, it may need modification. A large forested area may need to have openings created. Large areas of grassland may need to have tree plantings established.

Check to see if the plants in these areas are high in wildlife value. If not, you may need to convert the vegetation to more desirable species.
Vertical diversity refers to a layering of plants from the ground to the tree tops. A park-like setting in a forest does little for providing shelter and food for wildlife.

Plants up to three feet high provide nesting and resting cover for ground loving birds and mammals. It also serves as browse for white tail deer. The three feet to fourteen feet high layer of plants contains fruit producing shrubs which provide food for birds or mammals from late summer to early winter. In addition, many bird species nest and seek shelter in these shrubs. Saplings and shrubs are used extensively by white tail deer for browse. During winter this edge provides a much needed windbreak for wildlife. The next layer 14 feet to 45 feet high is least beneficial to wildlife, except for the occasional wild plum, chokecherry, or evergreen tree. At this stage the plants could even create a thick canopy which would shade out and kill the shorter beneficial layers of the woodlands. As timber reaches maturity it becomes more beneficial to wildlife. Mature mast (nut) producing trees such as oaks serve as a food source for several species of wildlife. As these trees become over mature and die they develop cavities which house squirrels, raccoon, and a number of cavity nesting bird species.

Land use practices can have an effect on vertical diversity. Over-grazing of livestock causes a decrease in the vertical diversity of the woodlands. This in turn reduces wildlife habitat.

Other general practices that help create wildlife habitat are wildlife borders, windbreaks, and buffer strips. These areas can also be used to help control water erosion when located on lands not suitable for grain crops. Wildlife are provided with food or cover in these areas. Many insect-eating songbirds, game birds, mammals, and pollinating insects will frequent these areas.

Leaving a 50 foot to 150 foot bufferstrip of trees along rivers and streams not only provides habitat for song birds and mammals, but can improve habitat for fish. Without trees along waterways the stream water temperature increases and the amount of oxygen in the water decreases. These conditions can decrease the number of cold-water fish such as trout. A buffer strip can also help control soil erosion. Increased sedimentation and stream flow can also reduce fish populations. Sediment in streams is very destructive to fish. It covers spawning beds and valuable food and organisms. It also causes mechanical injury to the gills of fish.

On all types of stream bank improvements, much of the value of wildlife comes from the planting of moisture-tolerant shrubs and trees between the banks and fences of adjacent fields. Streams should be protected from grazing.

MANAGING BY SPECIES While creating a diversity of habitat is an acceptable way to manage for wildlife, a landowner may wish to create habitat for a specific wildlife species. This second approach, management by species, requires that you:

1. Select desired species.
2. Research their habitat requirements.
3. Decide if it is feasible to manage for that species by considering:
   a) geographical range
b) habitat requirements - food, water, shelter
   c) species "privacy needs"
4. Obtain professional assistance where necessary

For more information on wildlife in Iowa refer to Wildlife Extension Publication's #WL-48 "Wild Turkeys in Iowa's Private Woodlands and #WL-49 "Wildlife Needs That Dead Tree".

**Study Questions**

1. List two ways to create wildlife habitat.
2. Explain the terms horizontal diversity and vertical diversity.
Topic 4: Introduction to Woodland Management

Woodland management is the art, science, and business of working with the forest ecosystem to produce the desired products and services for today and for the future. It is the art of creating and maintaining the woodlands visual qualities; it is the science of learning how the woodland community grows - its ecological interactions; it is the business of deriving forest products or maintaining quality services from the woodland area.

Woodland management can include establishing, caring for, harvesting, and maintaining your woodland. These seemingly simple tasks require long range planning skills, knowledge of the woodland community, knowledge of forestry practices, and knowledge of the business world.

Selecting the Right Management Objective

A landowner can choose a variety of woodland management objectives. Your woodland objective will depend upon the sites you have available. The presence of existing woodland areas may motivate you to select firewood production over plantation establishment. Your financial situation will determine if you can spend money for tree planting projects. Your willingness to assume additional work responsibility will help you decide between a labor intensive Christmas tree plantation and sawlog production. Of course, your personal preference plays an important part.

If you want an economic return from your land, consider firewood production, Christmas tree production, sawlog/veneer production, and a recreation enterprise. If you are less concerned about making a profit, objectives include: creating a forest preserve, establishing a soil control project, improving visual qualities, creating wildlife habitat, or establishing a family recreation area. Many landowners prefer to select a combination of objectives. One technique for doing this is an acre by acre approach. Objectives are selected according to "best" land use for a given acre or classification of land. For example, a loamy well-drained soil with good quality walnuts established should be managed for walnut production. The Iowa Department of Natural Resources - Forestry Division can work landowners to determine the best land use practices.

Long Range Planning Skills

Woodland management is not a get-rich-quick scheme. It requires investing time, effort, and capital for long periods of time, in most cases without any immediate financial returns. If timberland is established on marginal cropland, woodland management may be the wisest investment a land owner can make. According to Jerry Kemperman, District Forester in the Forestry Division of the Iowa Department of Natural Resources, in 1986 one farmer made $23,000 from selling walnut trees grown in timbered gullies. If you have timberland or idle land on your farm, woodland management or plantation establishment may provide an excellent agriculture diversification option.

Since forestry is a long term investment, it is important to develop a
long-term plan for the woodland.

The steps to developing such a plan include:

Step 1. Purchase or select a wooded area to be managed.
Step 2. Determine the management objective. What benefits do you want from your woodlands? Possible objectives include: veneer log production, sawlog production, firewood production, Christmas trees, recreation, wildlife, or erosion control. Each of these objectives would mean different management strategies.
Step 3. Contact your district forester and have him or her visit the woodland area. Discuss possible management strategies.
Step 4. Develop a management plan for your woodland area, given your management objective. Your district forester provides this service free of charge to the woodland landowner. When appropriate include timber stand improvement strategies, woodland protection strategies (insect, fire, and grazing), regeneration strategies, and a tentative harvest schedule.
Step 5. Follow through with your management plan.
Step 6. As needed, contact Forestry Extension at 251 Bessey Hall, Iowa State University, Ames, Iowa (515) 294-1168 or 4465 for free information and publications on forestry and woodland management topics.
Step 7. (optional) Attend a Forestry Field Day when one is presented in your area. (For more information contact your local County Extension Office.)
Step 8. (optional) Join appropriate organizations such as: Iowa Tree Farm System, Iowa Christmas Tree Growers, Iowa Wood Using Industries...

Following these eight steps will help you become a better woodland manager.

Study Questions:

1. Explain what woodland management is.
2. What steps should a landowner take to manage their woodlands?
4. List four woodland management objectives.
Topic 5: Woodland Management Techniques

Student Information Sheet

Refer to Forestry Extension Publication "Woodland Management".

Topic 5: Woodland Management Techniques Study Questions:

1. List four types of timber stand improvement.
2. Explain how to prune a tree.
3. List three basic types of weed control.
4. List four timber harvesting strategies and explain the pros and cons of each method.

Topic 6: Agricultural diversification—Where Does Woodland Management Fit In?

Student Information Sheet

Potential Drawbacks

The fact that woodland management is a long term project often deters landowners looking for quick dollar return from actively managing and establishing woodlands. Yet, the landowner can get immediate returns by incorporating woodland management with traditional agriculture crops. This then provides landowners with annual income as well as periodic incomes. Individuals who are under twenty-five have the greatest chance of seeing the economic returns from their efforts.

Other landowners think that woodland management is not compatible with practices and needs of the Iowa agriculturalist. Professional foresters and soil conservation officials for a number of years have been trying to encourage landowners to use trees for erosion control, aesthetics, and cash crops. However, since 1980, there has been a nation-wide effort to encourage landowners to incorporate agriculture diversification options as a part of traditional agriculture.

Woodland management is more complex than traditional agriculture crops management. This in itself deters some farmers from including forestry options into traditional agriculture systems. There are professional foresters available for you to consult with concerning woodland management.

Woodland Management Ideas to Incorporate

1. Refer to "Forestry and Agricultural Diversification". The publication is written by Steven E. Jungst and available from Forestry Extension at Iowa State University.

2. Tree Plantation/Truck Farming. Start a one-fourth to five acre horticulture truck farming operation between the rows of a tree planting. The horticulture crop will reduce the weed competition while not competing with the trees. After about five years the trees may begin to create too much shade for the horticulture crops to grow well. Move onto another area to establish a new plantation/truck farm.
3. Erosion Control Along Waterways. Establish or maintain a fifty to 150 foot buffer strip of trees along waterways on your farm. This will help reduce erosion and reduce water turbidity. The end result is cleaner streams. Protect this area from grazing animals.

4. Plant trees in gullies and other wastelands. This will help stop erosion. One Northeast Iowa farmer received over $23,000 from selling walnut trees left in gullies. This figure is about average for quality walnut sales in NE Iowa. Check the corners of fields or hayground for one-fourth to ten acre plots that could be planted to trees.

5. Establish wildlife habitat in field corners or along edges of hayfields.

6. Develop a tree plantation with a combination of fast and slow growing tree species. Sell the faster species within ten to fifteen years for fuelwood. Continue to maintain the remaining trees until they are harvestable in forty to eighty years.

7. Plant trees in spots or areas where corn and bean production is extremely low.

8. Plant a grove of basswood near an alfalfa field and establish a honeybee hive.

9. Establish a commercial raspberry, blackberry, or gooseberry patch between the rows of ten to fifteen year old trees.

10. Plant walnut trees and gather nuts for production within fifteen to twenty years. Also maintain the plantation for sawlog production.

11. Raise and market shiitake mushrooms and other woodland products, while still managing the woodland for timber production.

12. Market recreation/hunting opportunities provided by your woodlands.
IOWA FOREST COVER
(U.S.F.S. SURVEY, 1976)
IOWA'S FOREST COVER

1859: 6.68 million acres
Source: GLO Survey

1875: 2.52 million acres
Source: Andreas Atlas

1954: 2.62 million acres
Source: U.S.F.S.

1974: 1.56 million acres
Source: U.S.F.S.
WOODLANDS OF IOWA
SETTLEMENT PERIOD USES

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<th>Lumber</th>
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<th>Railroad Ties</th>
<th>Fuelwood</th>
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<th>Windbreaks, Shelter Belts</th>
<th>Urban Forests, Shade Trees</th>
<th>Hunting for Food</th>
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PRESENT-DAY USES

- walnut, oak, cottonwood, basswood
- more metal posts used, existing woodlands seldom used for posts by landowners

more nursery stock than wildlings

markets have moved out-of-state

still prevalent, plus other wood for energy products (chips, pellets)

more nursery stock than wildlings

mainly for 'sport' and appreciation

NOT A WISE MANAGEMENT PRACTICE.
PRESENT USES OF IOWA WOODLANDS

OTHER USES:
- NUT PRODUCTION
- MAPLE SYRUP
- CHRISTMAS TREES
- WILDLINGS

SOIL CONSERVATION

WILDLIFE HABITAT

WINDBREAKS

RECREATION, EDUCATION & NATURAL BEAUTY

FIREWOOD

LUMBER & VENEER
ACREAGE of IOWA TREE FARMS

acres

30,000
20,000
10,000

1,688 3,794 4,594 12,312 14,028 29,126

'55-'60 '61-'65 '66-'70 '71-'75 '76-'80 '81-'85

years
NUMBER OF IOWA TREE FARMS

Tree farms

400
300
200
100
0

192

58-38, 08-97, 66-70, 71-75, 76-80, 81-85
PARTS OF A TREE

- Crown
- Branch
- Trunk
- Lateral root
- Taproot
- Root hair
- Bud
- Leaf
- Twig
- Inner bark
- Outer bark
- Cambium
- Heartwood
- Sapwood
LEAF IDENTIFICATION CHARACTERISTICS

LEAF ARRANGEMENT

OPPOSITE

ALTERNATE

WHORLED
LEAF IDENTIFICATION
CHARACTERISTICS

LEAF MARGINS

SMOOTH
FINELY TOOTHED
TOOTHED
DOUBLE TOOTHED
COARSELY TOOTHED
LOBED & TOOTHED
LOBED
LEAF IDENTIFICATION CHARACTERISTICS

SIMPLE

COMPOUND

DOUBLY COMPOUND

LEAF TYPE
OTHER TREE IDENTIFICATION CHARACTERISTICS

TEXTURE

DIAMOND SHAPED
SMOOTH
DEEP GROOVES

COLOR

WHITE
GRAY
RED/ORANGE
BROWN
NEAR BLACK

BARK
OTHER TREE IDENTIFICATION CHARACTERISTICS

THORNED VS. UNTHORNED

SIZE

USUAL

STAR

PITHS

CHAMBERED

TWIGS
OTHER TREE IDENTIFICATION CHARACTERISTICS

**Size**
- Brown
- Red
- Yellow

**Color**
- One
- Few
- Many

**Shape**
- Single
- Clustered

**Number of Scales**
- Arrangement

**Winter Buds**

---

---
OTHER TREE IDENTIFICATION CHARACTERISTICS

LOCATION OF TREES

FLOODPLAIN
- willow, cottonwood, sycamore, silver maple, boxelder

TERRACE
- ash, walnut, elm, butternut hickory, basswood, Kentucky coffeetree

HILLSIDE and HILLTOP
- spruce, pine, cedar, hard maple, oak, shagbark hickory, basswood

OTHER TREE IDENTIFICATION
- walnut
- cottonwood
- elm
- willow
- ash
- pine
- hickory
- oak
- spruce
- cedar
THE WOODLAND COMMUNITY
DISTURBED VS. UNDISTURBED
PRACTICES THAT AFFECT TIMBER VALUE

GOOD
- Woodland Management
- Pruning Trees
- Controlling Pest Problems
- Silvicultural Treatments

POOR
- Grazing
- Unrestricted Recreation
- Careless Timber Harvesting
- "High Grading"
1. Contact your professional forester to discuss management strategies
2. Determine the management objective
3. Protect the woodland
4. As needed, contact Forestry Extension, Iowa State University, Ames, IA, for further woodland management information & publications
5. Develop a woodland management plan
6. Follow through with your plan
SILVICULTURE STRATEGIES

TIMBER STAND IMPROVEMENT

HARVESTING STRATEGIES

PRUNING

REGENERATION STRATEGIES
TIMBER STAND IMPROVEMENT

1. WEEDING
2. CLEANING
3. IMPROVEMENT CUTTING
4. LIBERATION CUTTING
5. SANITATION CUTTING

BEFORE CUTTING

Overlay for Timber Stand Improvement
TIMBER STAND IMPROVEMENT

1. WEEDING
2. CLEANING
3. IMPROVEMENT CUTTING
4. LIBERATION CUTTING
5. SANITATION CUTTING

AFTER CUTTING
FOUR TIMBER

SELECTION

CLEARCUT

HARVESTING

SHELTERWOOD

SEED-TREE

TECHNIQUES
<table>
<thead>
<tr>
<th>SELECTION</th>
<th>CLEARCUT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROS:</strong> visually pleasing; site maintains protective vegetative cover.</td>
<td><strong>PROS:</strong> cost efficient; best for regenerating shade intolerant species; provides openings for certain wildlife.</td>
</tr>
<tr>
<td><strong>CONS:</strong> costly; could reduce overall woodland quality; not possible to regenerate shade intolerant species.</td>
<td><strong>CONS:</strong> may not be visually pleasing; one time harvest income; possible short term erosion problems.</td>
</tr>
<tr>
<td>SHELTERWOOD</td>
<td>SEED-TREE</td>
</tr>
<tr>
<td><strong>PROS:</strong> allows for regeneration of intermediate shade tolerance species; it is a good option for oak; site remains protected.</td>
<td><strong>PROS:</strong> same as clearcut.</td>
</tr>
<tr>
<td><strong>CONS:</strong> logging costs higher, more complex.</td>
<td><strong>CONS:</strong> same as clearcut; natural regeneration may not be reliable; remaining trees susceptible to wind damage.</td>
</tr>
</tbody>
</table>
Date of Survey: ________________________

Woodland Benefits Survey

Name: Number of acres in farm ____________
Address: Number of pastureland acres ____________
Number of cultivated acres ____________
Number of woodland acres ____________
Length of farm ownership ____________

IF YOU HAVE PREVIOUSLY COMPLETED THIS SURVEY, DO NOT DO IT AGAIN!

1. Check all appropriate reasons for owning your woodlot. Than rank only those reasons you marked with yes.

<table>
<thead>
<tr>
<th>Reason for Ownership</th>
<th>Yes</th>
<th>No</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firewood production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil conservation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It came with the farm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreation/aesthetics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timber production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water quality control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grazing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction of ownership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part of the farm operation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. How did you acquire your woodlands?

[ ] As a part of farm purchase
[ ] Direct purchase of only woodlands
[ ] Inherit
[ ] Gift
[ ] Other ____________________________

(If more than one box is checked, please give percent of woodlands acquired by that method.)
3. Please circle whether or not you have used your woodlands for the following benefits. Then rank only those benefits you marked with yes.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Yes</th>
<th>No</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income from timber sale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grazing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firewood or fence posts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreation and aesthetics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil conservation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction of owning forest land</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. If you checked "yes" for recreation and aesthetics, please check specific recreational benefits listed below.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Yes</th>
<th>No</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camping</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature appreciation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife (non-hunting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photography</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aesthetics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hiking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife (hunting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snowmobiling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-country skiing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. Which land-use assistance service(s) have you heard of? And which have you actually used?

<table>
<thead>
<tr>
<th>Service</th>
<th>Heard of</th>
<th>Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Conservation Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Forestry Consultants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>District foresters with Dept. of Natural Resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forestry Extension at Iowa State University</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other - Who?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Do you have a written management plan for your woodlands?  
   [ ] yes   [ ] no

7. Was the management plan developed with the aid of a professional forester?  
   [ ] yes   [ ] no

8. What forest management activities have you done within the last five years, and expect to do within the next five years.

   Last 5 years | Next 5 years
   ------------ | ------------
   Plant trees: |             |
   Weed control: |             |
   Prune or shear: |             |
   Build roads: |             |
   Thinning trees: |             |
   Harvest timber: |             |
   Other:                     |             |

9. Have you ever attended a Forestry Field Day sponsored by Forestry Extension at Iowa State University and supporting agencies?  
   [ ] yes   [ ] no

10. Are you a member of the Tree Farm System?  
    [ ] yes   [ ] no
DIRECTIONS:
FILL IN THE BLANKS with the word or phrase that best describes the part of the tree designated.

PARTS OF A TREE
**How A Tree Grows**

Match the word on the left with its function on the right. There may be more than one answer for each blank. You can use the letters at the right more than once.

| xylem     | A) growth area for new leaves, twigs, and flowers |
| phloem    | B) photosynthesis (making food for trees by combining carbon dioxide, water, and sunlight. |
| cambium   | C) support |
| leaf      | D) stores starches |
| heartwood | E) absorbs water and dissolved minerals |
| sapwood   | F) core of inactive cells |
| outer bark| G) area where sap rises from roots to crown |
| annual rings | H) place where food for seed production and new tree growth are stored. |
| root hairs| I) layer of cells that divide and grow to produce a new layer of bark and wood each year. |
| meristem  | J) protects tree from weather, insects, disease, fire, and animals |
| primary roots | K) one year of diameter growth |
|           | L) cells that transport sugars and starches to roots |
There are 38 trees listed - Can you find them?

ALDER  FIR
ASH    GINKGO
ASPEN  HACKBERRY
BASSWOOD  HICKORY
BEECH  HONEYLOCUST
BIRCH  HORSECHESTNUT
BOXELDER  JUNIPER
BUCKEYE  LARCH
BUCKTHORN  LINDEN
BUTTERNUT  LOCUST
CATALPA   MAPLE
CEDAR  MULBERRY
CHERRY  OAK
CHESTNUT  OSAGE-CRANE
COFFEE TREE  PINE
COTTONWOOD  SPRUCE
DOGWOOD  TREE-OF-HEAVEN
ELM    WALNUT
         WILLOW
Tree Identification Trivia

1. The _______ tree has leaves that look like oriental fans.
2. A veneer quality _______ could bring $2000 per thousand board foot.
3. Railroad ties, cooperage, and buildings were made from _______.
4. Hybrid ______ is now a good source of quick growing firewood.
5. From syrup to flooring, a _______ tree provides a variety of goods.
6. Although it isn't called a maple, this floodplain tree _______ is a member of that family.
7. The Amana Colonies still produce baskets made from _______ cuttings.
8. The hard wood of the _______ was used for fence posts. The tree itself was used for a living fence in southern Iowa.
9. The _______ was used as an urban tree by setters on the open prairie. Since it grew so quickly it also provided a quick source of firewood and low quality syrup.
10. _______ trees are Iowan's favorite species of Christmas trees.
11. An oak containing leaves with rounded lobes is a _______ oak.
12. A tree with oppositely arranged leaves and a lucky nut is the _______ _________.
13. The _______ tree has a round ball of spikes as its seed capsule.
14. A _______ bark canoe was used by the native Americans and early settlers.
15. Shagbark, mockjernut, and pignut are types of _______ trees.
16. The blue berries of the Juniper or _______ _______ are great for wildlife.
17. The European Bark Beetle transports a fungi deadly to the American _______.
18. A dominant understory tree of many central Iowa woodlands is the _______, which has a seed resembling a Chinese lantern.
19. The _______ _______ beans were ground up and used as a coffee substitute by early settlers.
20. A Marshalltown business makes decoys from the _______. (A tree that shares part of its name with a fish.)
21. Silver maple, hackberry, balck walnut, cottonwood, elms, and green _______ are trees found in bottomland communities.
22. A _______ can be identified by its warty bark.
23. The _______ is a forest edge shrub.
**Tree Identification Information Cards**

Directions: Cut out individual tree information cards. Provide each student with one card prior to taking a tree identification field trip. When a tree is identified, the student holding the associated information card should provide the additional information.

<table>
<thead>
<tr>
<th>Species: Eastern Larch</th>
<th>Silvical Characters: Shade intolerant; shallow root system; grows well on moist beaches and well-drained uplands.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species: Black Walnut</td>
<td>Silvical Characters: shade intolerant; grows best on fertile moist well drained soils</td>
</tr>
<tr>
<td>Species: Eastern White Pine</td>
<td>Silvical Characters: Shade tolerant when young, becoming tolerant with age; grows best on rich, porous moist soils.</td>
</tr>
<tr>
<td>Species: Shagbark Hickory</td>
<td>Silvical Characters: Intermediate tolerance; grows uphill and on south slopes.</td>
</tr>
<tr>
<td>Species: Red Pine</td>
<td>Silvical Characters: Intermediate in tolerance; grows well on light, sandy soils.</td>
</tr>
<tr>
<td>Species: White Oak</td>
<td>Silvical Characters: Intermediate in tolerance; grows well on dry to moist sites.</td>
</tr>
<tr>
<td>Species: Eastern Red Cedar</td>
<td>Silvical Characters: Intermediate intolerance; Adapts to a variety of sites but typical on poor dry, abused soils.</td>
</tr>
<tr>
<td>Species: Hackberry</td>
<td>Silvical Characters: Intermediate in tolerance; adapts to a variety of sites</td>
</tr>
<tr>
<td>Species: American Sycamore</td>
<td>Silvical Characters: Very intolerant; grows best on moist sites</td>
</tr>
<tr>
<td>Species: Eastern Cottonwood</td>
<td>Silvical Characters: Shade intolerant; floodplain tree</td>
</tr>
<tr>
<td>Species: Black Willow</td>
<td>Silvical Characters: Shade intolerant; grows best on floodplains and stream banks</td>
</tr>
<tr>
<td>Species: Black Cherry</td>
<td>Silvical Characters: Intermediate in tolerance; grows best on moist sites</td>
</tr>
</tbody>
</table>
Species: Honeylocust  
Silvical Characters: Shade intolerant;  
grows well on moist sites or also sandy locations

Species: American Basswood  
Silvical Characters: Shade tolerant;  
grows well on moist sites

Species: White Ash  
Silvical Characters: Intermediate in  
tolerance; grows well on moist sites

Species: Sugar Maple  
Silvical Characters: Shade tolerant;  
grows best on moist north-facing slopes

Species: Silver Maple  
Silvical Characters: Shade tolerant,  
grows well on moist sites, compacted  
sites, and flood plains

Species: Honeylocust  
Silvical Characters: Shade intolerant;
Soils: What Are They?

Objectives
1. Students will identify the major components of a soil sample.
2. Students will examine a soil for texture.
3. Students will analyze the physical differences among several samples of topsoil.

Supplies Needed: magnifying glasses, microscopes, a sieve, soil samples

Explain that in this activity, students will be investigating soils. Determine your students' level of understanding of soils by asking them to write the word that first comes to their mind when they hear the word "soil." Write several of the words on the board. Later explain that a soil is a naturally occurring mixture of mineral and organic materials with a specific structure and composition that develops on the surface of the land.

State that the best way to understand soil is to get really close to it and to examine it. Ask students to collect soils from many different locations. Have them volunteer to sample the top two inches of soil from a flower pot, a backyard, a schoolyard, an agricultural field, a woodlot, a forest, near a creek, etc. (You can collect samples from locations where you feel your students should not go, such as near a river or a cliff.) Students can bring them to school in a jar or in a plastic bag. When your students collect the sample, they should answer the questions in Part 1 and label their samples (i.e., location, date, weather, etc.).

When your students have brought in soil samples, conduct Part 2. Describe the major ingredients of soils and list the types of minerals and the particle size on the board. Students should use magnifying glasses, microscopes, or sieves of different screen size to examine their soil samples.

To conclude this first activity, ask students to examine at least three different samples and then record on the back of the activity sheet the information requested.

Students should save the soil samples for use in Activity 5.

Source: "Conserving Soils".

Permission of Soil Conservation Service
MICRO-PLOT Activity Information Sheet

221

Purpose: The purpose of this activity is to make students aware of the complexity of the woodland community as compared to other plant communities.

General Directions: You will need to take a field trip to do the Micro-plot Activities #1 & #2. You should take a micro-plot at: 1) an ungrazed woodlot; 2) a grazed woodlot; 3) a corn field; and at least one of the following: urban or school yard, pasture, or prairie area.

Micro-plot Activity #1 Use a wooden stake with a ten foot string attached to make a circular micro-plot. Mark the boundaries of the plot. Use Micro-plot Activity Worksheet #1 to record the plants and organisms at each site. Start with the organic layer of soil (if one exists). Identify or describe the plants, plant parts, and organisms found in that layer. Record your findings on Micro-plot Activity #1 Worksheet. Now dig a hole at least ten inches deep by ten inches square and look for plant life and organisms. Again, record your findings on the worksheet. Next record all the layers of plants starting from the ground up. When recording trees, identify the species and determine what part of the canopy they occupy (suppressed, intermediate, co-dominant, dominant). See the figure below.

[CROWN CLASSIFICATION]

D = DOMINANT  C = CO-DOMINANT
I = INTERMEDIATE  S = SUPPRESSED

Micro-plot Activity #2 Using the Micro-plot Activity #2 Worksheet draw a land profile of each area. Use Micro-plot Activity #1 Worksheet for that information. Then write a comparative description of the area including soil condition, plant communities and animal life. Explain the differences between that area and the other areas observed. This should be done after all the microplots have been completed.
### MICRO-PLOT Activity Worksheet #1

This worksheet helps in identifying and categorizing vegetation and soil layers within a plot. The categories include:
- **ungrazed forest**
- **grazed forest**
- **cropland**
- **prairie**
- **pasture**
- **urban yard**

#### Location Within Plot
- **In**
- **Soil Layer**
- **Organic Layer**
  - < 5'
  - 5'-15'
  - > 15'
- **Identification or Description**
- **Number Found**

**Legend:**
- **S** = suppressed
- **I** = intermediate
- **C** = co-dominant
- **D** = dominant
**MICRO-PLOT Activity Worksheet #2**

**LAND PROFILE - Description and Sketch**

<table>
<thead>
<tr>
<th>15'</th>
<th>15'</th>
</tr>
</thead>
<tbody>
<tr>
<td>10'</td>
<td>10'</td>
</tr>
<tr>
<td>5'</td>
<td>5'</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5&quot;</td>
<td>5&quot;</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ungrazed Woodland</th>
<th>Grazed Woodland</th>
<th>Cornfield (specify)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Description</td>
<td>Description</td>
</tr>
</tbody>
</table>


Definition of Terms

Cleaning: a thinning out of trees in an even aged stand of trees not beyond sapling stage. It is used to release competition by trees of the same size.

Clear Cut: a harvest technique where all trees of all sizes are removed from the designated area.

Commercial thinning: a partial removal of trees for timber stand improvement and financial gain.

Competition: the fight between trees for soil nutrients, water, and sunlight.

Coppice growth: the sprouts from roots and trunks of newly harvested trees. These sprouts are capable of regenerating the woodland area.

Coppice Management: accomplished by harvesting trees capable of coppice growth and using coppice growth as a means of regenerating the forest.

Crown: the top part of the tree containing branches, twigs, leaves, and winter buds.

Cutting Cycle: a period of time between major timber harvests. Also called rotation age. Examples include: 40 year cutting cycle, 50 year cutting cycle, or 80 year rotation.

Diameter: the distance across the center of the tree (usually measured at 4.5 feet above ground). It can be calculated by measuring the circumference (distance around) an object and dividing by pi or 3.14.

Even-aged Stand: a stand of trees approximately the same age. Tree plantations would fit into this group.

Group Selection: harvesting a small group of trees from a timber stand.

Harvesting: is the removal of trees from a wooded area for income.

Harvesting Technique: a method of removing trees. These techniques range from removing all the trees to only removing select trees. Examples include: block clearcut, shelterwood, selection, strip clearcut, patch clearcut.

Improvement Cut: a timber stand improvement strategy where all undesirable trees are eliminated. The purpose is to improve stand composition. This type of cutting is done in an immature stand of merchantable size trees.

Intermediate cuttings: cuttings made through the rotation period prior to harvest.

Liberation cut: a timber stand improvement strategy done in a young stand to release it from overhead competition from older poor quality "wolf" trees.
Mature tree: a tree that is ready for harvesting. The size depends upon the species and the intended use. Typically, for sawlog production, a tree should be greater than 16 inches in diameter.

Natural regeneration: occurs when natural forces (wind, gravity, wildlife, and rain) help establish a woodland area.

Non-commercial thinning: the removal or girdling of trees to improve stand composition and to decrease competition.

Over mature tree: a tree that has reached its maximum growth potential and may even be starting to die.

Pole: a tree that ranges in size from five inches to twelve inches in diameter and 15 feet to thirty feet tall.

Pruning: the act of removing major branches of trees. For commercial timber it is best to remove the branches before they reach three inches in diameter. This practice is done to increase the value of the final product.

Reforestation: planting trees in an area that was once forested, so it can be converted back into a forest.

Regeneration: the establishment of young trees to replace older trees.

Regeneration techniques: ways to establish a young forest. Possible options are: natural regeneration, coppice management, and tree plantings.

Salvage Cut: a cut made to remove dead and insect, disease, or wind damaged trees from a timber stand.

Sapling: a tree just beyond seedling stage. A sapling has a diameter greater than one half inch and less than five inches and is at least three feet tall.

Seed tree harvesting: a harvest technique where all the trees are removed except a few superior trees that are left to naturally regenerate the area.

Seedling: a tree that has just emerged from the seed or nut. A tree is considered a seedling until it reaches three feet tall and has a diameter greater than one half an inch.

Selection cut: a timber harvest technique where single trees are taken from the timber.

Shelterwood cut: a timber harvesting technique where the tree are removed in a series of cuttings for the purpose of seeding and protection. It is used with stands of trees with an intermediate shade tolerance such as white oak. In a shelterwood cut, first large "wolf" trees and understory trees are removed to create adequate sunlight for the oak seedling to get established. Once the seedlings are established the remaining large trees are removed.
Silviculture: the art and science of producing and tending a forest.

Single-tree selection: a timber harvest technique based on the merits of individual trees. It is a term used synonymously with selection cut.

Snag: a term used to describe any damaged, dead, or dying tree.

Stand vigor: the growth potential of a group of trees.

Strip clearcut: a harvesting technique where all trees in a designated linear area of timber are removed.

Thinning: the act of cutting out unwanted trees from a timber stand to improve growing conditions for the remaining trees.

Timber stand improvement (TSI): any intermediate cutting that involves an investment rather than a revenue.

Uneven-age stand: a woodland with trees ranging in age from seedling stage to sapling to pole to mature, to overmature to dead.

Weeding: a timber stand improvement strategy in which all poor quality small trees are removed.

Wolf tree: a large limby poor quality tree that occupies a large area of the woodland canopy.

Woodland Management: the art, science, and business of producing goods and services from a forest.
WOODLAND MANAGEMENT TERMS
Crossword Puzzle

DOWN
1. Art, science, and business of producing goods from forest areas
2. Variety of tree sizes and species
3. Converting an area back to forest
6. A type of regeneration
8. Ability to survive in the shade of other trees
10. A type of clearcut
11. A type of clearcut
12. Intermediate cutting in sapling stand
16. A type of regeneration
18. Removing undesirable branches
19. Tree health
21. Placing trees into the ground
25. A large limby tree

ACROSS
4. Tree capable of producing thin sheets of wood
5. Natural, coppice, and plantings
7. Removing dead or damaged trees
9. Producing and tending a forest
11. A type of clearcut
13. Distance across the plane of a circle
14. Removing trees for profit and pleasure
15. Removal of wolf trees from timber stands
16. Silent struggle for water, sunlight, and minerals
17. Selection of groups of trees for harvesting is called selection.
21. A type of clearcut
22. Timber stand improvement
23. Cutting single-trees from a woodlot
24. Leaves, twigs, and branches
26. Tree capable of producing lumber
27. Harvesting damaged or dead trees for money
LAND DESCRIPTIONS - How Would You Manage The Area?

Assignment: You will be divided up into groups and each group will be assigned one land description. As a group you must decide what your woodland management objective(s) will be. Then you will need to suggest a long-term plan of action. Your group will then report your woodland management decision to the rest of the class. The class will have an opportunity to challenge your decision. Good luck!

Description #1  A riparian community of willow, cottonwood, and silver maple is established in alluvial soils. The area is subject to frequent flooding. The trees form a 50 to 150 foot strip along the creek.

Description #2  A hilltop is established with 35% bur oak of > 20" diameter; 15% small diameter elms; 15% basswood of varying size; 15% red oak of >20" diameter; 10% small diameter sugar maple; 5% small diameter hackberry; and 5% large diameter white oak. The soils are a clay loam and moderately drained.

Description #3  A hillbase with soils that are sandy loam with some rocks that have been pulled downhill by the force of gravity. The timber composition is: 24% basswood of mixed sizes; 20% small diameter elm; 20% small diameter hackberry; 8% small diameter Kentucky Coffeetree; 8% large diameter red oak; 8% large diameter walnut; 4% small diameter black cherry; 4% ironwood; and 4% sugar maple of mixed sizes.

Description #4  This 100 acres is near a floodplain community. It has a fertile, well drained black soil. The trees on this site include: 42% large diameter bur oak; 12% small diameter hackberry; 9% small diameter elm; 9% walnut 14" to 17" in diameter; 9% large diameter white oak; 9% small diameter black cherry; 3% large basswood; and 3% large ash.

Description #5  This site contains forty acres of scotch pine, white pine, and red pine. The trees are three years old and are having some problems with weed competition. The site is a moderately drained soil with a moderate clay content.

Description #6  This site contains no trees. It is a hill with a 30 percent south facing slope. The soils are classified by the Soil Conservation Service as Soil Suitability Class VIIe.
LAND DESCRIPTIONS - How Would You Manage The Area?

Teacher Discussion Guide

Purpose:
The purpose of this activity is to give students an opportunity to apply and evaluate the information they have learned in this unit.

Directions:
Divide the class into six groups. Give each group one land description. That group must decide how they would manage their site. Allow at least fifteen minutes for the groups to discuss their management strategies. Then have each group read their site description and tell how they decided to manage the area. Have an open discussion after each group presentation. (Note that descriptions #1, #5, and #6 are somewhat easier than #2, #3, and #4. Provide the easier problems to students having difficulty learning the material.)

Suggestions for Leading the Open Discussions

Remember, the students should use what they have learned. They are not expected to be forestry professionals upon completing this activity. Their final land use management suggestion is not as important as how and why they chose that management strategy. Encourage the students to think through the steps to woodland management. Make sure they identify their woodland management objective(s). Did they develop a long-term plan of action, when appropriate? Discuss whether or not their plan of action would help them reach their management objectives. Determine if they considered forest biology (matching species to site, soils, and topography; consider shade tolerance of trees; and considered regeneration strategies), when appropriate.

Below are some possible land use alternatives for each site.

Description #1

Option #1 : Soil Conservation
Action Leave the area as it is; Protect it from grazing livestock.

Option #2 : Firewood Production
Action Initially use selection harvest to remove trees. Eventually small clear cuts will have to be used so the shade intolerant tree species of the riparian community can survive. Do not cut within fifty feet of the stream bank. Leave some good quality trees to rejuvenate the area. Protect the area from grazing livestock.

Option #3 : Wildlife Habitat
Action Leave as is, protect from grazing livestock, build nesting boxes for birds.
Description #2

Option #1: Firewood Production/Sawlog Production
Action: Remove poor quality, insect and disease infected trees, and trees of little or no commercial value (hackberry, elms). Protect the area from grazing livestock.

Option #2: Maple Syrup Production
Action: Manage for maple trees. Since maple trees are shade tolerant, you should maintain the forest canopy. Some thinning can be done. However, too much thinning could create openings that would benefit weed competition. Protect the area from grazing livestock.

Option #3: Wildlife Habitat
Action: Manage for mast producing trees such as oaks, also maples can provide wildlife food. Create openings to provide forest edge. Leave some den trees for cavity nesting birds, squirrels, and raccoons. Protect the area from grazing livestock.

Option #4: Recreation Management
Action: Create trails, camping areas, or picnic areas in the woodlands. Select areas that are relatively level. Remove all dead trees from the designated recreation area so that they will not fall and cause damage to you or your property.

Description #3

Option #1: Sawlog/Veneer and Firewood Production
Action: Remove poor quality, insect and disease infested, and non-commercial species (elm, ironwood, Kentucky Coffeetree). Protect the area from grazing livestock.

Option #2: Maple Syrup Production
Action: See information in Description #2

Option #3: Wildlife Management
Action: See information in Description #2

Option #4: Recreation Management
Action: See information in Description #2
Description #4

Option #1: Black Walnut Production

Action #1: Remove all species except walnuts and plant to walnut trees where stocking is not adequate. Protect the area from grazing livestock.

Action #2: Manage for black walnut in pockets where walnut already exists. Manage the remaining areas for other species or clear in at least 150 foot strips and plant to walnut. Protect the area from grazing livestock.

Option #2: Sawlog/Firewood Production

Action: Remove over mature bur oak trees for firewood. Also remove elm and hackberry. Check for regeneration of commercial tree species. Develop strategies for maintaining these species before cutting is done. Protect the area from grazing livestock.

Option #3: Wildlife Management

Action: See wildlife information under Description #2

Option #4: Recreation Management

Action: See recreation information under Description #2

Description #5

Option #1: Christmas tree production (Best Option)

Action: Continue using the area for Christmas tree production. Protect the site from grazing animals (livestock, deer, rabbits, mice).

Option #2: Wildlife Habitat

Action: Leave as is. As the plantation grows consider creating a pattern of trees, grassland, shrubs in the area. Protect the site from grazing livestock.

Description #6

Option #1: Soil Conservation/Tree Plantation

Action: Establish woodland, prairie land, or grass land on the area to help control erosion on Class VII subclass e (erosion) lands. Since this land is on a south facing hill side, select oaks, hickory, pines. Protect the site from grazing livestock.
Homesteaders in much of Iowa faced a vast, treeless prairie (right). The soil was rich but the lack of wood was a major problem. Many farmsteads and towns still have large silver maples (above) and other fast-growing species planted by settlers.

By Reinee Hildebrandt

"Verdant vales, interspersed with towering oaks" was how Iowa's woodlands were described in John B. Newhall's Guide for Englishman around 1832-1844. Yet when the settlers arrived in Iowa they found more disconnected woodlands on banks of perennial streams, clay hills, sandy and rocky ridges than verdant vales interspersed with towering oaks. Although, these areas did exist.

The state was a prairie state where dangerous prairie fires raged over miles and miles of countryside. These fires kept the forest resources, which the pioneers needed so desperately, to a minimum by restricting them to stream bottoms or areas protected by natural fire breaks.

By Reinee Hildebrandt

There were three essential natural resources that the pioneers needed—food, water, and woods. Forest land was in very high demand for building houses and other buildings, for heating homes, and for fencing. Iowa only had 19 percent of its acreage in timber. Those trees were old and often scrubby, storm-tossed and fire-scarred.

Woodland resources were important to the settlers' choice of where to live. Iowa's lack of woodlands actually slowed the settlement of the state and when Iowa was being settled the property near a good supply of wood was the most demanded. In Cedar County in 1850 to 1870, wooded lands were worth $10/acre, and prairie land (which is now highly valued crop land) could be had for the asking. In other cases when all the land was sold for $1.25/acre (in accordance with the Homestead Act) forest land often had to be purchased at second rates from $8 to $15 per acre.

Those settlers who were not fortunate enough to have a wood supply of their own had to purchase materials. According to Dr. George W. Thomson, Dept. of Forestry, Iowa State University, the cost of fencing was a severe burden to those who settled on the prairie. While it cost $50 to purchase 40 acres of homesteaded prairie, it would cost $560 to fence it.

Woodlands were essential to the settlers, yet some trees were more important than others. Settlers used certain species for certain purposes.

FENCING

Pioneers used whatever species were readily available for fencing materials. Locust, cedars, white oak, walnut, and hardy catalpa were highly demanded because they lasted for 12-25 years depending on the species. Less fortunate settlers who used ready supplies of soft maple, boxelder, cottonwood, elm, ash, and willow had to reset these short lived posts every three to six
years. During early settlement char-
ing the end of the post that would come into contact with the ground was the early settlers technique for increasing the longevity of the post. Reports indicate this technique added five years to the post’s life.

With the invention of creosote treatment for logs around 1910, it became economical to use posts of elm, ash, cottonwood, willow, maple, sycamore, red oak, and hickory. This treatment cost 15 cents per post and increased the service of the post from about five years to 15 to 20 years.

Another tree species — the osage orange (Maclura pomifera), an introduced species, was also used for fencing. While some settlers attempted to use its obnoxiously hard wood as posts, most settlers planted it as living fence and shelterbelt. By the mid 1850’s hedges as fences had become common practice across southern and parts of eastern Iowa. The osage orange or “hedge” tree, as some people called it, was easily transplanted. It could tolerate both wet and dry soils, had no disease or insect pests, and could tolerate both extreme winds and temperatures. Its thorny branches provided a impenetrable barrier to livestock. Once it was established, provided an impenetrable barrier to disease or insect pests, and could tolerate both extreme winds and temperatures. Its thorny branches provided a legal fence for the landowners.

BUILDINGS

The black walnut and the mighty oaks were used for a number of products such as houses, barns, sheds, railroad ties, and fuelwood. Many barns were made of black walnut because it is naturally durable. The red and white oak were the best oak trees for buildings. However, the bur oaks had their own attraction to the settlers. Settlers who arrived from the east had expectations of “verdant vales, interspersed with towering oaks.” In some places they found parklike stands of bur oaks called “oak groves” or “oak openings.” These areas were favorite homesteads.

URBAN FORESTS

Since these parklike areas were not available for all the settlers, other settlers had to homestead on the great prairie. Here they had to plant trees to provide shade, shelter, and fuelwood. These settlers were accustomed to forest and tree-lined streets of the east. They needed fast-growing trees that were hardy and adaptable. In some cases, the tree’s appearance was only a secondary criteria for choice. Boxelder (Acer negundo), silver maple (Acer saccharinum), and eastern cottonwood (Populus deltoides) were first choices because of their fast growth rate. Silver maple was one of the most popular shade trees especially of prairie towns of western and central Iowa. The maples were planted side by side with American elm, which has a medium growth rate, when there was room for trees of their size.

FOOD

Food was another requirement of the settlers which the woodlands were used for. The woodlands contained both plants and animals useful to the settlers. Squirrels, deer, opposums and raccoons were plentiful as a source of meat. Walnut trees, mulberry trees, gooseberry bushes, hazelnut bushes, raspberry and blackberry bushes, and rose hips from rose bushes, provided nuts and berries for the settlers. Maple trees and bee hives in hollow trees provided natural sugars for the person with a sweet tooth. A variety of mushrooms such as the common morel were available. Other plants such as the common woodland violet were used for medicines.

THREAD AND CORD

The red mulberry bark contains very tough fibers. These fibers have been used by Choctaw Indians in Southeastern U.S. for making cloaks and by the Spanish conquistadors for ship ropes. Iowa’s pioneers used these materials also for ropes and fibers. The basswood trees tough, fibrous inner bark or “bast” was used for making cords, thongs, and ropes.

RECREATION

Trees, believe it or not, were also used for recreation. Willows and basswood were used for whittling “folk lore” toys. Whittling on these soft woods was in itself a form of recreation. Willows had a special recreational use all their own. In the spring when the bark was slippery they could be made into willow whistles. The woodlands themselves were also used by children taking hikes to pick wildflowers or walking barefoot down a woodland stream.

The woodlands were more than a group of plants to these early settlers. They were their existence. Early settlers relied on the woodlands for food, shelter, heat for winter warmth and for cooking, food, and recreation. They were a vital part of early settlers’ lives. To them elimination and ruination of the woodlands would have been a foolish gesture. Their day-to-day living relied heavily on Iowa’s woodland resources. Perhaps it is time for today’s Iowan’s to reconsider the importance of trees in their lives.

REFERENCES


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5. Realms of the Soil

The thin layer of soil that forms a patchy covering over the continents controls our own existence and that of every other animal of the land. Without soil, land plants as we know them could not grow, and without plants no animals could survive.

Yet if our agriculture-based life depends on the soil, it is equally true that soil depends on life, its very origins and the maintenance of its true nature being intimately related to living plants and animals. For soil is in part a creation of life, born of a marvelous interaction of life and nonlife long eons ago. The parent materials were gathered together as volcanoes poured them out in fiery streams, as waters running over the bare rocks of the continents wore away even the hardest granite, and as the chisels of frost and ice split and shattered the rocks. Then living things began to work their creative magic and little by little these inert materials became soil. Lichens, the rocks' first covering, aided the process of disintegration by their acid secretions and made a lodging place for other life. Mosses took hold in the little pockets of simple soil—soil formed by crumbling bits of lichen, by the husks of minute insect life, by the debris of a fauna beginning its emergence from the sea.

Life not only formed the soil, but other living things of incredible abundance and diversity now exist within it; if this were not so the soil would be a dead and sterile thing. By their presence and by their activities the myriad organisms of the soil make it capable of supporting the earth's green mantle.
Also present in prodigious numbers are microscopic mites and primitive wingless insects called springtails. Despite their small size they play an important part in breaking down the residues of plants, aiding in the slow conversion of the litter of the forest floor to soil. The specialization of some of these minute creatures for their task is almost incredible. Several species of mites, for example, can begin life only within the fallen needles of a spruce tree. Sheltered here, they digest out the inner tissues of the needle. When the mites have completed their development only the outer layer of cells remains. The truly staggering task of dealing with the tremendous amount of plant material in the annual leaf fall belongs to some of the small insects of the soil and the forest floor. They macerate and digest the leaves, and aid in mixing the decomposed matter with the surface soil.

Besides all this horde of minute but ceaselessly toiling creatures there are of course many larger forms, for soil life runs the gamut from bacteria to mammals. Some are permanent residents of the dark subsurface layers; some hibernate or spend definite parts of their life cycles in underground chambers; some freely come and go between their burrows and the upper world. In general the effect of all this habitation of the soil is to aerate it and improve both its drainage and the penetration of water throughout the layers of plant growth.

Of all the larger inhabitants of the soil, probably none is more important than the earthworm. Over three quarters of a century ago, Charles Darwin published a book titled *The Formation of Vegetable Mould, through the Action of Worms, with Observations on Their Habits*. In it he gave the world its first understanding of the fundamental role of earthworms as geologic agents for the transport of soil—a picture of surface rocks being gradually covered by fine soil brought up from below by the worms, in annual amounts running to many tons to the acre in most favorable areas. At the same time, quantities of organic matter contained in leaves and grass (as much as 20 pounds to the square yard in six months) are drawn down into the burrows and incorporated in soil. Darwin’s calculations showed that the toil of earthworms might add a layer of soil an inch to an inch and a half thick in a ten-year period. And this is by no means all they do; their burrows aerate the soil, keep it well drained, and aid the penetration of plant roots. The presence of earthworms increases the nitrifying powers of the soil bacteria and decreases putrification of the soil. Organic matter is broken down as it passes through the digestive tracts of the worms and the soil is enriched by their excretory products.

This soil community, then, consists of a web of interwoven lives, each in some way related to the others—the living creatures depending on the soil, but the soil in turn a vital element of the earth only so long as this community within it flourishes.
Forest Structure

A forest is much more than the tall trees that dominate it. A number of other plants grow at various predictable positions beneath its canopy. In very complex forests—a tropical rain forest, for example—there are five or six layers of plants, each consisting of many species. In Iowa forests, in addition to the dominants, there are four distinguishable strata: the understory, the shrub layer, the herb layer, and the ground layer. Each forest stratum has slightly different physical conditions to which its species have been able to adapt. Within a stratum, each species has evolved a special set of characteristics that make it better able than any other species to survive and prosper in its own special niche.

The understory of an Iowa forest usually contains some young canopy trees, but many of its characteristic species are different. Probably the most representative and widespread understory tree is ironwood. Also called hop-hornbeam, ironwood is frequently a crooked tree up to eight inches or more in diameter and approximately twenty feet tall. It is especially easy to identify early in the fall, when it bears pendulous dry fruits resembling clusters of hops. On lower slopes, where there is more moisture, the American hornbeam (also called blue beech and, confusingly, ironwood), may be found. Closely related to ironwood, its sinewy trunk is covered with smooth gray bark. Another small tree, sometimes found in the understory, is the alternate-leaved dogwood. Reminiscent of the flowering dogwood of the southeast, it is not nearly as spectacular in flower, but is completely redeemed by its splashy red, autumn foliage.

The shrub stratum of the mature forest is usually not a continuous layer, but consists of clumps of various shrubs scattered more or less at random. Sometimes these shrubs appear to be more prosperous where patches of sunlight have leaked through the tree canopy. In Iowa they may include such common and easily recognized species as the gooseberry, with its prickly stems and edible fruits, and the viburnum with its arrow-straight stems. Also likely to be found are the coralberry, sometimes called buckbrush, its crimson foliage adding to the fall colors near the ground; several species of dogwood with interesting fruit clusters and often, brightly colored stems, and the curious hazelnut, its male flowers in pendulous catkins remaining on the bush through winter.

The herb layer is composed of nonwoody species that grow above the ground and beneath the shrubs. Most Iowa forest herbs die back to the ground or below in winter and are renewed in spring either from seeds or from underground parts that tolerate winter subsurface temperatures. Among various herb forms are the grasses and the grass-like sedges. Sedges, in fact, are often the most abundant species in the herb layer. To distinguish them from the grasses, look closely at the lower stem and the way in which its leaves are attached. The sedges are distinctly triangular in cross-section, while the grasses are round.

In the herb layer, Iowa’s incomparable spring wild-flower display occurs, only to give way in a few weeks to the less spectacular summer woodland plants. Here, too, woodland ferns appear, growing best in more moist and protected spots. In this dense and busy forest stratum, you may learn about the medicinal plants, the poison plants, the dye plants, and the edible plants. Alternatively, your curiosity may be piqued by the bees’ favorites or by wild herbs and spices, or by plant potions and remedies from folklore. The herb layer can be the most fascinating of the forest layers and is also the most diverse.

Emerging through the herb layer, and making their way into the crowns of the dominant trees, a group of aggressive vines make up a conspicuous part of the forest’s structure. Dependent upon the larger plants for support, the vines often spread from tree to tree, in a sense sewing the canopy together. Most common among these curiosities are poison ivy, the Virginia creeper, and the wild grape.

Lowermost of the structured Iowa forest’s definable strata is the ground layer. Here fungi break down dead plant and animal tissues and start the return back into the natural nutrient cycle. Here, too, to the mushroom hunter’s delight, following spring rains, morels push up among the dead leaves.

Mosses, liverworts, lichens, and other small ground layer plants are often overlooked as we walk through the woods. They do much to stabilize and enrich the forest soil but, because they are relatively inconspicuous, few people are aware of them.

A once proud tree, draped in a green mossy blanket, returns to the earth whence it came.

(Right) Bigtooth aspen leaves and those of quaking aspen, brighten the forest floor in eastern Iowa.

Source: "Iowa's Natural Heritage" Permission by: Iowa Natural Heritage Foundation
Many people consider Iowa's soil resources to be our most precious natural heritage. Thick, nutrient-rich soils, blessed with favorable temperatures and ample rainfall, have made Iowa agricultural production the envy of the world. No other state has a higher proportion of land in food production than our state; three of every four acres are devoted to cropland.

Our soil is a unique resource, comprising the greatest concentration of prime farmland in the world. Recent USDA inventories report that nearly one-fifth of the best cropland in the United States is found in Iowa. Fertile, black topsoil, reaching an average depth of 14 inches or more, is the "black gold of Iowa."

The largest part of our rich inheritance of soil was formed under great expanses of tall grass prairie that once covered the state. The fibrous root systems of grasses and forbes contributed plant material to the soil that decomposed, releasing abundant nutrients. These soils have a strong granular structure that allows them to remain workable even after many years of cultivation. However, breaking up the prairie sod often required as many as seven yoke of oxen to pull a single plowshare.

Large areas of prairie were poorly drained and thought to be unfit for farming by early settlers. In prairie sloughs and potholes, vegetation grew so well that the process of decay fell behind and peat bogs were formed. These peat deposits, sometimes up to 20 feet deep, often caught fire and burned out of control for years. The smell of burning peat was a familiar one to early settlers in central Iowa. As methods of draining land were developed and clay tile became available, these wet prairie areas became some of the most productive of the prairie soils.

Soils found under forest vegetation make up the second largest portion of our state's soil resources. Early settlers chose these woodlands over the less familiar prairies. Availability of firewood and logs to build cabins influenced their choice, but this land also was much easier to break up for farming than the deep prairie sod. Topsoil developed under woodlands is thinner and often lighter in color than that developed under prairie. A gray subsurface layer is often associated with soils developed under forest vegetation. For this reason, these kinds of soils were called "white oak soil" by the early pioneers.

Source: "Iowa's Natural Heritage"  Permission by: Iowa Natural Heritage Foundation
Management Quiz

Matching

In the blank provided, place the letter in front of the appropriate response on the right.

___ woodland management  A. root and stump suckers
___ silviculture  B. a new crop of trees
___ pruning  C. removing unwanted branches
___ regeneration  D. a timber harvest done in phases
___ coppice  E. art, science, and business of producing and maintaining woodland areas for future benefits and services
___ clearcut  F. removing all trees during harvest
___ shelterwood  G. planting trees to convert an area back to forest
___ selection  H. art and science of growing and caring for trees
___ reforestation  I. managing an area for more than one benefit
___ multiple use  J. harvesting only the "best" trees
___ timber stand improvement  K. thinnings or cuttings done to release competition and improve growing conditions for remaining trees.

Short Answer

1. You come home from school and your parents are in the process of hiring someone to bulldoze the timber and convert it to row crop. When you confront your parents they say, "So what good is it?" List the economic and non-economic benefits that can be derived from woodland management.
2. They still aren't convinced. Explain how woodland management can be integrated into traditional agricultural systems.

3. As you are riding to school on the bus, a little girl states, "I don't like the forest. It's full of scary things and they are all dead." Explain to her all the living things that make up a woodland.

Fill in the Blank

On the page provided, fill in the blank with the name of the appropriate tree part.
APPENDIX D - WOOD AS ENERGY
WOOD AS ENERGY-
PRODUCTION AND MARKETING

Instructional Materials Developed
for
Iowa Teachers of Vocational Agriculture

Prepared by:
DEPARTMENTS OF FORESTRY AND AGRICULTURAL EDUCATION
IOWA STATE UNIVERSITY
AMES, IA
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UNIT OBJECTIVES

Upon completion of this unit the student should be able to:

1. Explain how wood for energy production can help improve our woodlands.
2. Explain what a person should know before they begin cutting down trees for fuelwood.
3. Determine the proper steps to take in cutting down trees for fuelwood.
4. Explain the post-cutting activities a person should do before marketing or utilizing fuelwood.
5. Determine strategies for marketing fuelwood.

TOPIC 1 - INTRODUCTION AND INTEREST APPROACH

Objectives:

1. Define the terms: BTU, standard cord, face cord, rick, cubic foot.
2. Determine the number of cords in a given stack of wood.
3. List the top three tree species for providing the most BTU's/cord.
4. Determine which species provide the most BTU's per acre per year.
5. Explain the relationship between weight and amount of heat per species.
6. Explain the effect of log size and uniformity on the actual cubic foot content of a cord of wood.

VISUAL MASTERS

1. What is a Cord?
2. Cord Determination.
4. Rating for Hardwood Firewood.
5. Benefits of Iowa's Woodlands
6. Trees to Remove for Firewood.
7. Spacing Crop Trees.
8. The Right Cuts.
10. Chain Saw Parts
11. Different Wood Splitters.

ACTIVITIES

1. Cord Determination #1
2. Selecting the right tree
3. Cut that Firewood, Sammy!

Prepared by:
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Teaching Procedure:

1. Have students read technical information entitled Wood as Fuel. Summarize "Background Information" and "Measuring Firewood" sections.

2. Refer to visual "What is a Cord". Help the students determine a cord.

3. Activity 1: Take the class to a pile of wood. Divide the class into two groups. Have one group stack a standard cord of wood and the other stack a face cord of wood. Have each group measure the appropriate dimensions of each cord. Ask them which cord they would rather purchase if each sold for the same price.

5. Take the class to three large stacks of firewood. Divide the class into three groups. Have each group determine the number of cords in their stack.


7. Activity #3: Determining Cubic Foot Content.
   a. Using the stacks of wood from Activity 2, have students determine the cubic foot content by placing a 1/2" square wire mesh over end of cord.
   b. Have students count the number of squares that have at least 1/2 total air space.
   c. Have students determine the total number of squares.
   d. Divide the number of squares containing air space by the total number of squares to obtain the percent of the volume that is air space.
   e. Take the resulting number and multiply it with the total cubic foot volume of a cord (128 cu. ft.) to find out the total cubic feet volume of the stack of wood.

8. Do optional experiments (Ease of Splitting, Rate of Burning, Weight, Wood Comparison).

TOPIC 2 - PRE-CUTTING ACTIVITIES

Objectives:

1. Define: weed trees, TSI, wolf tree.
2. Explain how firewood cutting can affect timber resources.
3. List four criteria for selecting trees to be thinned out.
4. Describe how removing trees for firewood can enhance the development of the timber stand.
5. Visit a wooded area to:
   a. identify trees
   b. determine if a given stand needs to be thinned.
   c. mark appropriate trees for firewood production or develop a timber cutting scheme that considers Timber Stand Improvement (TSI) for saw log production, recreation, or wildlife.
6. Assess the potential market for firewood in your area.
7. Describe alternatives for marketing firewood.
8. Develop a marketing strategy.
9. Explain how to properly use a chain saw (include safety requirements):
   a. list the parts of a chain saw.
   b. list safety considerations in operating a chain saw.
   c. list the steps in chain saw maintenance.

Teaching Procedure:

Part 1 - Planning a Fuelwood Cutting

1. Ask your district forester to talk to the class about TSI.

2. Have students read the technical information entitled Pre-Cutting Activities.

3. Discuss the information in Pre-Cutting Activities.
   a. Refer to visual "Benefits of Iowa’s Woodlands" to show students the management objectives a person could adopt. Emphasize selecting trees for removal that help meet management objectives.
   b. Refer to visuals "Trees to Remove for Firewood" and "Spacing Crop Trees" to show tree selection for timber stand improvement.
4. Activity #1: Selecting the Right Trees. Use activity sheet, "Selecting the Right Trees". Have students mark an X through the base of the trees they would cut out.

5. Show slides (included with this unit) of common trees in Iowa.

6. Activity #2: Field Trip to Local Woodlot
   a. Explain how to use Extension Publication #Pm-970, "Key for Trees of Iowa".
   b. Take students to a local woodlot.
   c. Identify trees using the "Key for Trees of Iowa".
   d. Flag all weed trees, wolf trees, and trees of poor quality.

7. Activity #3: Quality Determination
   a. Randomly select 5 points on the woodlot (which was marked in Activity #2) and have students mark a 100' circle around each point.
   b. Have students count the total number of trees in each circle.
   c. Have students count the total number marked trees. Have students calculate the percentage of marked trees using this formula: Number marked trees / total trees * 100 = % of marked trees.
   d. If a district forester can attend, have him/her to help the students to determine if cutting out all of the marked trees open up the woodland stand too much. If the answer is yes, then the forester should help them determine the proper stocking level. To do this establish a list of criteria for cutting out trees and then prioritize the list from first to cut to last to cut.

Part 2 - Marketing

Teaching Procedure:

1. Use visual "Steps in Preparing Firewood for Market".

2. Activity 1: Market Determination
   a. Have students develop a marketing analysis survey that includes:
      - who purchases firewood.
      - the prices paid for firewood.
      - what species of firewood are preferred.
      - how firewood is sold in the area (truck load, bundles, etc.).
      - determine how many people prefer to have firewood delivered and/or stacked.
   b. Have students survey a sample of the community and compile the results.
   c. Discuss the survey results and draw conclusions.
   d. Organize the conclusions into a marketing strategy.

3. Activity 2: Marketing Firewood
   a. Use the marketing strategy developed in Activity 1.
   b. Secure a source of firewood.
   c. Have students develop advertising fliers and a newspaper ad.
   d. Market the firewood to the community.
   e. Keep records of all transactions.
   f. Discuss and evaluate the activity.

Part 3 - Chain Saw Safety

1. Preview film on chain saw safety. Two appropriate films are: "Safety is No Accident" and "Do It Right". See the reference section. List on the board, the most important points from the film.

2. Refer to the points on the board and then show the film to the class.
3. Discuss the important points from the film.

4. Have the students read the technical information entitled Chain Saws.

5. Discuss the important points in Chain Saws.

6. Activity #4: Chain Saw Fashion Show. Have one student dress properly and one dress improperly for operating a chain saw. Have the class point out what is right and what is wrong.

7. Ask a local dealer to give a demonstration on the proper use of a chain saw, felling techniques, and safety.

TOPIC 3 - CUTTING ACTIVITIES

Objectives:

1. Diagram the proper way to cut down a tree.
2. Cut down enough trees to make a cord of firewood.
3. List 11 points to keep in mind while limbing a tree.

Teaching Procedure:

1. Have students read the technical information entitled Cutting Firewood.
2. Discuss the important points in Cutting Firewood. Use visual "The Right Cuts".
3. Field Trip (select one)
   a. Ask a commercial firewood producer (select a safety conscious person) to demonstrate tree felling.
   b. Observe the logging activity in the local area or attend a field day.

TOPIC 4 - POST-CUTTING ACTIVITIES

Objectives:

2. Discuss the various ways to split wood. Include the advantages and disadvantages of drying firewood.
3. Explain the advantages of drying firewood.
4. List various ways to stack and dry wood.
5. List the proper drying procedure for firewood and explain the effect of length of time for drying on percent of heat efficiency.
6. Explain the benefits of proper firewood storage.
7. Properly split, stack, and dry a cord of firewood.

Teaching Procedure:

1. Have students brainstorm what steps they need to consider in marketing their firewood once it is cut.
2. Have students read the technical information entitled Post-Cutting Activities.
3. Discuss the important points in Post-Cutting Activities. Use the visuals: "Steps in preparing wood for use and market", "Different wood splitters" and, "How does it stack up?"
4. Activity #2: Log Splitting Demonstration. Ask a commercial firewood producer or log splitter sales representative to give a demonstration to the class on the proper use of a log splitter. If this is not possible consider a teacher demonstration.
TOPIC 5 - NON-TRADITIONAL WOOD FOR ENERGY USES

Objectives:
1. Define the terms: biomass, wood for energy, energy plantation.
2. List the types of biomass fuel.
3. List the types of wood products used for biomass.
4. Explain what an energy plantation is.
5. List 3 species to plant in an energy plantation.
6. Plan an energy plantation:
   a. Species selection
   b. Spacing requirements
   c. Regeneration
7. Determine when to harvest the energy plantation crop.

Teaching Procedure:
1. Have students read the technical information entitled Biomass Production.
2. Activity 1: Biomass ID Quiz
   a. Obtain samples of the various wood biomass products.
   b. Number the samples and provide the names of the products to the students.
   c. Ask the students to name the products.
   d. Go over the names of the products with the students and explain the advantages and disadvantages of each product.
3. Activity 2: Energy Plantations
   a. Have students read the technical information entitled Energy Plantations. Discuss the most important points.
   b. Divide the class into groups of two and give each group a piece of graph paper (1/2" squares).
   b. Designate the scale for the squares and give the class symbols to use for different tree species.
   c. Have the students draw a plan for an energy plantation.
   d. Discuss the plans:
      - Number of species
      - Choice of species
      - Row spacing
      - Harvest rotation

TOPIC 6 - A FIREWOOD BUSINESS

Objectives:
1. Determine what records need to be kept for tax purposes.
2. Determine the cost of a cord of firewood.
3. Analyze the cost of various transportation methods.
4. List the types of accounts that need to be maintained.

Teaching Procedure:
1. Ask students which cord of wood costs more: a cord that was free from a woodlot 50 miles away or a cord that costs $25.00 that is 10 miles away.
2. Refer to Extension Publication F-335, "Cost of Cutting Your Own Firewood".
3. Activity #1: Do the "Cut that Firewood, Sammy!" activity.
4. Have students read the technical information entitled "A Firewood Business". Discuss this information bringing out the following points:
   a. The importance of keeping good records.
   b. What records need to be kept.
   c. Help the students understand how record keeping can affect the tax burden of a firewood producer. Contrast keeping records of cost of wood versus cost of wood plus other expenses listed in Activity #1.
5. Activity #2: Keeping records
   a. Have the class develop a record keeping system for an actual or simulated firewood business.
   b. Have the class determine their costs, revenue, and profit before and after taxes.
c. Have the class determine their tax burden if they did not use capital gains and/or only recorded the cost of the wood rather than including the cost of cutting the wood.

SUGGESTED REFERENCES


WOOD AS FUEL

Firewood production has become a popular alternate source of energy for many homeowners. Many people enjoy cutting firewood for the exercise, others do it out of economic necessity, while even others have developed successful firewood businesses. Since the increase in popularity of cutting firewood, some of Iowa's woodlands have suffered increased exploitation. Many people simply start at one end of the woods and cut to the other end. This practice simply eliminates our already scarce woodland resources. It is time people learned to extract firewood in a manner which will improve the quality of the woodlands and maintain their existence.

By cutting out the right trees, there is reduced competition for light, water, and nutrients among the trees which remain.

Background Information

Whether you intend to be a firewood consumer or producer, it is important to know about your product. First, how is the product sold? Firewood can be sold by the standard cord, face cord, truck full, bundle, or rick.

A standard cord is the most reliable measure of firewood. It is a stack of wood 8'x4'x4'. A face cord may look like a standard cord at first glance, since the length and height dimensions are 8'x4'. However, the width dimensions can vary from 3 inches to 4 feet. Therefore, if the same price is paid for a standard cord as a face cord the consumer could get short-changed by agreeing to purchase the face cord.

When a person buys wood by the truck load, the load size may vary from 1/4 a cord to 1/2 a cord. Truck loads sell for $35 to $75. The least economical way to purchase wood is purchasing it by the bundle. If figured on a per cord basis the bundle can cost as much as $350/cord.

Provided that you are dealing with only a standard cord, there are still variations in the actual cubic foot content, weight, and number of BTU's of energy each cord has. This variation is determined by the size and uniformity of the logs in the stack, plus the tree species.

A stack of large, uniform, cylindrical shaped logs will have less air space between logs than a stack of irregularly shaped logs. This means there will be more cubic feet of wood. Large, uniform logs also have less airspace than small, uniform logs.

The other major variable is the tree species used. If you have ever held an equal-sized piece of oak in one hand and basswood in the other hand, you know that there is a definite difference in weight of woods.
Weight per standard cord of Iowa hardwoods at 20 percent moisture content.*

<table>
<thead>
<tr>
<th>Species of Wood</th>
<th>Weight (lbs.) per cord</th>
</tr>
</thead>
<tbody>
<tr>
<td>osage orange</td>
<td>4800</td>
</tr>
<tr>
<td>black locust</td>
<td>4200</td>
</tr>
<tr>
<td>shagbark hickory</td>
<td>4100</td>
</tr>
<tr>
<td>white oak, ironwood</td>
<td>3800</td>
</tr>
<tr>
<td>red oak, white ash</td>
<td>3500</td>
</tr>
<tr>
<td>hard maple</td>
<td>3400</td>
</tr>
<tr>
<td>green ash</td>
<td>3300</td>
</tr>
<tr>
<td>red elm</td>
<td>3000</td>
</tr>
<tr>
<td>American elm, sycamore</td>
<td>2900</td>
</tr>
<tr>
<td>silver maple</td>
<td>2750</td>
</tr>
<tr>
<td>boxelder</td>
<td>2550</td>
</tr>
<tr>
<td>aspen, cottonwood, willow</td>
<td>2300</td>
</tr>
<tr>
<td>basswood</td>
<td>2000</td>
</tr>
</tbody>
</table>

* Information from Forestry Extension Pub. Pm-622 "Using Hardwood Firewood".

It is interesting to note that the heavier and drier the wood, the more BTU's (British Thermal Units) that species provides. The higher the BTU's, the longer the fire would burn. However, lower BTU rated woods will burn faster, but more intense and hotter than the high BTU woods. In Iowa the tree species with high BTU ratings include: osage orange, black locust, oak, and hickories.

If you are considering starting a timber stand for firewood you might want to consider fast growing trees such as cottonwood, ash, basswood, silver maple and hybrid poplar.

These trees have lower BTU's per cord than other trees species, but from the standpoint of producing BTU's/acre/year, these trees are the most productive.

*References


Study Questions

1. What is a standard cord?
2. What is a face cord?
3. What is the range of prices for:
   a. a truckload of wood
   b. a cord of wood
   c. a bundle of wood
4. If a stack of wood is 6' by 5' by 10', how many cords does it contain?
5. How does log uniformity affect the actual cubic foot content of a cord of wood?
6. What are three species that could be planted in an open area which yield the most BTUs per acre per year?
7. Which provides the most BTUs per cord, dry or wet wood? Why?
Introduction

Most people who want to cut down timber simply start up the chain saw and begin cutting any tree in sight. It should be stressed that this is NOT a wise management practice.

Before the actual cutting activities begin the firewood cutter must know: 1) what species of trees are in the woodlot, 2) what the long term goals for the woodland are, 3) what the best criteria for selecting appropriate trees is, and 4) how to safely operate and maintain a chain saw (see Information Sheet No. 3).

Unless sound management practices are used, harvesting firewood could reduce the quality and quantity of forested areas. When people start at one end of a woodland area and cut to the other end they are only eliminating the area. Also, if the tallest and straightest trees are the only ones cut, then only poor quality trees remain. These poor quality trees will produce a new generation of poor quality trees. Planning a sound management strategy can help improve and maintain Iowa’s woodlands.

Planning a Firewood Cutting

In planning for a firewood cutting the landowner must first determine his/her long term objectives for the woodlands. These woodland areas provide a multitude of benefits such as lumber or veneer logs, firewood, erosion control, beauty, recreation, and wildlife.

If the landowner wishes to produce lumber and veneer logs; or provide recreation, wildlife cover, beauty, etc.; timber stand improvement (TSI) should be used. This means the valuable trees will be identified, and the weed trees, wolf trees, dead trees and poor quality trees will be cut out for firewood.

Weed trees are trees that readily invade an area and take it over. They typically are fast growing tree species of little commercial value. Examples include ironwood, elm, and boxelder. Woodlots also typically contain "wolf trees." These trees are often the largest trees in the stand in terms of crown width and they take lots of growing space. Such trees are typically low quality for sawlogs because they are branchy and poorly formed, but they produce a large volume of firewood.

Periodic thinnings to provide adequate growing space for sawlog trees can produce material suitable for firewood. Undesirable species can be removed during the fuelwood thinnings. Crooked, damaged, or partly decayed trees should be harvested as a part of the stand improvement (Table 1). Trees removed during such periodic thinnings are often of ideal size for firewood. Splitting may not be necessary with these small trees.
Figure 1. Improve the value and productivity of a woodlot by harvesting fuelwood.*

Trees killed by insects or disease should also be harvested for fuelwood. Cut dead trees as soon as possible after they die to minimize deterioration from decay. However, if you wish to provide wildlife habitat, leave at least 4-7 dead trees per acre. These trees will become den trees or homes for song birds, raccoons, squirrels, and other wildlife.

Do not overcut stands when harvesting fuelwood. Seek help from a knowledgeable source to achieve the right stocking level. Maintain full tree cover on the land to optimize quantity and quality production. This is especially important if your objectives are for erosion control, beauty, and recreation. In a recreation area you will need to maintain at least a 50 to 100 foot buffer strip around trails, camp grounds, and other areas used for recreation. For erosion control purposes never clear an area within 150' of a river, stream, or other similar area. Very open stands are not desirable for either fuelwood or sawlog production. Open areas will produce trees that have long branches close to the ground. Verneer quality sawlogs are trees that have a clear straight trunk void of branches closer than 8 feet to the ground. That is what the landowner desires if the objective is sawlog production.

Existing woodlands may also be managed primarily for fuelwood production. Proper cultural techniques are similar to those used when sawlogs are the primary product, but the owner would typically manage for smaller diameter crop trees. A well-stocked, 5 to 10-acre stand should provide a continuous supply of wood sufficient to heat an average insulated home.

Marketing

If you want to market firewood, the first thing to consider is whether or not there is a market demand. In colonial days, wood was the principal heating fuel for homes. As recently as 1900, wood supplied almost half of the energy used in the United States. As coal and petroleum products became available, the use of wood for fuel declined. But with the advent of the energy problems in the 1970's the position of wood has changed once again. As a renewable resource, wood is again supplying heat in
many homes. Wood as an alternative or supplemental fuel is likely to increase in importance during the next few years. However, local demand for wood varies so it is wise to assess the market demand in the area. Secondly, consumer preferences need to be considered. Find out how people in your marketing area respond to the following:

1. Price range they pay for firewood.
2. What species are preferred.
3. How they prefer to purchase firewood: bundle; face cord; cord delivered; stacked.
4. Length of logs desired.
5. Whether split or un-split logs are desired.
6. If they prefer the stack of wood to be all one species.

The answers to responses will help you to determine if it would be profitable to market firewood. The answers will also help you to determine a market strategy.

Third, determine marketing strategies. This includes: advertising, locating buyers, degree of service (i.e. stacked vs. not stacked), and transportation needs/costs. You also need to maintain business records on all transactions.

Conclusion

Iowa has district foresters who can visit your woodlands and provide landowners assistance in developing a woodland management plan. The district forester can also help you identify the trees in your woodlot. The key point is to plan for your firewood cutting so you don't end up diminishing the quality and quantity of the existing woodlands.

*Reference


Study Questions

1. List four things a person should know or consider before cutting wood for firewood.
2. What is a wolf tree?
3. List three weed trees.
4. Explain how firewood cutting can affect forest resources.
5. List four types of trees that could be removed for firewood.
Your timber is marked. Your chain saw is in prime working order. So you’re ready to cut down that tree. Right? Wrong. You’re almost ready to take one last look around to size up your surroundings for dangers. You can never be too cautious. Now determine where it would be practical for the tree to fall. Look for an open area in a direction that gravity can help pull the tree over, and use this as the drop site.

Felling Trees

Now you’re ready for the 3-cut process. This process consists of 2 undercuts, which form a v-notch in the tree and a backcut. The undercut is a v-shaped cut made in the direction you wish the tree to fall. This cut should be about 1/3 of the tree’s diameter. The first cut of the v-notch should be placed 12”-16” from the ground. The second cut should be around 2 1/2” wide for each foot of the tree’s diameter. For example, if the tree has a 24” diameter the second cut would start 5” above the first cut. It is important to note that any tree greater than 6” in diameter should never be cut without a proper undercut.

The backcut is a straight cut toward the undercut. The undercut should be located 1-2 inches above the first cut in the undercut. This provides a heavy hinge for controlling the kick back of the falling tree. Make sure you have good footing, an observant outlook and an escape path. Trees don’t always fall in the direction you have planned. You may have misjudged the pull of gravity, the lean of the tree, the top-heaviness of the top, or an unpredictable wind could throw the tree being cut into an unplanned direction.

When the saw reaches within an inch or so of the notch, the tree falls toward the notch, turning on the hinge of wood that has been left. A wedge is often driven into the back cut to help move the tree in the right direction. Crooked or leaning trees present special problems and safety hazards. These trees should only be removed by professionals. Trees which fall and get caught up in other trees should be left alone until an experienced cutter can assist in dropping it to the ground.
Limbing the Tree

Once the tree is felled the next task is limbing the tree. Special care should be taken during this process since limbs are often under extreme tension. Below are 11 pointers to keep in mind when limbing a tree:

1. Keep a firm grip on the saw.
2. Have a good footing.
3. With small logs, stand on the side opposite the limb being cut.
4. If on a hillside, work on the uphill side.
5. Trees in lodged positions should be unlodged before limbing.
6. Watch the spring or jump of the limbs being cut.
7. Do not cut the limbs that are propping the log.
8. In limbing, work from the butt end of the tree toward the top. More accuracy can be obtained at the lower side of the limb than at the crotch.
9. The chain should be stopped when the saw is being carried over limbs and brush.
10. Use a chain designed for limbing or brushing.
11. Be alert for anything that can touch the end of the cutter bar and cause kickback.

*References


Study Questions

1. Diagram the proper way to cut down a symmetrical, straight tree.
2. What is the first thing you should do before cutting down a tree?
3. List 6 points to keep in mind when limbing a tree.
POST-CUTTING ACTIVITIES

Before marketing firewood, the wood needs to be split, seasoned, and stored.

Splitting

Generally, firewood more than 6 or 8 inches in diameter should be split before burning. Splitting is usually easiest when the wood is green. Splitting may be done by hand, using an axe or splitting maul, or by using various types of mechanical splitters. As shown in Table 1, species vary in their ease of splitting; pieces containing knots are more difficult to split than clear wood. Use a heavy splitting maul alone or in combination with wedges to split firewood. A chopping block will provide a stable base and reduce tool wear (fig. 1).

Table 1 - Ease of Splitting

<table>
<thead>
<tr>
<th>Easy</th>
<th>Moderate</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspen, ash</td>
<td>hard maple,</td>
<td>black locust,</td>
</tr>
<tr>
<td>basswood, birch,</td>
<td>hickory, oak,</td>
<td>elm, ironwood,</td>
</tr>
<tr>
<td>boxelder, cherry,</td>
<td>soft maple,</td>
<td>osage orange,</td>
</tr>
<tr>
<td>cottonwood, willow</td>
<td>walnut</td>
<td>sycamore</td>
</tr>
</tbody>
</table>

Figure 1 - Splitting wood with a maul and wedge on a chopping block.

If a large amount of splitting is anticipated, mechanical splitters can be rented, built, or purchased. Available splitters are generally of three types: hydraulic powered, cable driven, or screw auger (fig. 2). Hydraulic and cable types use a similar technique - firewood is split by forcing a splitting wedge into the end of the piece. Screw auger types use a different method - firewood is fed laterally into the splitting screw. Homemade splitters may cost only a hundred dollars; commercial models may cost from $400 to $3,000.
Figure 2 - Hydraulic wood splitter (top) and splitting action of a screw auger type splitter.

Seasoning Firewood

Proper drying of firewood is very important. Burning unseasoned wood is not recommended. Properly seasoned firewood has higher heat value per pound than green wood, is easier to ignite and maintain, is less prone to pop and throw sparks, and is less likely to promote creosote formation during burning.

Fuelwood in 4-foot lengths typically requires 9 to 12 months to become thoroughly air-dry (20 percent moisture content). Small diameter, short lengths of firewood will dry more rapidly than long, large pieces. To increase drying rate, cut firewood to desired length and split oversize pieces.

Firewood dries more rapidly during late spring, summer, and early fall than during other months of the year. Severe end-checking and splitting that may occur on firewood during the hot summer months does not affect the fuel value.

Wood will become lighter as it loses water, and severe end checking usually develops during drying. Firewood should be dried to 20 percent moisture content or less. Moisture content can be checked by cutting a sample from the middle of a few pieces, weighing the samples, oven-drying the samples for 24 hours at 212 degrees F, and reweighing the samples. Moisture content is calculated by subtracting oven-dry weight from original weight, dividing the product by the oven-dry weight, and multiplying by 100.

Plans for solar firewood dryers have been developed (fig. 3). Such dryers will increase drying rate and can dry the wood to a lower moisture content than air-drying. A large solar drying unit has been developed in Virginia that dries a standard cord. Dryers may be useful for those who have limited time to dry their firewood and who do not intend to dry large quantities. But these units involve some time and materials to build.
Figure 3 - A solar firewood drying unit.

In sunny weather, the temperature within the dryer rises much higher than outside temperatures, warming the wood and evaporating the contained moisture.

Cover with 4 mil polyethylene

Raise stack off the ground to increase air flow

Prevailing Winds

Storing Firewood

Store dry firewood under cover in an outside shed (fig. 4). Dry firewood will pick up moisture from rain and snow if not protected. Avoid storing large quantities in the house, warm garage, or basement - the increased temperature may activate fungi and insects. Limited inside storage near the stove, furnace, or fireplace that can be used for a week before burning to promote further drying and improve burning qualities.
Figure 4 - An open wood shed used to protect firewood during drying or for storing dry material.

References


Study Questions
1. How should wood be prepared for market?
2. List three ways wood can be split.
3. Why should wood be dried?
4. How can wood be dried?
Biomass in the broadest sense is solar energy stored in biological systems by the process of photosynthesis. Biomass uses include feed or food, a source of products for industrial manufacture (particle board is an example), protein production, the manufacture of chemicals, or fuel production. We will focus on the fuel production aspect.

Biomass as fuel finds three uses: 1) direct combustion, 2) conversion to more concentrated forms of ethanol or methanol, or 3) anaerobic digestion into methane. The direct combustion aspect is what will be discussed as it relates to wood use.

After a century of decline, the use of wood as an energy source is gaining in interest and application. Up until about the last 15 years, sawmill residues and wood bark were regarded as an abundant nuisance in the logging regions of the U.S. and Canada. Lately this has changed as these "wastes" are being burned to provide heat, steam for electricity, or increasingly as a source of fiber for such wood products as particle board. Biomass use as an energy source has become quite popular due to the high price of oil and uncertainty of its availability. This has created a demand for research into ways to increase mechanization and automation of harvesting, processing and utilization equipment. When such equipment exists which can produce biomass energy economically, this encourages even more enthusiasm in biomass production.

Between 1977-1982 petroleum imports in the U.S. were cut in half. Wood used for energy went from 84 million dry tons in 1973, to more than 160 million dry tons in 1984. Much of this consumption was by the wood industry.

Currently there is wood burning equipment in use by industry and homeowners that is somewhat automated. Chunk-wood is used by some industries as it requires less energy to make than chips. However, chips appear to be the most common form used in Iowa at the present time. Pelletized wood is also being used. The pellets are made using sawdust which is often mixed with a glue and put under pressure. Advantages of the pellets include less dust and insects; easier handling, as the pellets can be stored in such a way as to reduce or eliminate trips outside; and they can be economical to use. In Minnesota there are at least 30 schools using pellets to heat their facilities. The pellet burning stoves for homes are set up with an automatic feed system and can hold enough pellets to heat the home for up to a day and a half. Both of these aspects means less labor involvement than a traditional wood stove. Some of these stoves are so efficient that they can be vented using light gauge metal. Therefore, a chimney does not have to be used or cleaned.
References


Study Questions

1. Which biomass fuel use relates most directly to wood use?
2. What wood products can be used for biomass?
The term "energy plantation" is used for a planting of selected species which are grown for the major purpose of providing fuelwood. Energy plantations are comprised of genetically improved, intensively cultivated, often closely spaced trees, which can be harvested repeatedly (after re-sprouting) on cycles of 10 years or less.

Species Selection

Producing the greatest BTU yields per acre per year is the top priority in tree selection. In Iowa the highest yielders are cottonwood and cottonwood hybrids, sycamore, silver (soft) maple, green ash, white ash, box elder, black locust, European black alder and hybrid aspen. White ash will not re-sprout after cutting and will have to be planted. Hybrid aspens are performing best in Iowa at this time. Silver maple is the best sprouting species, producing multiple stems.

Planting Plan

It is best to plant a number of species; no less than three, with five or more being best. Such a mix helps to reduce problems with diseases and insects. It also enables the grower to evaluate the species to determine which do best for a given soil and climate.

Spacing between rows depends on how weeds will be controlled the first 2-3 years. If mechanically cultivated, the spacing cannot be closer than the width of the equipment used.

As each species has a different growth rate, they should be planted in separate rows or in small blocks. This prevents the detrimental effects of competition which could occur if within-row species plantings were made.

Black locust and silver maple can be direct seeded, but poplar and aspen are planted as cuttings because their seeds are small and prone to drying out.

Harvesting

Harvest of the fast growing species can commence when the trees are 5-7 years old. Within a few years later, slower growing trees can be cut. The trees should be 4 to 6 inches in diameter at this time.

When harvesting, remove trees in blocks to allow for the trees to re-sprout (coppice) without excessive shading. The new sprouts will grow quicker than seedlings because a root system already exists. Re-sprouting also saves the expense of having to buy and plant seedlings. After the sprouts have grown for one season, it is desirable to allow only one or two sprouts per stump to continue to grow.

To ensure good sprouting it is essential that harvest be done after fall leaf drop has occurred. At this time food reserves in the root system are at their maximum levels, which allows for successful coppice regeneration.

Given proper management, yields of 2 1/2 to 5 tons of dry matter per acre per year are common. It is not an unreasonable possibility to get 10 ton yields.
*Reference


Study Questions

1. What is an energy plantation?
2. What species should be used for an energy plantation?
3. How many species should be planted? Why?
4. What spacing is needed?
5. How many years does it take before harvesting can begin?
6. How is an energy plantation regenerated?
In any business it is important to keep the appropriate records for tax purposes. In a firewood business two types of records need to be kept: (1) a record of production costs and product income and (2) equipment costs.

Costs and Income

Records of expenses and incomes need to be kept. Costs include: the cost of firewood, cost of cutting and transporting firewood, marketing and advertising costs, and excess firewood not marketed. The income is the price per cord multiplied by the number of cords sold.

Once these basic records have been recorded, the tax treatment can be determined. Some portion of the sales of firewood may qualify for capital gains treatment. Standing timber must be held for more than six months to qualify for long-term capital gains treatment and receive the 60 percent exclusion from regular income tax (this is the case only if the firewood business is part of the total farm operation). From sales of standing timber owned less than 366 days, income is treated as short-term capital gains. Short-term capital gains income receives no exclusion and is, therefore, taxed the same as ordinary income.

The stumpage value of the wood can be eligible for capital gains. The stumpage value is the dollar value of the wood in a standing tree. To determine the stumpage value take the total number of cords and multiply it by the present fair market stumpage value. Ask your local district forester or the Iowa Utilization Forester (515/294-0445) for the current fair market stumpage value of a cord of wood.

Once the total stumpage value is determined that amount is subtracted from the total price received from the firewood. The remaining amount is taxed as ordinary income. Here is an example: You have 10 cords of wood from your woodlot. The present stumpage value is $25 per cord. Therefore, $250 will be eligible for capital gains, if the qualifications have been met. This means $100 is taxable. If the 10 cords sold for $75 per cord, then your total gross income is $750. Subtract the $250 (capital gain) from the $750 and you have $500 (less operating expenses) to be taxed as ordinary income.

Equipment Expenses

The second type of records is for the purchase of equipment. Equipment can be deducted using the appropriate depreciation schedule. You will need to keep an equipment account. This account includes the usual equipment associated with a woodland operation: chain saws, tractors, logging trucks, and skidders. These items are capital assets and should be depreciated.

Deductible operating costs include normal repair and maintenance of equipment. Major repairs that increase the life of the equipment, such as an engine overhaul, are treated as capital investments that must be depreciated.

Most of the equipment used in timber operations is eligible for investment tax credit. Both new and used property are eligible. Claim the credit in the year you acquire the property.
For property placed in service before 1981, the full credit was only available for assets held for seven years. For properly disposed of in less than seven years, part or all of the credit was recaptured.

The Economic Recovery Tax Act of 1981 altered the investment rules for property purchased after 1980. Certain property, such as cars and light trucks, are only eligible for 6 percent credit. However, most property remains eligible for the 10 percent credit. Beginning in 1983, if you claim the full credit, then you must reduce the basis for depreciation by half of the credit claimed. For more information on the investment tax credit, see IRS Publication 572, Investment Credit.

If you farm, the woodland operation is probably incidental to the farm business, and you will maintain a single farm equipment account. But if the woodland operation is a separate business, you must set up separate depreciation accounts.

*Reference

GLOSSARY TERMS

Back cut. The last cut, placed 1"-2" above undercut, which actually fells the tree.

Biomass production. Term used to refer to plant matter produced in bulk such as wood chips, corn cobs, and various plant stalks, primarily for energy uses.

Capital gains. A tax advantage where only 40% of the dollars brought in from selling timber is taxable.

Chipper. A piece of machinery used to reduce whole pieces of wood into chips. Limbs and small diameter boles (tree stumps) can be chipped.

Energy Plantation. Term used to refer to trees of fast growth which can be used for chips, sawdust, firewood logs, etc.

Face Cord. A stack of wood with the measurement of 4 feet high and 8 feet wide but the lengths are less than 4 feet.

Hybrid Poplar. Genetically superior poplars bred for disease and insect resistance; tree characteristics such as growth rate and tree form; and site requirements such as drought and flood tolerance.

Standard Cord. A 4'x4'x8' stack of wood which contains 128 cubic feet of wood plus air spaces. A typical cord may be logs which are 4 feet long in a pile 4 feet high and 8 feet wide.

Timber Stand Improvement (TSI). Improving the quality of an existing timber by eliminating crooked, dead, and diseased trees; and improving the spacing between trees to reduce the amount of competition between trees.

Undercut. The first, v-shaped cut made 12"-16" above ground and in the direction the tree will fall.
What Is A CORD?

128 cubic feet of wood and air space
Cord Determination

Formula:

\[ \text{Length} \times \text{Width} \times \text{Height} = \text{Number of Cords} \]

\[ \frac{128 \text{ cu. ft.}}{128 \text{ ft}^3} = 10 \text{ cords} \]

Example:

\[ \frac{10 \text{ ft.} \times 10 \text{ ft.} \times 12.8 \text{ ft.}}{128 \text{ cu. ft.}} = \frac{1280 \text{ ft}^3}{128 \text{ ft}^3} = 10 \text{ cords} \]
Heat Potential of Wood
(million Btu's per cord)

- Osage Orange: 33.5
- Black Locust: 29.3
- Red Oak: 24.7
- Red Elm: 20.8
- Cottonwood: 15.9
## Ratings for Hardwood Firewood

<table>
<thead>
<tr>
<th>Species</th>
<th>Ease of splitting</th>
<th>Ease of starting</th>
<th>Rate of burn</th>
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<tr>
<td>Osage orange</td>
<td>difficult</td>
<td>difficult</td>
<td>slow</td>
</tr>
<tr>
<td>Black locust</td>
<td>difficult</td>
<td>difficult</td>
<td>slow</td>
</tr>
<tr>
<td>Hickory</td>
<td>moderate</td>
<td>fair</td>
<td>slow</td>
</tr>
<tr>
<td>Ironwood</td>
<td>difficult</td>
<td>difficult</td>
<td>slow</td>
</tr>
<tr>
<td>Oak</td>
<td>moderate</td>
<td>difficult</td>
<td>slow</td>
</tr>
<tr>
<td>Hard maple</td>
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<td>difficult</td>
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</tr>
<tr>
<td>Ash</td>
<td>easy</td>
<td>fair</td>
<td>slow</td>
</tr>
<tr>
<td>Elm</td>
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<td>fair</td>
<td>medium</td>
</tr>
<tr>
<td>Boxelder</td>
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<td>fast</td>
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<tr>
<td>Aspen, cottonwood</td>
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<td>easy</td>
<td>fast</td>
</tr>
<tr>
<td>Willow</td>
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<td>fair</td>
<td>fast</td>
</tr>
<tr>
<td>Basswood</td>
<td>easy</td>
<td>easy</td>
<td>fast</td>
</tr>
</tbody>
</table>
BENEFITS OF IOWA'S WOODLANDS

OTHER USES:
- NUT PRODUCTION
- MAPLE SYRUP
- CHRISTMAS TREES
- WILDLINGS

WILDLIFE HABITAT

SOIL CONSERVATION

WINDBREAKS

RECREATION, EDUCATION & NATURAL BEAUTY

LUMBER & VENEER

FIREWOOD
TREES TO REMOVE FOR FIREWOOD

"Wolf" tree

Dead/diseased

Crooked

Low forked
SPACING CROP TREES

Before fuelwood cutting

Crooked
Forked
Dead
Spreading Top
Crowded
SPACING CROP TREES

After fuelwood cutting
THE RIGHT CUTS

3rd Cut (Backcut)
1-2" above undercut

1st Cut

Wedge

2nd Cut

12"-16" above ground
Steps in Preparing Firewood for Market

Cut

Check out local market and advertise

Split, stack, dry and store

Firewood
$40/pickup
Call 288-heat
Chain Saw Parts
Chain Saw Parts

- Chain brake
- Choke
- Slope control
- Roller nose
- Chain guide (bar)
- Production number
- Starting handle
- Throttle control
- Starter throttle catch
- Idling catch
- Stop control

Diagram: Drawing of a chain saw with labeled parts.
DIFFERENT WOOD SPLITTERS

Fig. 2. Splitting wood with a maul and wedge on a chopping block.
Cord Determination

Which pile contains the most cords?
SELECTING THE RIGHT TREE
Situation:

Sammy Slick has been offered free!! access to a wood pile 50 miles from his home in Cheap-a-Skate Town, IA. He has also been offered access to a wood pile 10 miles from home, but it would cost him $25.00 per cord. He figures he can cut and split 1 cord of wood per 5-hour day (not including driving time).

Ever since Sammy bought his chain saw last week for $250.00, he has wanted to go into the firewood business. Heavens, you can sell a cord of firewood for $150.00! Sammy knows that if he sells two cords he'll have the chain saw paid off. This is a much faster profit than the $5.00 per hour he is making now. (He's figuring the chain saw costs approximately $1.50 for gas and oil; and that he'll be able to cut 500 cords during it's 10-year life span).

He figures transportation will cost a little. He's got a 1/2-ton Ford pickup that gets about 15 miles per gallon and can safely go 40-miles-per-hour with a half-cord of wood. Depreciation and maintenance is $1.00.

Questions:

1. Which option should Sammy Slick use - the free firewood or the $25.00 firewood?
2. Will two cords of firewood really pay for Sammy's new chain saw?
3. How much depreciation per cord will Sammy need to figure?
4. Will proper firewood production with proper drying ... bring in money faster than Sammy's present job?
5. If Sammy rents his uncle's truck for $5.00 per load, would this business deal make Sammy more money? (This truck can carry 2 cords of wood and gets 8 miles per gallon), plus $1.00 depreciation. It will go 50 mph with a full load.
6. How much money will Sammy make per cord with each of the four options?

Formula:

\[
\text{COST PER CORD} = S + \left( \frac{P + M + F}{M} \right) (ND) + \left( T + \frac{ND}{R} \right) (L)
\]

Where:
- \( S \) = chain saw cost (variable & fixed) for cutting one cord
- \( P \) = price per gallon for truck fuel
- \( M \) = miles per gallon for truck
- \( F \) = fixed cost per mile for truck
- \( N \) = number of round trip hauling distance
- \( T \) = hours required to cut, split, load and unload one cord
- \( R \) = average speed of truck during haul
- \( L \) = labor charge per hour
- \( D \) = distance to the firewood source and back home
CHRISTMAS TREE -
PRODUCTION AND MARKETING

Instructional Materials Developed
for
Iowa Teachers of Vocational Agriculture

Prepared by:
DEPARTMENTS OF FORESTRY AND AGRICULTURAL EDUCATION
IOWA STATE UNIVERSITY
AMES, IA
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1986 - The Year of the Tree

UNIT OBJECTIVES

Upon completion of this unit the student should be able to:

1. List some advantages for growing Christmas trees in Iowa.
2. Describe what is involved in starting a Christmas tree plantation.
3. Explain the key factors in maintaining a Christmas tree plantation.
4. Know how to determine if a market exists for Christmas trees.
5. Determine several marketing strategies for Christmas trees.

VISUAL MASTERS

1. Steps for Establishing a Christmas Tree Plantation
2. Match Tree Species to the Site
3. Criteria for Matching Species to Site
4. Popular Christmas Tree Species in Iowa
5. Tree Planting Methods
6. 2 Methods for Hand Planting with a Spade
7. Reasons for Shearing
8. Shearing Christmas Trees
9. Three Shearing Tips
   a. Controlling Height
   b. Eliminating Extra Leaders
   c. Developing Uniform Taper and Density
10. Watch Out for Biological Problems.
11. Methods of Selling Trees
    a. Wholesale Marketing Strategies
    b. Retail Marketing Strategies - Lot Sale
    c. Retail Marketing Strategies - Cut and Choose

ACTIVITIES

1. Where Would You Shear This Tree?
2. Matching Species To Site

TOPIC 1 - INTRODUCTION TO CHRISTMAS TREE PRODUCTION AND MARKETING

Objectives

1. To introduce students to the advantages of growing Christmas trees in Iowa.
2. To make students aware of the demand for Christmas trees in their local community.

Introduction

There is potential for more Christmas trees to be grown and sold in Iowa. Currently, 83 percent of the Christmas trees purchased in Iowa are grown outside the state. Iowa growers can gain a larger share of the market and there are those growers who are attempting to do so.

Prepared by:
Reinee E. Hildebrandt
W. Wade Miller
Stephen G. Eckles
Much of Iowa's climate, typography, and soils are suitable for the production of some of the most popularly purchased tree species. Farmers interested in Christmas tree production will be glad to know that some of the equipment which they already use in farming can be used for growing Christmas trees. A good portion of the work which must be done on the trees can be scheduled around field work. Income from the sale of the trees comes in at a good time. If managed and marketed properly, a Christmas tree plantation can provide the best returns on investment for certain pieces of land. Other benefits derived from growing trees in the state include:
   a. most of the money stays in the state.
   b. trees are fresher and will last longer.
   c. the trees can compete with trees grown outside the state because of lower transportation costs.
   d. for the choose and cut operation, some people prefer picking out their own tree and cutting it themselves.
   e. some of the areas planted to trees may be exempted from property tax (see Extension Publication Pm-605, Iowa's Forest Reserve Laws)

Interest Approach

Pick out a student to write the results of the following class survey on the board. Survey the class by asking them the following:
   a. Which of you had a natural Christmas tree in your house last year?
   b. Which of you had an artificial tree in your house last year?
   c. Did your grandparents have a natural or artificial tree last year?
   d. If you had a natural tree, how tall was it?
   e. Do you remember where you acquired your natural tree?
   f. How much did your natural tree cost?
   g. What do you feel to be some of the reasons people prefer the artificial tree over the real one and vice-versa?

Teaching Procedure

Bring in a local grower (if available) or the district forester and ask him/her to speak on the pros and cons of growing Christmas trees.

Refer to Extension Publications F-340, Forestry Contacts and Organizations in Iowa, and Pm-668, Directory of Christmas Tree Producers in Iowa, for addresses.

Activities

1. Have the class survey 10 households in the community and find out the following:
   a. Did the household use a natural or artificial tree last year?
   b. Why did they use the tree they did?
   c. If the tree was real, how big was it?
   d. If real, where was acquired?
   e. If the tree was not acquired from a cut and choose operation, would they have preferred to get a tree from a cut and choose operation?

From the results of the survey the students should write up a short report about the local demand for natural trees, the preferred height, and the potential for a local cut and choose operation.

2. From the students' personal knowledge and from contacting
the local Chamber of Commerce or other sources, have the students list who sells Christmas trees in town. Have them contact these sellers and try to determine how many trees are sold in their community.

**TOPIC 2 - STARTING A CHRISTMAS TREE PLANTATION**

**Objectives**

1. Select appropriate and marketable species for Christmas tree production.
2. Select appropriate sites to plant the trees.
3. Describe the steps to tree planting.
4. Explain how a mechanical tree planter is operated.
5. Explain how to use a tree bar.

**Interest Approach**

1. Have an experienced Christmas Tree producer or the District Forester visit the classroom and talk about what it takes (initial investment, costs, potential profits, cultural needs, intensive management) to start a Christmas tree plantation.

2. Have the class read the technical information entitled "Starting a Christmas Tree Plantation" up through Site Selection. Using the county Soil Survey map and personal knowledge the students should brain-storm in groups of two about possible sites that would be good for growing trees. Tell them to keep in mind possible sites on their own properties. Have them write down the location of the sites and hand it in.

**Teaching Procedure**

1. Use the visual master "Steps for Establishing a Christmas Tree Plantation" and discuss the steps involved.

2. Have students read the Species Selection section in the technical information entitled, "Planning a Christmas Tree Plantation". Ask students which trees they would choose for planting in a Christmas tree plantation. Refer to the visual entitled "Match Tree Species to the Site" and use the "Match Species to Site" activity sheet. Have the students give reasons for their choices.

3. Discuss pros and cons of site selection: slope, accessibility, ease of maintenance, etc. Refer to the visual entitled "Criteria for Matching Species to Site". Discuss the points with the class.

4. Visit one of the sites chosen in #1 of the Interest Approach section. Using information gathered from the soil survey and after measuring off the site, determine as a group the number of trees that would need to be ordered to plant the site. The students will also need to read the section on Planting Design from "Planning a Christmas Tree Plantation" and Extension Publication Pm-661, Christmas Tree Production in Iowa.

5. Use the visual master "Popular Christmas Tree Species in Iowa" and speak on the ways to distinguish between the species as to their identification. Attempt to gather branches of the different trees and have the students study them.
6. Demonstrate the use of a tree bar (tree spud) by consulting Extension Publication Pm-496, Tree Planting in Iowa. These bars can be purchased through nursery companies or built in vo-ag shop class. It may also be possible to get one on loan from the County Extension Office or a local grower. Refer to the visuals entitled "Tree Planting Methods" and "Methods for Hand Planting with a Spade".

7. Summarize the key points to consider in starting a Christmas tree plantation.

Activities

1. Inquire of the County Extension Agent, District Forester or other contact person to determine if anyone in the local area is planning to plant Christmas trees. Ask this potential producer if it would be possible to have the class watch or assist in the planting. If so, have the class do it.

2. Determine if anyone in the class would be interested in planting Christmas trees at their home. If so, have them order the trees and the class can plant them. Trees can be ordered via the State Nursery, 2404 S. Duff, Ames, IA 50010 (515/292-0445) or through one of the nurseries listed in Extension Publication Pm-956, Directory of Iowa Nurseries that Deal in Forestry and Ornamental Planting Stock. The district forester can also suggest other nursery sources.

3. Ask the District Forester if there is a tree-planting machine available. Should there be, find out if anyone will be using it and see if this person would be willing to have the class watch it being used on their property.

4. Have students plant a few evergreen trees or establish a small Christmas tree plantation on school property.

TOPIC 3 - MAINTAINING A CHRISTMAS TREE PLANTATION

Objectives

1. Explain what biological problems may affect Christmas tree production.
2. List four methods of weed control.
3. List three animals which could damage Christmas trees and explain how they can be controlled.
4. Given a picture of an unsheared tree show how it should be sheared.
5. Shear a Christmas tree.

Interest Approach

Give students the following situation: "You have $200 invested in your Christmas tree plantation. List 5 things you think you will need to do/deal with in order to get those trees to market in 6 to 8 years." Discuss students' responses and introduce shearing; weed control; diseases and insects; deer, mice and rodents; and fertilizing.

Teaching Procedure

1. Have students read the technical information entitled "Maintaining a Christmas Tree Plantation". Discuss the most important points.

2. Using the visual master "Reasons for Shearing", explain how a tree should be sheared.
3. Using the series of visual masters on shearing Christmas trees, speak on how to shear the trees so that they will have good market shape.

4. Photocopy the Plant Specimen form and hand it out to students. Speak on how growers may use the technical services at Iowa State University to determine how to prevent and control insect and disease problems. Refer to the visual entitled "Watch Out for Biological Problems". Discuss the points with the class.

5. Use Extension Publication F-319, Weed Control for Tree Plantings. Divide students into small groups to discuss which method would be the most appropriate and the least appropriate. Have students re-assemble, present and defend their choices.

**Activities**

1. Shear some evergreen trees as if they were Christmas trees. Locate evergreen trees in the local area and gain permission to shear them.

2. Have students write an informational composition on maintaining a planting of Christmas trees, to be published at the appropriate time, in the local paper. This would be suitable for the small acreage owner who has a stand of Christmas trees.

3. Help a local Christmas tree grower shear trees.

4. Practice weed control around the school grounds or in a Christmas tree plantation.

5. Ask a local producer to demonstrate cutting and bundling a Christmas tree or conduct a demonstration on bundling a Christmas tree.

**TOPIC 4 - MARKETING CHRISTMAS TREES**

**Objectives**

1. Describe and conduct a marketing survey.
2. Determine marketing options available to producers.
3. Develop a marketing and advertising plan.
4. Write an effective radio ad, newspaper ad, or advertising flier.

**Interest Approach**

1. Conduct a marketing survey in the community. Have students write a survey instrument containing the following: Use of natural or artificial trees, source of natural trees, size of tree preferred, species of tree preferred, price paid last year, where natural trees were purchased.

2. Have students interview 50 - 100 people and record the results.

3. Have class summarize the results and draw conclusions.

**Teaching Procedure**

1. Have students read the technical information entitled "Marketing Christmas Trees".

2. Help students draw conclusions regarding species, prices paid, most popular size of tree, and where to sell trees.

3. Use the visual masters: "Methods of Selling Trees", "Wholesale Marketing Strategies", "Retail Marketing Strategies - Lot Sale" and
"Retail Marketing Strategies - Cut and Choose" and discuss the information with the class.

4. Have students read the technical information entitled "Marketing Options".

5. Discuss the marketing options open to a producer. Have them list some of the factors which influence a producer’s choice of a marketing option.

6. Divide the class into three groups and have each group assume one of the options. Have each group defend its assigned option to the class. List the pros and cons of each option.

7. Have the class assume it has a Christmas tree plantation and that it wants to market its trees "Choose and Cut" directly to the public. Have the class devise a marketing plan. Use the calendar and list goals, ways, and means.

8. Help the class determine what it needs to know to properly plan an advertising campaign. It will need to determine the various media available in the area and determine the accessibility of each. Information on cost of adds in newspapers and spots on the radio would be very important. They should research what the ads would cost, how often they should be run, what audience to target, etc.

9. Have the class plan an advertising campaign and add this to the marketing plan. Include fliers, radio ads, and newspaper ads in the campaign.

10. Have each class member write, and record on tape, a 30 second radio ad. Have the class evaluate each ad and select the top three.

11. Have each class member design and write an ad for the local newspaper or design an advertising flier. Have the class evaluate the ads and select the top three from each type.

**Activities**

1. Invite a local Christmas tree producer (preferably one who markets choose and cut) to speak to the class about how he/she markets trees. Students should have a list of questions written up beforehand to ask the producer.

2. Invite a person from a local radio station or ask a high school marketing teacher to speak to the class on designing radio ads, when they should be used, and how audiences are targeted. Listen to examples of ads promoting other products, services, or events.

3. Invite a person from a local newspaper to speak to the class on designing effective newspaper ads, when they should be run, and where they should be run.

4. Take a field trip to a local choose and cut operation during the Christmas season and observe how the operation is run, the number of people employed, advertising skills used on the site, etc.

**EXTRA SUGGESTED ACTIVITIES**

1. Get involved in "Trees for Schools Program".
2. Start a Christmas tree plantation on school land or on private property.
3. As a project, operate a Christmas tree lot this year.
4. If a local organization operates a Christmas tree lot, ask a representative to speak to the class about the enterprise.

SUGGESTED REFERENCES


The Iowa Cooperative Extension Service's programs and policies are consistent with pertinent federal and state laws and regulations on non-discrimination regarding race, color, national origin, religion, sex, age, and handicap.
Production of Christmas trees in Iowa can be an attractive investment opportunity. But, contrary to many stories, production of Christmas trees is not a get-rich-quick scheme. It is a planned-production venture requiring money, considerable time, and a willingness to accept risk.

High-quality Christmas trees are not produced by merely planting seedlings and waiting a few years for a harvestable crop. There are several possible combinations of species, weed control, shearing patterns and other decisions that make up the production sequence. The most profitable combination depends on the circumstances of the individual land manager.

High returns can be achieved only if the landowner thoroughly understands the problems of Christmas tree management. A lack of knowledge will usually result in reduced profits or even losses. And there are many situations where Christmas tree production is not a wise investment compared with other land use alternatives.

To produce high quality Christmas trees, the potential grower should understand the environmental factors and their effects on different species. These factors include: site and species selection.

**Site Selection.**

Slopes that face north and east and have loam soils are the best sites for growing Christmas trees in Iowa. These slopes are protected from hot, dry summer winds, and their soils provide excellent growing media for trees.

Christmas trees will grow on other slope faces and soils, but they will not grow as well. They will not flourish on calcareous (high lime) soils. Slightly acid soils are required for good growth. Avoid soils that are continually wet and those with clay hardpan subsoils. For good growth, Christmas trees need well-drained soils. The Christmas tree producer has a wider choice of species if planting is done on a good site rather than on a poor site.

**Species Selection**

When choosing a species for Christmas tree production, you should know if it is adapted to Iowa's climate and whether or not it will be accepted by the consumer.

Species that have possibilities for Christmas tree production in Iowa are: Scotch pine, white pine, red pine, Norway spruce, Colorado blue spruce, Douglas fir, concolor fir, ponderosa pine (for western Iowa), and balsam fir. White, red and Scotch pine account for approximately 90 percent of the Christmas trees grown in Iowa.

Before deciding on the species to produce, investigate local consumer preferences. One species may be more desirable than another in a given locality. Douglas fir, for example, is favored by consumers in Nebraska and Kansas. Balsam fir is the favorite of people in the Lake States, while Scotch pine is most popular in Iowa.

Because of public acceptance and species adaptability, the choice for Iowa Christmas tree production might be narrowed to four: Scotch pine, white pine, red pine, and Norway spruce (as there seems to be a growing interest in short needle trees).
For a general idea of what and where to plant, here are descriptions of the most commonly planted species in Iowa:

**Scotch pine (Pinus sylvestris).** Scotch pine is the most common Christmas tree throughout the nation as well as in Iowa. Its great variation in straightness, growth rate, branching habit, and winter color characteristics are the major difficulties with the species. A producer has little control over these characteristics when selecting planting stock. Northern varieties tend to yellow before Christmas. However, they are more suited to Iowa's harsh winters and have less winter injury. A dark green to blue-green French seed source produces a most desirable tree. However, they are more susceptible to winter injury. Other varieties include: Scotch Hyland, Austrian Hill, and East Anglia. These are hardy in Iowa and have less problem with winter injury. They are also more resistant to brown spot needle blight and Lophodermium needlecast (both fungi).

Scotch pine needles are medium long, stiff and twisted, in bundles of two. The tree holds ornaments well.

This species needs a fairly well-drained soil. Plant trees on north and east-facing slopes in western Iowa; all slopes in eastern Iowa.

**White pine (Pinus strobus).** Investigate local market demand for this species before planting. In some areas, white pine Christmas trees are in high demand, while in others demand is lower.

The needles are medium long, thin, in bundles of five, and blue-green in color. White pine foliage has a soft texture. The tree has poor density if not sheared. The branches are very limber and do not lend themselves to heavy ornaments.

White pine is widely adapted on well-drained soils. It also does well in moist sites. It can be planted on all slopes in eastern Iowa and north- and east-facing slopes in western Iowa.

**Red or Norway pine (Pinus resinosa).** These pines are widely planted in eastern Iowa. Red pine is more difficult to shape than white or Scotch pine. In addition, death of individual trees, 3 to 8 feet tall, in many plantations has been reported. Reasons for this difficulty are unknown.

The needles are long, somewhat flexible, in bundles of two. It grows well on high, well-drained soils, and is adapted to north- and east-facing slopes in eastern Iowa only.

**Norway Spruce (Picea sp.).** A short needle tree, which prefers medium to heavy soils. It is planted throughout the state for windbreaks and is relatively fast growing for a spruce. This tree is very winter hardy and fairly drought resistant.

**Austrian pine (Pinus nigra).** A relatively drought-resistant species that is widely planted in Iowa, it is not adapted to close plantings in wind-sheltered locations because of susceptibility to needle blight fungus.

The needles are long, stiff, coarse, and in bundles of two. Austrian pine does best on well-drained soils in open sites. It is well-suited for ridge and hilltop plantings. Set the trees on north and east slopes in western Iowa and on all slopes in eastern Iowa, but only where considerable air movement will occur throughout the stand.
Austrian pine is highly susceptible to dothistroma needle blight and presently is not highly recommended for Christmas tree plantings.

PLANNING A TREE PLANTING

Planting Design

A landowner should have a plan before planting their plantation. Some thought to layout and design of the plantation is needed before you begin planting to avert future problems in maintenance and operation. Here are some suggestions to consider.

Lanes should be planned every 6 to 10 rows for firebreaks, for access during development, and for tree removal at harvest time. The lanes should be 12 to 16 feet wide, located around and through the entire plantation. They should be kept free of vegetation by disking (only on level areas) or spraying with soil sterilants. Mowing is acceptable for steeper areas.

Provide easy access to the plantation for trucks and equipment by avoiding sharp turns and steep slopes.

Plan ahead for harvest time when an area is needed at the front of the plantation for concentrating the cut trees, loading and truck turnaround.

Space rows farther apart on steep slopes to provide clearance for equipment which may slip some on these slopes.

The distance between trees and rows depends largely upon the kind of machinery the landowner plans to use in maintaining the trees. If a garden-type tractor will be used for mowing, disking and spraying, space the trees 5 x 5 feet (5 feet apart, in rows 5 feet apart). If the 5 x 5 spacing is selected, the trees will be smaller than if a wider spacing is used. On the other hand, if a 2- or 3-plow tractor and equipment, such as a 60-inch rotary cutter, will be used, distances of 8 to 10 feet between the rows are more desirable. The most popular spacing has been 5 x 7 feet or 5 feet between trees, with 7 feet between rows. The table below shows the number of trees to plant per acre at various spacings.

<table>
<thead>
<tr>
<th>Tree Spacing:</th>
<th>5 x 5</th>
<th>5 x 6</th>
<th>5 x 7</th>
<th>5 x 8</th>
<th>6 x 6</th>
<th>6 x 7</th>
<th>6 x 8</th>
<th>8 x 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees per acre:</td>
<td>1,740</td>
<td>1,450</td>
<td>1,244</td>
<td>1,090</td>
<td>1,210</td>
<td>1,037</td>
<td>910</td>
<td>680</td>
</tr>
</tbody>
</table>

Site Preparation and Planting

Fall plowing, followed by disking in the spring, provides ideal planting conditions where the ground is sufficiently level not to erode.

In heavy sod on steep land, strips for planting each row of trees can be plowed and disked. Some tree-planting machines are equipped with a sod-busting blade which facilitates planting directly without prior ground preparation; however, most tree planting machines in Iowa are not heavy-duty enough to provide satisfactory planting in sod.
The best time to plant is in the spring between the time the frost leaves the ground and the new growth first appears. This will be just about oat-sowing time in April. If possible, go directly to the nursery to pick up the young trees. Sometimes damage occurs in commercial shipments. You can avoid this by picking up your own stock. If the trees need to be stored for a time, put them in a cooler at 35 to 40 degrees F. If no cooler is available, you must "heel" them in the ground in a protected, shady spot. Dig a trench by pitching the soil to one side, place the roots in the trench with the tops protruding above, then fill the trench with the soil removed originally. Soak thoroughly with water. For best results trees should be picked up when there is time to plant them immediately afterward.

When you're ready to plant, simply dig up the plants as you need them. Be sure to keep the roots moist at all times. Tree roots exposed to drying winds, even for a short time, will be injured or killed. When planting, carry the seedling trees in a pail containing enough thin soupy mud to cover the roots. For further planting information consult Extension Publication #496, Tree Planting in Iowa.

On level or rolling ground, you can use a treeplanting machine. Two people using a tractor and planter can set 6,000 to 8,000 trees per day. One person can hand-plant about 400 to 600 trees per day. If you want to plant by machine, you may want to contact your County Extension Director or District Forester for help in locating one you can use.

If you are planting several different species of trees, set each species separately in blocks, rather than mixing them in the rows.

Reference

Iowa State University Extension Publication Pm-661, Christmas Tree Production in Iowa. Excerpts used by permission.


Study Questions

1. What is the most popular spacing for Christmas trees?
2. When is the best time of year to plant the trees?
3. What might you do with the trees if they cannot be planted immediately?
4. About how many times more trees can be planted with machinery versus by hand?
5. How many species account for about 90 percent of Christmas trees grown in Iowa?
6. What are the species which account for 90 percent of Christmas trees grown in Iowa?
7. Which of the species written about in this unit is not recommended? Why?
The total environment of the tree is a complex interrelation of physical and biological factors. Physical factors include climate and soil. Biological factors are the plant associates, man and his cultural activities, large and small animals, fungi and insects.

Weed Control

The intensity of weed control necessary depends primarily on soil type. Less weed competition occurs on coarse, sandy soils than on rich, loamy soils.

Weed control research by the U.S. Forest Service indicates that Princep (80-percent wettable powder) is an effective control on a prepared soil in early spring. Applications should conform to the manufacturer's recommendations.

Another method of weed control is use of a rotary mower. Mowing three times during the growing season will usually control major weed competition between rows of trees. One difficulty with mowing is that when the competing vegetation is high, the young seedlings cannot be seen, and they often are mowed along with the weeds. A partial solution to this problem is to mark the rows of trees with dye or to use a chemical weed control until the rows can be easily identified. Mowing is the least preferred method since there is still competition for needed water and nutrients as the grass and weeds are not eliminated.

An effective way to control weeds is to cultivate, either by hand or mechanically. Cultivation will probably need to occur at least three times during the growing season. Care must be exercised so that cultivation is neither too deep or close to the tree.

A method for both reducing water loss and controlling weeds around the base of trees is mulching. Mulch should be in 2 to 4 foot strips or circles and a depth of at least three inches. Do not use too coarse of materials as rodents will nest in it and feed on the bark.

Fertilizer

Evergreen trees do not have heavy nutrient requirements. The naturally fertile soils in Iowa generally do not require additional fertilizer. Excessive nitrogen can "burn" young, supple needles. Do not pile manure or other organic materials around the trees after they have been planted.

Animal Nuisances

Rodents, rabbits, and deer can damage Christmas tree plantations. Field mice frequently girdle the young stems of small trees in the wintertime. Rabbits usually chew on the bark. They also eat buds, which can be a serious hindrance. Deer will not bother a plantation, unless there is insufficient winter browse in the area, but often damage trees mechanically by rubbing off the velvet of their antlers against 4 to 6 foot conifers.

Trees may be protected with such commercially available products as Deer Away, Hinder, and Protect. A method which has met with some success is to hang nylon stockings containing human hair from the trees. A temporary fence made of 5 strands of twine and surrounding the trees is recommended by some growers.
Deer do most of their feeding on Christmas trees between November and April. They seem to prefer white pine and will go after this species first. If at all possible, the plantation should be checked daily, for once feeding begins it seems like every deer around will soon be feeding on the trees.

**Insects and Diseases**

There are numerous insects and diseases which may affect Christmas trees. If a problem arises it is best to contact the district forester or an experienced local grower and have them inspect the site. A specimen which is believed to be affected should be sent to the state extension plant pathologist along with a completed Plant Disease Identification Form which looks as follows:

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**Plant Disease Identification Form**

Submit specimens to: Extension Plant Pathologist  
105 Bessey Hall  
Iowa State University  
Ames, IA 50011

See reverse side of form for instructions on collecting and shipping plant specimens.

---

County _________________ Date _________________

Owner _________________ Address __________________

Collector _______________ Address __________________

Plant ________ Variety ________ Age ______ Size ______

No. of acres/Distribution of symptoms in planting___________________

Site and soil description_______________________________

Previous crop ______________ Chemicals used ______________

Symptoms:

---

Diagnosis and control recommendations: (Collector do not write in this space)

---

**Collecting Specimens**

1. Examine the plant carefully. Keep in mind that symptoms may appear at some distance from the actual site of the disorder. Look for any irregularities or injuries in lower portions of the plant.
2. Make sure specimen is representative of condition in question.
3. Include enough material to show all stages of the disease from healthy to maximum disease involvement.
4. Wrap specimens in dry paper toweling or clean newspaper (Do not add moisture!) and pack loosely in a plastic bag to prevent excessive drying. Package in a strong carton for mailing.
5. Send only freshly collected specimens by the most rapid transit method-undue delays can result in extensive deterioration of the specimen which makes diagnosis difficult or impossible.
6. Fill out form as completely as possible.

**Hints for specific plant materials**

1. Small plants - send entire intact plant/plants (gently shake excess soil from roots).
2. Fleshy fruits, roots and tubers. Wrap in enough clean absorbent material such as paper toweling to absorb any leakage.
3. Woody plants-branch specimen should consist of 4-6 pieces, 6-8 inches long from branches 1/2 to 1 inch in diameter. Collect only from branches actively displaying symptoms. Dead, deteriorating branches are often worthless as specimens. Cankers may be sampled by cutting out a rectangular section of bark across the margin of the canker so that some healthy tissue is included with the margin and the central portions of the canker.
4. Turf-lift out a section of turf about 4-6 inches square so that healthy plants are included along with those at the margin and the central portions of the affected area.

**Shearing**

Shearing or pruning is essential to produce top-quality trees with full, symmetrical crowns having dense foliage and good taper. An ideal tree is about two-thirds as wide as it is tall. This means a tree 6 feet tall would be 4 feet wide at the base. Pines should have a slightly wider base than spruce and firs.

Shearing does three things to make the trees more marketable. First, the trees can be shaped to meet local demands, broad and rounded or narrow and columnar. Most producers may end up with a combination of shapes but tend to shear to match local customer preferences. Second, sheared trees have more branches resulting in a denser, thicker foliage. Third, shearing controls the distance between whorls of branches. This is critical because growth rates vary between years and different species of trees.

Most consumers in Iowa expect a tree to have uniform spacing between branches, dense foliage and a symmetrical shape. Trees which are not sheared or improperly sheared will not have these characteristics.

Shearing usually starts 2 to 3 years after planting, or as soon as growth of the terminal leader exceeds 10 to 12 inches. Corrective pruning of multiple leaders is done annually until the actual shearing for shape and density is begun.

Pines are sheared during the growing season, usually between June 10 and June 20, through mid-July. You may be shearing earlier in southern Iowa or in years with earlier seasons than normal. Clip the terminal leader, on a 45-degree angle, back to a uniform length that conforms to the length of the previous year’s whorls. This means not jumping from one spacing to another twice its size. Don’t have the length between whorls exceed 10 to 12 inches in length. Shear all lateral branches in the top whorl to 4 to 6 inches in length. Then shape the rest of the tree to conform to a cone. Pines can be sheared back into 1-year-old wood, but do not shear into 2-year-old wood. Healthy, vigorous needle bundles are
needed to set new buds, and they are not present on 2-year-old wood.

Spruces and firs are sheared during the dormant season in late summer and fall, usually after the middle of August. Cut back the leader on a 45-degree angle, 1/2 to 1 inch above a bud. Also cut back the laterals around the leader, leaving at least one bud so the lateral branches fit the desired cone shape.

Spruces and firs are generally sheared in the shape of a cone while pines may be sheared for a more rounded shape. Pines are more difficult to shape into a tall, slender, conical shape. Long-needled pines should be sheared with a hand clippers or a shearing knife. This is done to avoid cutting off needles adjacent to the sheared branch. Once shearing is begun, it is done annually until the tree is harvested.

Christmas tree terminology.

For the first shearing, cut all side branches necessary to give the tree the desired shape and taper. Desired taper varies from 1/2 to 2/3 as wide as the tree is tall. Begin cutting the terminal when it is longer than 10 to 12 inches. Shearing should usually be done only on the current year's growth. Occasionally it may be necessary to cut older growth to correct a shape problem.

Spruces and firs are generally sheared in the shape of a cone while pines may be sheared for a more rounded shape. Pines are more difficult to shape into a tall, slender, conical shape. Long-needled pines should be sheared with a hand clippers or a shearing knife. This is done to avoid cutting off needles adjacent to the sheared branch. Once shearing is begun, it is done annually until the tree is harvested.
Shearing for shape and density

Practice and experience is critical to good shearing. Experienced growers will usually produce a higher proportion of top quality trees. Good shearers can shear approximately 60 trees per hour. Shearing is probably the most labor intensive practice in Christmas tree production, but it is necessary for the production of top quality trees.

A Christmas Tree Management Calendar

January-February

1. Inventory the supplies unused and carried over from the previous year: herbicides, fugicides, fertilizers, shears, knives, tree tags, etc.
2. Order those supplies or materials, or plan the ordering of any supplies or equipment which must be on hand at a later time.
3. Cut brush in and around plantations as weather and conditions permit.
4. Service and maintenance work on equipment: mowers, sprayers, tractors, small tools, etc.
5. Build those items which will facilitate work during the busy season such as cases and chests to carry equipment in.

March

Depending upon the weather, items for February may be done in March, and items for March may have to be post-poned until April.
1. Prepare planting sites by brush chopping and tree removal if necessary.
2. Construct and/or improve roadways to, from and within plantations.
3. Inspect plantations for winter losses: winter burn, animal and snow damage, etc., taking inventory to determine replanting needs.
4. Herbicide application such as Princep.
5. Planting.
April

1. Planting
2. Insecticide application
3. Herbicide application, preplant

May

1. Planting
2. Herbicide, postplant
3. Insect control

June

1. Tag trees prior to shearing (trees to be sold in current year).
2. Shearing
3. Rogue out insects and insect infested trees while shearing.
4. Spray to control insects not controlled by rogueing out.

July

1. Shear trees to remain in plantation for an additional year or more. Do this until about mid-July.
2. Begin shearing trees to be harvested during the coming fall or winter.
3. Continue to control insects.

August

1. Shear trees to be marketed during the current year.
2. Remove from plantation and destroy insect and disease infested trees.
3. Apply green colorant.
4. Inventory trees to be sold in the current year.
5. Stake up trees.
6. Control brush by chopping.
7. Apply herbicide to control woody plants.

September

1. Continue staking trees.
2. Continue green colorant.
3. Continue brush control (herbicide treatment should be completed before frost).

October

1. Same as above.
2. Same as above.
3. Shake trees to remove debris.

November

1. Cut trees for wholesaling and load trucks.
2. If entire areas are cut, brush cut them.
3. Treat stumps to control insects from harboring in them.
1. Load trucks and semi-trailers.
2. Chop brush and clean up cutover plantations.
3. Continue treating stumps.
4. Summarize sales and income, and approximate tax calculations. Plan purchase of supplies and fertilizer to minimize taxes.

*References* (Excerpts from the following publications used by permission)

1. Iowa State University Extension Publication F-348, Christmas Tree Shearing.
2. Iowa State University Extension Publication F-339, Weed Control For Tree Planting.
3. Iowa State University Extension Publication Pm-661, Christmas Tree Production in Iowa.

**Study Questions**

1. How many trees can be sheared by an experienced grower in an hour?
2. Which method of weed control is least recommended? Why?
3. When do deer do most of their damage?
4. About how wide should a well-shaped tree be?
5. What three things does shearing accomplish?
To market Christmas trees it is also important to know which species of trees sell in your area as well as the price and size. It is equally important to produce a high quality product.

Species

Three species made up 92 percent of the Christmas tree population in Iowa during 1982. Scotch pine was the most popular species followed by white pine and red pine. See the table below:

Percent of total acres planted to different species in Iowa - 1982

<table>
<thead>
<tr>
<th>Species</th>
<th>Percent of Total Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scotch pine</td>
<td>56</td>
</tr>
<tr>
<td>White pine</td>
<td>27</td>
</tr>
<tr>
<td>Red pine</td>
<td>9</td>
</tr>
<tr>
<td>Other (spruce, fir, Austrian or ponderosa pine)</td>
<td>8</td>
</tr>
</tbody>
</table>

Tree Quality

Don’t assume that all surviving trees will be sold as Christmas trees. Some trees will be deformed to the point that they can be sold only as cut greens.

As a producer gains experience in shearing, more trees are saved and the marketability percent increases. Experienced Iowa producers report 90 percent marketability of their sheared trees. New producers should plan for maximum marketability, but realize that they may only get about 60 percent or less marketability for the initial production cycle due to their inexperience.

Price

Christmas trees are sold either on a dollar per tree or dollar per foot basis; with a price per foot being the most popular method. In 1982, the average retail price per foot was $2.63; average price per tree was $11.39. The table below summarizes the ranges and averages for retail and wholesale prices charged by Iowa producers in 1982.

Retail and wholesale prices charged by Iowa Producers in 1982

<table>
<thead>
<tr>
<th>Type of Sale</th>
<th>Range($)</th>
<th>Average ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail per foot</td>
<td>1 to 5</td>
<td>2.63</td>
</tr>
<tr>
<td>Retail per tree</td>
<td>6 to 18</td>
<td>11.39</td>
</tr>
<tr>
<td>Wholesale per foot</td>
<td>1 to 2</td>
<td>1.50</td>
</tr>
<tr>
<td>Wholesale per tree</td>
<td>8 to 12</td>
<td>9.00</td>
</tr>
</tbody>
</table>

Size

Prices paid for Christmas trees are related to their height and other quality characteristics. It is important, therefore, to select the most profitable age for harvest. Retailers report that marketable Christmas trees heights range from 3 to 8 feet. They
also indicate that 2 1/2 to 3 foot trees seem to be increasing in popularity relative to taller trees. Most of the Christmas trees sold in Iowa during 1982 were 5 to 6 feet tall. The table below summarizes the data for three different height classes.

**Height of Christmas trees sold in Iowa - 1982**

<table>
<thead>
<tr>
<th>Height (feet)</th>
<th>Percent of Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 to 4</td>
<td>11</td>
</tr>
<tr>
<td>5 to 6</td>
<td>61</td>
</tr>
<tr>
<td>7 or more</td>
<td>28</td>
</tr>
</tbody>
</table>

A producer should have at least 500 trees available to interest wholesale buyers in purchasing them at roadside. A recent producers' survey revealed that for the four species being evaluated, marketability for nonsheared trees ranged from 4 percent for white pine to 30 percent for Scotch pine. The percent of marketable sheared trees is higher but varies depending on the experience and ability of the shearer.

**Where to Sell**

Nearby towns and neighbors provide the best markets for Christmas trees. Some growers sell standing trees to individuals at retail prices and the buyer does his own cutting. Producers near large urban communities can become affiliated with a retail city lot and sell directly to customers through these lots.

Large wholesalers generally contract for sales well in advance of the Christmas season. Producers may contract the sale of trees on the stump or for cut trees. Consignment sales to wholesalers should be avoided and down payments or "binders" should always be required. Remember, when wholesaling trees you will receive a lower price per tree, but sell a greater volume of them. If you plan to wholesale your crop, begin making contacts for sale of your trees by midsummer.

**Christmas Tree Business**

It is impossible to determine the exact dollar return per acre per year from a venture in Christmas tree production. The cost of labor, land, equipment, trees, the local markets, tree quality, individual management - all determine economic return, which can fluctuate widely.

Before venturing in to the Christmas tree business, do an economic analysis based on the best information you can obtain. As an example, let's make some assumptions and calculate costs and returns based upon number of trees grown per acre.

Let's assume the species is Scotch pine, to be planted at 6-by 6-foot spacing, or 1210 trees per acre. Ten percent of the acre will be directed to roads and lanes, so that only 1090 trees will be planted. Of these, another 10 percent probably will not reach maturity, and another 10 percent will not be salable. That reduces harvested to 883 and leaves 98 unsalable cull trees to be removed during the 8-year production period.

Land value is assumed to be $1000 per acre. Management costs and taxes are $30 an acre, labor is hired at $3 an hour, interest rate is 6 percent (Table 1). Trees will be sold at $7 per tree. Follow these assumptions through the economic analysis (Table 2). Look also at the actual cash flow for an acre of Christmas trees.
following the assumptions previously made (Table 3). A cash flow analysis depicts the actual flow of money during the operation.

Table 1. 6% Compound Interest

<table>
<thead>
<tr>
<th>Years to end of rotation period</th>
<th>If cost occurs only in this year, multiply by factor below</th>
<th>If cost is a recurring constant cost from a given time period on, multiply by factor below</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.761</td>
<td>13.181</td>
</tr>
<tr>
<td>9</td>
<td>1.669</td>
<td>11.491</td>
</tr>
<tr>
<td>8</td>
<td>1.594</td>
<td>9.898</td>
</tr>
<tr>
<td>7</td>
<td>1.544</td>
<td>8.394</td>
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<tr>
<td>6</td>
<td>1.419</td>
<td>6.975</td>
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<tr>
<td>5</td>
<td>1.338</td>
<td>5.637</td>
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<tr>
<td>4</td>
<td>1.262</td>
<td>4.375</td>
</tr>
<tr>
<td>3</td>
<td>1.191</td>
<td>3.184</td>
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<tr>
<td>2</td>
<td>1.124</td>
<td>2.050</td>
</tr>
<tr>
<td>1</td>
<td>1.050</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Table 2. Economic Analysis of Christmas Tree Production per Acre

<table>
<thead>
<tr>
<th>Item</th>
<th>Basis</th>
<th>Yrs.</th>
<th>6% Interest Factor</th>
<th>Costs</th>
<th>Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxes management</td>
<td>$30 00</td>
<td>Yr 1</td>
<td>1.0600</td>
<td>2438 81</td>
<td></td>
</tr>
<tr>
<td>Land value</td>
<td>$1000 A</td>
<td>8</td>
<td>1.5008</td>
<td>1500 00</td>
<td></td>
</tr>
<tr>
<td>Planting stock</td>
<td>$55 M x 1 000 = 69 95</td>
<td>8</td>
<td>1.5008</td>
<td>95 55</td>
<td></td>
</tr>
<tr>
<td>Planting cost</td>
<td>$50 M x 1 000 = 65 40</td>
<td>8</td>
<td>1.5008</td>
<td>104 23</td>
<td></td>
</tr>
<tr>
<td>Weed control</td>
<td>$20 A</td>
<td>8</td>
<td>1.5008</td>
<td>31 88</td>
<td></td>
</tr>
<tr>
<td>2nd yr</td>
<td>$20 A</td>
<td>6</td>
<td>1.4190</td>
<td>20 28</td>
<td></td>
</tr>
<tr>
<td>3rd yr</td>
<td>$20 A</td>
<td>5</td>
<td>1.3361</td>
<td>26 76</td>
<td></td>
</tr>
<tr>
<td>Mowing between rows</td>
<td>$5 A</td>
<td>8</td>
<td>1.0600</td>
<td>50 38</td>
<td></td>
</tr>
<tr>
<td>Pest control spray</td>
<td>$15 each year</td>
<td>7</td>
<td>1.0600</td>
<td>125 91</td>
<td></td>
</tr>
<tr>
<td>Shearing and base pruning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5yr 1st tree</td>
<td>$9 24</td>
<td>5</td>
<td>1.3361</td>
<td>52 51</td>
<td></td>
</tr>
<tr>
<td>4th yr 2nd tree</td>
<td>$19 62</td>
<td>4</td>
<td>1.2625</td>
<td>24 77</td>
<td></td>
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<tr>
<td>5th yr 2nd tree</td>
<td>$19 62</td>
<td>3</td>
<td>1.1910</td>
<td>24 77</td>
<td></td>
</tr>
<tr>
<td>6th yr 3rd tree</td>
<td>$29 43</td>
<td>2</td>
<td>1.1236</td>
<td>33 07</td>
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<td>Trees sold</td>
<td>1 = 400 x $7 00 = $2800</td>
<td>1</td>
<td>1.0600</td>
<td>3635 80</td>
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</tr>
<tr>
<td>Retaining cost</td>
<td>$ 85 tree x 400 = $34 00</td>
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<td>1.1236</td>
<td>487 98</td>
<td></td>
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<tr>
<td>Shearing 3rd year</td>
<td>$15 72</td>
<td>2</td>
<td>1.1236</td>
<td>15 72</td>
<td></td>
</tr>
<tr>
<td>Trees sold</td>
<td>5th yr</td>
<td>$2 751 00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retaining cost</td>
<td>$ 85 tree x 400 = $34 00</td>
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<td>1.0600</td>
<td>354 00</td>
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</tr>
<tr>
<td>Clean up cost</td>
<td>$10</td>
<td></td>
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<td>10 00</td>
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<td>Residual land value</td>
<td>$1000</td>
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<td></td>
<td>1000 00</td>
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</tr>
<tr>
<td>Total accumulated returns</td>
<td></td>
<td></td>
<td></td>
<td>7386 80</td>
<td></td>
</tr>
<tr>
<td>Total accumulated costs</td>
<td></td>
<td></td>
<td></td>
<td>3376 79</td>
<td></td>
</tr>
<tr>
<td>Net income for 1 crop unit</td>
<td></td>
<td></td>
<td></td>
<td>4009 43</td>
<td></td>
</tr>
<tr>
<td>Av returns tree</td>
<td>($7 306 60 - 483)</td>
<td>8</td>
<td>8 36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs tree</td>
<td>($3 376 37 - 683)</td>
<td>3</td>
<td>86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net income tree</td>
<td>($4 030 23 - 863)</td>
<td></td>
<td></td>
<td>4 53</td>
<td></td>
</tr>
</tbody>
</table>

* Factors from Table 1.
*References* (Excerpts from the following publications used by permission).

1. Iowa State University Extension Publication Pm-661, Christmas Tree Production In Iowa.
2. Iowa State University Extension Publication F-310 (Rev.), Survey of Iowa Christmas Tree Producers.

**Study Questions**

1. What are the three most popular species for Christmas trees in Iowa?
2. In 1982, what was the most popular height range of Christmas trees sold in Iowa?
3. Where is the most likely place a small producer would find a market for his/her trees?
There are three basic marketing options open to Christmas tree producers:

1. Producer to wholesaler - the producer sells the product to wholesalers.
2. Producer to retailer - the producer functions as both a producer and a wholesaler.
3. Producer to consumer - the producer functions as a producer and a retailer.

Depending upon the size of the operation a producer may use more than one of the options. The choice depends upon many factors inherent in a particular operation.

Choosing an Option

With each stage of the marketing process which producers assume, they will increase their potential share of the final sale price of the Christmas tree, but each subsequent stage also adds more labor and more risks to compensate for the added potential income.

There is a rule of thumb on pricing in the Christmas tree trade which states that each level of distribution doubles the tree's basic cost. This is not always accurate, but the trend is correct. Some operators of city lots indicate that the first half of their tree sales pay for their trees, the second half pays operation costs and profit.

It would seem then that producers could double their intake by assuming the wholesale function, and that they could double it again by becoming a retailer. There is no question that producers can increase their share of the final dollar if they assume the extra labor and the extra risks of the additional levels of the distribution process. There are several questions producers must ask themselves before assuming additional levels of marketing. Some of these questions are: Do you have additional time? Do you have a source of labor? Are you willing to accept additional risk? Is your location and operation suitable for more than one marketing options? It is difficult to answer these questions without considering additional factors.

Additional Factors to Consider

Here are some of the factors which influence producers in their choice of marketing options. It includes some of the most important factors which apply to many producers:

1. Producers planning for a continuing operation with a more or less uniform number of trees to be sold each year should design their marketing plan for a continuing basis and attempt to establish a long term plan that can use up their entire annual output. Producers with only one crop to sell should consider selling to a wholesaler, another grower, or to a retailer on a one shot basis. The same would apply to a producer with a temporary over supply of trees.

2. What is the size of your operation? How many trees are to be sold? If the quantity is only a few hundred, many
channels are open. Producers with several thousand trees would need to sell at least a portion to a wholesaler unless they are prepared to go into retailing.

3. Where is the plantation located in relation to available markets? Producers who are near their market have a wide choice of channels, but the further away the market, the more the choice is restricted. For example, if the plantation is close to town, a producer could sell retail on his/her plantation. If the plantation is 25 to 30 miles from the market, then retailing becomes more difficult, and the volume which can be sold this way is more limited. The producer then could set up a retail lot in town or wholesale to someone who operates a lot.

4. What is the size of the market in the area? How many trees can nearby markets use? What is the competition for the market? If the only nearby market is a town of 4000 to 5000, it may need 1000 trees. A city of 50,000 persons may use 10,000 trees.

5. How much time and labor can the producer devote to marketing and harvesting? Each stage of the distribution process requires more labor which the producer must do or hire to be done. If the producer plans to operate a lot then someone must set up and operate that lot, whether the lot is on the plantation or on in town. If the producer is wholesaling, then the trees must be harvested and shipped.

6. What facilities and resources are available to the producer? These include: buildings, equipment, space and labor? Some producers may sell their entire crop without harvesting any, but as a wholesaler they may need to cut, grade, bundle and even deliver the trees. As a retailer the producer would need to sell each tree individually and that requires more time and resources.

Marketing Alternatives

Selling on the stump is the most basic way to market Christmas trees. The producer plants and cares for the trees and when they get to marketing size he/she sells them as they stand. The buyer harvests the trees. Choose and cut retailing is one popular method, but for large quantity selling, the producer usually contacts a wholesaler or distributor. Trade magazines sometimes carry ads from distributors wanting to buy entire plantations, or trees on the stump. Some will send in a crew to harvest. Usually they will not consider small numbers of trees (less than 4000) because of the economics. This type of sales is usually made on a contract basis. The contract should specify the trees to be cut, after harvest clean up, method of payment. All details should be carefully written out to avoid misunderstandings.

Some producers sell directly to retail lots, a form of "wholesale choose and cut." Lots operated by civic, service, or school organizations, or other groups who have enough labor available and can borrow equipment, are often interested in cutting and hauling their own trees to increase their profits by doing part of the work. Under this system the producer is usually responsible for spraying with colorants where necessary and for clean up.
Wholesaling is a step further up in the marketing chain. In contrast to "selling on the stump" and "choose and cut" retailing, this system could be described as "cut and deliver" selling. Wholesaling is selling directly to retailers. The producer is usually required to cut and deliver the trees.

Many producers do some wholesaling even if they retail most of their trees, either to increase their sales volume above the available retail market or to keep their own operation in balance and to have an outlet for surplus trees.

Wholesaling is usually considered to be a high-volume operation, in contrast to retailing where trees are sold one at a time. A producer may sell from a few hundred trees up to thousands in this way. The sale price is also higher than for the "on the stump" method because it involves more labor and more risk. Wholesaling provides some flexibility in managing the plantation and in marketing. Location of the plantation is not important as long as all-weather roads are available. Producers can plan their operation to meet their facilities and goals. Wholesaling is also less dependent upon the weather than the other methods of retailing.

Retailing, or selling directly to consumers, is the method which can produce the largest return, but it also involves the greatest risks. Retailing is considered to be a small unit operation. Some producers sell 5000 to 6000 trees per year, but most sell considerably fewer trees. Retailing is one-at-a-time sales, and most lots sell fewer than 1000 trees.

When the producer decides to sell at the retail level he/she assumes all phases of the marketing chain. The producer also assumes all of the labor from production up to the final sale. The producer will have to cut, trim, grade, price and transport the trees. Their are three basic choices in retailing:

1. Sell at a lot or lots in town, away from the plantation.
2. Sell cut trees at a location on or near the plantation. Many retailing problems are minimized this way because the supply of trees is nearby.
3. Choose and cut, where the consumer goes into the field, chooses the tree, cuts it, and hauls it home.

Selection of retailing method varies on several factors including location of the plantation, facilities available, labor available, size of plantation, and producer goals.

*Reference


Study Questions

1. What are the three basic marketing options available to producers of Christmas trees?
2. What are some of the factors which influence the producers decision regarding marketing?
3. What does "choose and cut" mean?
4. What are the three basic choices in retailing Christmas trees?
1. Marketability percent - The number of trees that can be sold at the average tree price divided by the number of trees that survived to maturity.

2. Lake States - Those states which border on any of the Great Lakes.

3. Dithostroma needle blight - A fungus which lives almost solely on Austrian pine, attacking and killing needles of all ages.

4. Plantation - A group of trees planted together, allowing for better management.

5. Firebreaks - Open areas within a plantation which help to prevent fire from travelling uncontrolled among trees.

6. Whorls - Several branches radiating from the same level on the stem.

7. Shearing - Pruning a tree to give it a desirable shape.

8. Dormant season - The period of time during the year when the tree is not actively growing.

9. Terminal leader - The apex, or the top and center part of the tree.
Steps for Establishing a Christmas Tree Plantation

Step 1. Determine market
Step 2. Obtain funding
Step 3. Select tree species
Step 4. Match species to site
Step 5. Develop planting design
Step 6. Do site preparation
Step 7. Obtain trees
Step 8. Plant trees
Step 9. Develop management strategies
Step 10. Shear trees
Step 11. Develop marketing strategies
MATCH TREE SPECIES
to the SITE

FLOODPLAIN
willow, cottonwood, sycamore, silver maple, boxelder

TERRACE
ash, walnut, elm, bitternut hickory, basswood, Kentucky coffee tree

HILLSIDE and HILLTOP
spruce, pine, cedar, hard maple, oak, shagbark hickory, basswood
CRITERIA for MATCHING SPECIES to SITE

1. Climate
2. Soils
3. Topography
4. Shade tolerance
Popular Christmas Tree Species
in Iowa

Scotch Pine

White Pine

Red or Norway Pine
TREE PLANTING METHODS

Tree Spud
(40 trees/hr.)

Spade
(40 trees/hr.)

Mechanical Tree Planter
(1,000 trees/hour)
2 METHODS FOR HAND PLANTING WITH A SPADE

1. Take out a V-notch of soil. *
2. Set it aside.
3. Lay tree in hole.
4. Replace V-notch of soil.
5. Heal in the soil.

* If soil is clayey, scarify (scratch) sides of the hole.

1. Dig a hole. *
2. Place tree in hole at correct depth.
3. Replace dirt.
4. Compact soil slightly.
Reasons for Shearing

1. Improves tree quality
2. Improves tree form
   a) Develops uniform spacing between branches
   b) Develops a symmetrical shape
   c) Increases foliage density
3. Increases percent of sellable trees
4. Increases the value of the trees
Shearing Christmas Trees

Try to maintain 60-70 percent taper
Three Shearing Tips

1. Eliminate Extra Leaders
2. Control Height
3. Develop Uniform Taper and Density

Cut terminal leader in half when it has extended 8"–10".

Confine shearing primarily to new growth.

Eliminate extra leaders while trees are young.
Controlling Height

Cut terminal leader to 8"-10".
Cut branches of terminal whorl to about 1/2 length of leader.
Eliminating Extra Leaders

(A) Terminal leader
(B) Extra leader

Eliminate extra leaders while trees are young.
Developing Uniform Taper and Density

Confine shearing primarily to new growth (A)
WATCH OUT FOR BIOLOGICAL PROBLEMS

Fire

Insects

Weed Competition

Disease

Animal Damage
Methods of Selling Trees

Wholesale

Choose & Cut

Lot Sells

Retail
Wholesale Marketing Strategies

1. Have good quality trees
2. Contact buyers directly or through local newspapers
3. Demand a written agreements
4. Provide properly bundled trees
5. Provide freshly bundled trees
Retail Marketing Strategies
Lot Sale

1. Have good quality trees
2. Select a visible lot near a heavily travelled road
3. Select a lot which has easy access and plenty of parking
4. Display a sign or banner (in advance of the driveway)
5. Have an easy pricing system
6. Don't overprice your trees
7. Be a pleasant sells person
Retail Marketing Strategies

Cut and Choose

1. Have good quality trees
2. Tag all trees currently for sale
3. Have a simple and readily understandable pricing system
4. Provide for easy access
5. Advertise in local newspapers (provide directions to tree farm)
6. Display noticeable sign at entrance
7. Provide ample, all weather parking
8. Use imagination and ingenuity in advertising and displaying trees
9. Be a friendly sales person
Where would you shear this tree?
## Matching Species to Site

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<th></th>
<th>Scotch</th>
<th>White</th>
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<tr>
<td>Well-drained soil</td>
<td></td>
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<tr>
<td>Moist soil</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Somewhat drought resistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No close spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Iowa - north and east slopes</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>East Iowa - all slopes</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>East Iowa - north and east slopes</td>
<td></td>
<td></td>
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<tr>
<td>Higher sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Affected by dithistroma</td>
<td></td>
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</tr>
</tbody>
</table>
Situation:

Sammy Slick has been offered free++ access to a wood pile 50 miles from his home in Cheap-a-Skate Town, IA. He has also been offered access to a wood pile 10 miles from home, but it would cost him $25.00 per cord. He figures he can cut and split 1 cord of wood per 5-hour day (not including driving time).

Ever since Sammy bought his chain saw last week for $250.00, he has wanted to go into the firewood business. Heavens, you can sell a cord of firewood for $150.00! Sammy knows that if he sells two cords he’ll have the chain saw paid off. This is a much faster profit than the $5.00 per hour he is making now. (He’s figuring the chain saw costs approximately $1.50 for gas and oil; and that he’ll be able to cut 500 cords during it’s 10-year life span).

He figures transportation will cost a little. He’s got a 1/2-ton Ford pickup that gets about 15 miles per gallon and can safely go 40-miles-per-hour with a half-cord of wood. Depreciation and maintenance is $1.00.

Questions:

1. Which option should Sammy Slick use - the free firewood or the $25.00 firewood?
2. Will two cords of firewood really pay for Sammy’s new chain saw?
3. How much depreciation per cord will Sammy need to figure?
4. Will proper firewood production with proper drying ... bring in money faster than Sammy’s present job?
5. If Sammy rents his uncle’s truck for $5.00 per load, would this business deal make Sammy more money? (This truck can carry 2 cords of wood and gets 8 miles per gallon), plus $1.00 depreciation. It will go 50 mph with a full load.
6. How much money will Sammy make per cord with each of the four options?

Formula:

\[
\text{COST PER CORD} = S + \left[ \frac{P}{M} + F \right] (ND) + \left[ T + ND/R \right] (L)
\]

Where:  
\(S\) = chain saw cost (variable & fixed) for cutting one cord  
\(P\) = price per gallon for truck fuel  
\(M\) = miles per gallon for truck  
\(F\) = fixed cost per mile for truck  
\(N\) = number of round trip hauling distance  
\(T\) = hours required to cut, split, load and unload one cord  
\(R\) = average speed of truck during haul  
\(L\) = labor charge per hour  
\(D\) = distance to the firewood source and back home
APPENDIX F - WOODLAND MANAGEMENT FOR SAWLOG AND VENEER PRODUCTION
MANAGING WOODLANDS FOR SAWLOG AND VENEER PRODUCTION

Written by: Reinee Hildebrandt
4-H and Forestry Departments
Iowa State University

Goal:

Upon completion of this unit the students will be able to manage an existing woodland area for sustained sawlog and veneer production.

Unit Objectives:

1. Know how to identify trees of commercial value in Iowa.
2. Describe how a tree grows.
3. Determine potential value of an individual tree.
4. Explain the complex ecosystem of the woodland.
5. Explain how land management practices affect timber quality.
6. Define woodland management terms.
7. List woodland regeneration strategies.
8. Develop woodland protection strategies.
9. List timber harvesting and marketing strategies and tell the benefits and drawbacks of each strategy.

Visual Masters:

1. Leaf Identification Characteristics (Leaf Shape)
2. Leaf Identification Characteristics (Leaf Arrangement)
3. Leaf Identification Characteristics (Leaf Margins)
4. Leaf Identification Characteristics (Leaf Type)
5. Other Tree Identification Characteristics (Bark)
6. Other Tree Identification Characteristics (Winter Buds)
7. Other Tree Identification Characteristics (Twigs)
8. Other Tree Identification Characteristics (Location)
9. Common Commercial Tree Species in Iowa
10. Parts of a Tree
11. Calculating Board Foot Volume
12. Tree Conditions Indicating Decay
13. Tree Shape/Branching vs. Tree Quality
14. Tree Quality From Veneer to Firewood
15. Tree Limbs Produce Knots
16. The Woodland Community
17. Disturbed vs. Undisturbed
18. Present Uses of Iowa Woodlands
19. Practices That Affect Timber Value
20. Steps for Sawlog and Veneer Production
21. Silviculture Strategies
22. Where to Prune
23. Pruning - A Three Cut Method
24. Timber Stand Improvement (before cutting)
25. Timber Stand Improvement (after cutting)
26. Four Timber Harvesting Techniques
27. Pros and Cons of Timber Harvesting
28. Thinning Pays
29. Four Timber Marketing Strategies
30. A Timber Sale Contract

Activity Handouts:

1. Parts of a Tree
2. How A Tree Grows
3. "Micro-Plot" Activities Information Sheet
4. "Micro-Plot" Activity Worksheet #1
5. "Micro-Plot" Activity Worksheet #2
6. Forest Regeneration Plot Study
7. Woodland Management Terms Crossword
8. "A Day With The Foresters" (Student Worksheet #1)
9. "A Day With The Foresters" (Student Worksheet #2)
10. "A Day With The Foresters" (Teachers Guide)
11. Sawlog/Veneer Management Quiz

Topic 1: Identifying Trees of Commercial Value

Objectives:

1. List leaf and tree characteristics that can be used to identify trees.
2. Identify Iowa tree species potentially valuable for sawlog and veneer log production.

Teaching Procedure:

1. Show the students characteristics used to identify trees using visuals #1-8. Use visual #9 to show the students tree of commercial value.
2. Do an "Adopt A Leaf" Activity. Give each student a twig from a different tree. Tell them that they will be expected to find their twig again. Allow the students three minutes to look at their twig and to observe the leaves. Collect the twigs. Spread the twigs in a circle and have the students come find their twig. Discuss how they could identify their twig. Emphasize the tree identification characteristics when the students refer to them. For example: opposite vs. alternate leaf arrangement, simple vs. compound leaves, leaf margins, etc.
3. Develop a key for commercial tree species recently marketed in your area. Contact your district forester for a list of recently marketed tree species.
4. Take a hike in a local woodlot. Have students use a tree key (for example, Iowa State University extension publication Pm-970 "Key for Trees of Iowa") to identify trees of commercial value. Mark trees of commercial value with brightly colored flagging. Record the species and their frequency of occurrence. (A follow-up activity called "Micro-Plot" is provided in Topic #3).

Topic 2: The Individual Tree

Objectives:

1. List three basic parts of a tree.
2. List the components and function of the three basic parts of a tree.
3. Explain how a tree grows.
4. Determine board foot volume of an individual tree.
5. Determine the value of an individual tree.
6. Define the term merchantable volume.
7. List criteria for determining individual log quality.
8. (optional) Make a biltmore stick.

Teaching Procedure:

1. Start with Subtopic #1: "Tree Growth". Refresh the students knowledge of trees. Have students list the three major parts of a tree and explain their function. Provide students with Activity Handout #1 and #2: "Identifying Parts of a Tree" and "How a Tree Grows". Visual #10 provides the answers to Handout #1. These handouts can be used as a pre-test to determine if Teaching Procedure Steps #2-4 are necessary.

2. Provide students with the Student Information Sheet #2: "The Individual Tree" and the Forestry Extension Note entitled, F-308 "How a Tree Grows".

3. (optional) Before the class session have some tree cross sections made. Divide the class into groups of two or three students. Give each group a cross section from a different tree. Have the students make up a story of that tree's life.

4. Move on to Subtopic #2: "Determining the Value of an Individual Tree". Generate a discussion on the value of trees. Include the following questions: What products do we get from trees? What species are the most valuable in Iowa? How do we determine the value of a tree? What is board foot volume? How do we determine the board foot volume of a tree? Use the enclosed information sheet, "Sub-topic 2: The Value of a Tree".

5. Invite your math instructor into class to explain the mathematical formulas for determining tree height and diameter. Have the students determine tree height and diameter. Use Information Sheet #2 entitled the "Individual Tree - Sub-topic #2". Explain how to measure tree height using a yard stick and provide instructions on how to make a D-tape. Use visual #11 to discuss calculating the board foot volume of an individual tree.

6. (Lab) Take a hike around the local community or school grounds. Select several tree species and have the students determine the board foot volume in each tree. Have the students use a D-tape and yardstick to measure tree diameter and height. Determine board foot volume using the volume table provided. For the first two trees try to determine total board foot volume. Have the first tree contain branches about six feet from the ground. Have the second tree contain a straight trunk with very few branches. At each tree, after volume has been determined, generate a discussion. Ask the students: Would this tree be suitable for lumber? Why or why not? If not, what other goods and services (oxygen, shade, wind protection, firewood, recreation, soil erosion control...) can be obtained from that tree? If the tree is suitable for lumber, can all of the tree be used for lumber? Why or why not? Introduce the concept of merchantable volume. Next, determine the merchantable board foot volume of one sawlog or veneer quality tree. Using Iowa State University extension publication Pm-785, "Iowa Timber Prices", have the students determine the stumpage value of the tree for both sawlog quality and veneer quality. Introduce the idea of tree quality. Explain the factors that degrade the quality and value a tree (decay, crook, branch stubs or knots). Use visual #12-15 to summarize the discussion. If a professional forester or local logger is available have them estimate the percent of defect in the tree they just measured. Then determine the total board foot volume the tree contains. Determine the reduction in
dollar value of the tree due to defect.

9. Visit a local sawmill operator. Look for examples of sound logs and logs with decay. Use Iowa State University extension publication, Pm-1161 "Directory of Sawmills, Veneer Mills, and Pulp Mills in Iowa", to locate the sawmill closest to your school. Discuss log value and log grading.


Topic 3: Iowa’s Woodland Community

Objectives:

1. List the biotic components of the woodland.
2. Describe the appearance of a forest soil.
3. List four types of woodland communities in Iowa.
4. Describe what an undisturbed woodland looks like.

Teaching Procedure:

1. Show a film about woodland ecology. Suggestions include: "Life in the Woodlot" #S-48398 (good story line emphasizing human and wildlife interaction with ecosystem and long-term ownership of woodlands, applicable to Iowa farm youth, color is not of good quality); "Nature's Half Acre" #S-50045 (good general ecology, but is not directed only to woodland areas); or "A Walk in the Forest" #S-57513 (not as specific to Iowa but it does show ecological relationships and emphasize land stewardship). These films can be rented from Iowa State Media Center, Ross Hall, Iowa State University, Ames, Iowa 50011.

2. The instructor should discuss the woodland community. Use visuals #16-17. Consider the following options:
   A) Read the soils information from Rachael Carson's "Silent Spring" to the students.
   B) Have students develop a bulletin board titled, "The Woodland Eco-system".
   C) Have students read Topic #3: Iowa's Woodland Community, Sub-topics #1 and #2.
   D) (optional) Suggested Project Learning Tree activities: #24 - Economic Web of Life; #53 - The Value of 100 Acres of Forestland; #62 - Food Mobile; and #71 Biography of a Favorite Thing.

3. Take a field trip to a local woodlot. Invite your district forester to talk about the forest ecosystem. While on the field trip have the students do Activity Handout #3-5 "Micro-Plot" Activities. Also do Activity #6: Forest Regeneration Plot Study. At each area, the instructor should comment on species composition, plant diversity, and the amount of regeneration. Have the students decide what each area will look like in fifty years providing current land use continues.

Topic 4: Land Management Practices and Timber Quality

Objectives:

1. List woodland management practices that could improve timber stand composition.
2. List woodland management practices that could reduce the quality of trees in a timber.

Teaching Procedure:
1. Ask students to list different ways local woodland owners use their timbers.
2. Using visual #18 discuss present woodland benefits in Iowa.
3. Have students read Information Handout Topic #4.
4. Use visual #19 to summarize land use practices that influence Iowa's woodland quality.
5. (optional) Suggested Project Learning Tree activities: #14 - Community land Use; #15 - Where Are the Cedars of Lebanon?; #84 - Plan Your Community's Future.

Topic 5: Woodland Management Terms

Objectives:
1. Define the terms: board foot volume, cleaning, clearcut, commercial maturity, commercial thinning, crop tree selection, cut and sell marketing, district forester, even-age stand, extension forester, grade and yield marketing, harvesting, improvement cut, liberation cut, noncommercial thinning, patch cut, percent cut marketing, planting, regeneration, sawlog, Scribner log rule, seed tree, selection cut, shade tolerant, shade intolerant, shelterwood, silviculture, stand composition, stumpage sale, timber stand improvement, uneven-age stand, veneer log, weeding, wolf tree, woodland management.

Teaching Procedure
1. Provide students with the information sheet entitled, "Woodland Management Techniques and Terms - Definition of Terms". Have the students do Handout #8: "Woodland Management Terminology Crossword". Let them make reference to the information sheet.
2. The instructor should go over the word find or crossword with the students. Reinforce the definition of each term.
3. Talk about woodland management techniques using visual #21-28. Iowa State University extension publication Pm-718, "Woodland Management in Iowa" can provide background information.

Topic 6: Woodland Management for Sawlog and Veneer Production

Objectives:
1. Define the term woodland management.
2. List the steps to woodland management for sawlog production.
3. List and explain four types of intermediate cuts.
4. List four types of harvesting techniques and explain the pro's and con's of each.
5. List four types of forest regeneration and explain the benefits and costs of each.
Teaching Procedure:

1. Show the slide/tape show developed by the Department of Natural Resources Forestry Division titled, "Woodlands for Profit". Copies can be borrowed by writing: Roy Hatcher, State Nursery, 2404 South Duff, IA 50010; Phone: (515) 233-1161. You will be responsible for the cost of returning the slides/tape program.

2. Discuss the topic of Woodland Management. Ask students to list steps they need to consider for sawlog production. Discuss their answers. Discuss the steps to proper woodland management listed on visual #20.

3. Divide the students into three groups. Have each group read one sub-topic information sheet on sawlog/veneer management and report that information to the class. You may want to have your English or Speech teacher give a short lecture or provide a handout on informative speeches.

4. Summarize the information presented by the students. Use visuals #21-28. Discuss silviculture.

5. Discuss marketing timber. Use Forestry Extension Publication Pm-413 "Marketing Iowa Timber" and the teacher information sheet as references. Use visuals #29-31 to help with the discussion.

6. Have the students do the Handout #8 or #9: "A Day With The Foresters". Handout #10 is an answer sheet for the teacher. Give each student either Handout #8 to #9. Allow them 15 minutes to complete that handout. Next divide the class into two groups according to the handout situation they received. Each groups should discuss their answers to the questions and come to a decision on how to manage the area. After the groups have made their decision, have them report their answers. After each report have a question answer period for each group.

6. Take the class to a "Forestry Field Day" sponsored by Iowa State University Forestry Extension.

Suggested References:


NOTE: To obtain more information about related material write to: Forestry Extension Service, 251 Bessey Hall, Iowa State University, Ames, IA 50011.
Introduction:

Not every tree in a forest can be sold for sawlogs or veneer. The tree species, size, and quality determine if a tree can be sold commercially. The species also determines the price range you can get from your tree. The prices range from $20.00 per thousand board feet for cottonwood sawlogs of poor quality to $5200.00 per thousand board feet for black walnut veneer of superior quality. (It would take three trees each containing one 16 foot log with a diameter of at least 28 inches to make 1000 board feet.)

Black walnut, red oak, and white oak are the most common tree species marketed throughout Iowa. These tree species typically make up the major component of a timber sale. Other species that might make up a major or minor component of a timber sale include: silver maple, hickory, eastern cottonwood, hard maple, red elm, bur oak, black oak, basswood, hackberry, Kentucky coffeetree, mulberry, black cherry and green ash. See Figure 1 for picture of the most common commercial tree species.

Figure 1. Common Commercial Tree Species in Iowa (1986)
Consult with your district forester or local timber buyer to find out what trees are marketable in your area. Many timber buyers have been able to locate specialty markets. Some of these markets are international companies that send a special representative to Iowa. For example, in 1986, there was a market for red cedar and butternut in the Northeastern part of the state and a market for cottonwood in the northwestern and south central part of the state.

Identification Characteristics

Trees have many characteristics that can be used to identify different species. See Figures 2 and 3 below. Leaves are arranged either oppositely, alternately, or whorled. Leave margins range from smooth to coarsely toothed to lobed. Leaves can also be simple, compound, or doubly compound. A tree's bark, seed type, twigs and its location on the land can all be used to identify tree species. Refer to a tree identification book or key to identify trees in the forest.

![Figure 2. Leaf Characteristics for Tree Identification](image-url)
Figure 3. Other Tree Identification Characteristics

Study Questions:

1. List the three most common commercial sawlog species in Iowa.
2. List three leaf characteristics that help identify trees.
3. List three non-leaf characteristics that help identify trees.
Parts of a Tree and Their Function

A tree has three basic parts; a crown, a trunk, and a root system. The crown consists of branches, twigs, buds, and leaves. The trunk usually consists of one single stem containing heartwood, xylem, phloem, cambium, and bark layers. The root system contains a collection of major roots, secondary roots, tertiary roots and finally numerous root hairs.

Each of the major tree parts perform specific tasks. The leaves of the crown produce sugars and oxygen. The trunk is the trees support and transport system. The root system also provides support by anchoring the tree in place and its numerous root hairs absorb water and nutrients from the soil.

Let's see how these three tree parts work together as a team. In the spring, as the ground thaws, the tree absorbs soil nutrients in water solution through numerous hair-like rootlets. This fluid taken is then transported through the outer part of the wood (sapwood or xylem), up the trunk and branches, and into the leaves. There it combines with carbon dioxide absorbed from the air and energy from the sun to make "tree food" (sugars and starches). This process is called photosynthesis. These liquid sugars and starches move down through the phloem in the trunk. They are stored in the root system or used in the tree growth process.

In the tree growth process, this energy is used to develop new rings of annual growth around the trunk and branches. This ring is the diameter growth. When the tree trunk is cut, these "annual rings" look like circles. A tree may gain from one tenth to three inches in diameter growth per year.

A tree also grows in height. Each spring new flushes of leaves and twigs emerge from winter buds. This adds height growth to the tree. A tree may grow one inch to several feet in total height per year. The amount of growth depends on growing season conditions and the suitablility of planting site.

The tree is an amazing factory. A 50 foot tall oak tree with a 24 inch diameter can absorb up to 100 gallons of water from the soil and release it into the atmosphere each day. Each acre of woodland produces enough oxygen each year to fulfill the requirements of eighteen people. Trees also act as natural filters for the air we breath. The trunk of this factory provides lumber. Each annual ring adds to the total volume of lumber that the tree contains.

How Trees Grow

Read the Forestry Extension Note F-308, "How A Tree Grows".

Factors Influencing Tree Growth

A woodland owner should know what influences the rate of tree growth. This knowledge can be applied to woodland management.
A number of factors influence tree growth. The first is natural growth rate. Some trees naturally grow faster than others. Fast growing trees include: eastern cottonwood, black willow, silver maple, boxelder, green ash, black ash, river birch, tree-of-heaven, red mulberry, black cherry, black locust, honeylocust, swamp white oak, catalpa, quaking aspen, and bigtooth aspen. These fast growing trees are typically short lived trees (30-50 years). Slow growing trees typically live 100-300 years. Slow growing trees include: chinkapin oak, bur oak, white oak, eastern red cedar, mockernut hickory, shagbark hickory, shelled bark hickory, bitternut hickory, Ohio buckeye, and sugar maple.

A second factor influencing tree growth is how well that tree was matched to the site. When a tree is planted in the wrong area, its growth may be slowed and the tree may even die prematurely. The soil type, topography, flood tolerance and shade tolerance all need to be considered. Hilltop trees can not grow well in flood plain areas. Shade intolerant trees can not survive long in a dense forest. Check with a tree identification book for this information. One example is Gary Hightshoe's book "Native Trees for Urban and Rural America". It provides this information.

Biological factors also influence tree growth. Throughout its life a tree faces various climatic conditions such as hail, frost, flooding, drought, and wind damage. These conditions can effect tree growth. Hail and wind can damage trees and break out the tops. Frost can damage buds that are opening or ruin newly emerged leaves. Then the tree has to expend energy to develop new buds rather than adding onto the current years growth. Floods can deposit soils around tree trunks. Floodplain trees will then expend energy to develop a new root system rather than using that energy to add height and diameter growth. During droughty periods, trees have the ability to shut down their "photosynthesis" factory to conserve energy. When this happens the tree is producing less sugars and carbohydrates for tree growth.

A final factor is competition. Trees in a forest compete with neighboring trees for nutrients, moisture, and sunlight. When favorably situated, trees in young, even aged forests (in which all trees are about the same age) have rapid height growth to avoid being overshadowed and suppressed. They obtain their greatest height growth when some competition is present. In an uneven-aged forest (trees varying from young seedlings to mature or overmature) the understory often grow slowly for long periods awaiting release from crowding. When an opening occurs in the forest canopy, the shade tolerant trees living under the forest canopy may begin to grow in height and diameter.

Study Questions:

1. List the parts of a tree and explain their function.
2. Explain how a tree grows.
3. List four factors that influence how a tree grows.
Topic 2: The Individual Tree
Subtopic 3: The Value of a Tree
Student Information Sheet

Trees can provide a variety of lumber products from construction lumber to plywood to flake board to compressed board. Look around you and see all the products made from wood. A desk chair, window frame, yard stick, and flooring may all be made from wood.

The major wood products from Iowa's forests include: lumber, railroad ties, veneer, survey stakes, pallets, blocking and skids, stave bolts, crating, fletches, chips, cants, kraft paper, industrial fixtures, cooperage bolts, furniture, doors, windows, wood carvings, cabinets, agriculture structures, wood patterns, and posts.

Not every tree can provide wood products. The tree in your front yard may be better for shade than for lumber. Many people think that any tree can be used for lumber. This is not so. The value of a tree for lumber depends upon the tree species, the tree's form, the soundness of the tree, and local markets. See Pm-785 "Iowa Timber Prices" for a listing of common commercial trees and their respective value.

There are three basic classes of tree quality. They are veneer, sawlog and firewood or pulp quality. A veneer quality tree produces a large diameter defect-free log. This log is used for producing thin layers of wood. A sawlog quality tree produces lumber for construction and other wood products. Inferior quality trees may be used for firewood, pulp or wood chips.

The form of the tree affects tree value. It is best to have a tall straight trunk void of branches or branch stubs. Living branches reduce the value of lumber. Each place where a tree had a branch, a knot will appear. Every place a knot occurs, the wood product is more susceptible to breakage. See Figure 1. Knot-free lumber brings the best price on the market.

Figure 1. Tree Limbs Produce Lumber With Knots
By looking at tree condition and shape, a person can estimate the quality of a tree. If the tree has many large limbs located within five feet of the ground, it is considered a firewood or pulp quality tree. To produce sawlogs, the tree should be at least twelve inches in diameter (measured at four and one half feet above ground) and contain at least one straight eight foot log. A sawlog quality tree can contain small living branches, but the number and size of branches help determine the value of the tree. The more numerous and larger the branches are, the lower the value of the tree. A tree of veneer quality should have at least an eighteen inch diameter trunk. It should contain a straight limb-free trunk that is at least eight feet long, preferably sixteen feet long. It is possible for one tree to contain all three types of products. The bottom log may be a veneer log. The next log may be sawlog quality. And the crown may be used for firewood. See Figure 2.

![Figure 2. From Veneer to Sawlog](image)

A word of caution is necessary. Just because you find a large commercial tree with a straight limbless trunk, does not mean that tree is veneer quality. Look very closely for evidence of decay. Do you see any holes along the trunk? Are there any conks or mushrooms growing on the tree? Are there any bumps or swellings on the trunk? Are there any open branch stubs or rotten branches? All of these things can be evidence of decay. Therefore, that tall straight limbless trunk may be an empty shell with all its heartwood decayed away. If the branches have begun to decay, a larger part of the tree will be rendered unuseable. See Figure 3.
Decay within a tree is restricted to certain parts of a tree. This process is called compartmentalization. It is a tree's way of protecting itself. Foresters and timber buyers use knowledge of compartmentalization to estimate the amount of decayed wood in the tree. They are estimating the soundness of the tree. The less decay within the tree the higher the value of the tree. Decay reduces the value of a tree by reducing the total volume of lumber that a tree contains.

To determine the dollar value of a tree a person must calculate the number of board feet within that tree. A board foot is a unit of measure. It represents a piece of lumber twelve inches long by twelve inches wide by one inch thick. When a person calculates the number of board feet a tree contains, he or she must estimate the percent of decay and defect in the tree. That percent is used to determine the total number of board feet of volume lost. The volume lost is then subtracted from the total volume calculated.

If you would like to determine the board foot volume of a single tree, you will need to take a diameter and height measurement. Then you would refer to the volume table (Table 1) to determine the total board foot volume.

Diameter is the distance across the plane of a circle. Since it is impossible to measure diameter of a standing tree without cutting it down,
the circumference is measured instead. This number is then converted to diameter using the formula Diameter = Circumference divided by 3.1416.

Tools have been developed that will do this automatically. A diameter tape is the easiest tool to use in measuring diameter. To make your own diameter tape, use an old cloth tape and refer to the numbers on the table below.

<table>
<thead>
<tr>
<th>Circumference (feet &amp; inches)</th>
<th>Diameter (inches)</th>
<th>Circumference (feet &amp; inches)</th>
<th>Diameter (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1'1/2&quot;</td>
<td>4</td>
<td>7'4&quot;</td>
<td>28</td>
</tr>
<tr>
<td>1'7&quot;</td>
<td>6</td>
<td>7'10 1/2&quot;</td>
<td>30</td>
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<td>2'1&quot;</td>
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<td>8'5&quot;</td>
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<td>6'10&quot;</td>
<td>26</td>
<td>13'1&quot;</td>
<td>50</td>
</tr>
</tbody>
</table>

Tree diameter should be measured at four and one half feet above the ground. If you are standing on a hill measure from the uphill side of the tree. When there is a bulge in the tree trunk right at four and one half feet, measure the tree directly above the bulge. If the tree is forked at or below 4 1/2 feet, measure both stems. If the tree is forked above four and one half feet, measure it as a single stem.

Tree height can be determined using a clinometer or a biltmore stick. Both of these tools are based on the rule of equal triangles. A clinometer costs at least $60.00. A biltmore stick costs about $27.00 or it costs very little to make.

In determining the height of the tree, you need to consider merchantable height. Merchantable height is the point on the main stem where the trunk no longer can be used. For sawlog quality, this is typically at ten or twelve inches in diameter. For veneer quality walnut, a twelve inch minimum diameter is acceptable. For most other species the minimum diameter ranges from fourteen to eighteen inches in diameter dependent upon species quality, tree condition, and strength of the market. To determine tree height, many times, all you need to do is estimate the number of eight foot logs there are in that tree, up to the merchantable height.

Once the height and diameter measurement is taken, use the volume table below to determine the board foot volume.
If only a few trees are to be marked for sale, it may be possible for you to determine total board foot volume of the sale. Many times, trees in a stand are sold for a lump sum. For these sales, an estimate of volume is made by sampling plots of trees in the forest. Before you announce your timber sale, someone must calculate the total board feet of lumber marked in the sale area. A professional forester can provide that service.

To summarize, the value of a tree depends on: tree species and local markets; the type of product derived from the tree; the size (height and diameter) and form of the tree; and the quality of the log obtained from the tree. Trees with old wounds, branch stubs, fungal growth and irregular bulges on the trunk may have decay problems. Decay reduces the quality and value of the tree. Large major branches close to the ground could reduce the tree to firewood quality. Any smaller branches will reduce the log to sawlog quality.

Volume of an individual tree can be determined by taking height and diameter measurements and referring to the volume table. Consult with your district forester to determine the volume of your entire stand.

Table 1. Board Foot Volume Tables

<table>
<thead>
<tr>
<th>Diameter (inches)</th>
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</table>

Study Questions:
1. List three things that determine the value of an individual tree.
2. List three basic classes of tree quality.
3. Describe a sawlog quality log.
4. Describe a veneer quality log.
5. List the steps in determining board foot volume of an individual tree.
6. List four tree characteristics that could indicate decay problems.
A forest is not merely a group of trees growing in the same location. The woodland community is a theater of soil, microorganisms, plants, and animals. These players interact with the elements of nature; the wind, water, climate, and numerous ongoing cycles. Together they create a complex story called woodland ecology.

The peaceful appearance of a forest is deceiving. A fierce, though slow and silent, battle is going on constantly. Plants struggle for water and food with their roots. They compete for light and space. When trees compete for life, the strongest win. The strongest, however, are not always the most desirable for our needs.

Some of Iowa's woodlands may appear healthy and undisturbed, but actually aren't. A disturbed and undisturbed woodland community are very different. The main difference between an undisturbed woodland and a disturbed woodland area is the amount of vegetation. An undisturbed woodlot will have many layers of plants from small ground layer to a herb layer to a shrub layer to a layering of trees. A disturbed woodlot will have a park-like appearance (many large trees with only grass or bare ground below). Note however, that an undisturbed woodlot with a dense canopy of leaves could also have a park-like appearance. So you need to look closer. Look for a distinct "browse line". This is the height above which grazing livestock cannot reach. Look for soils lacking the organic matter layer; soils that are highly compacted; and trees with exposed roots. These conditions indicate the site has been disturbed by grazing.

The grazing of woodlands threatens the existence of understory species. Iowa has many rare and endangered plant species that live in our woodlands. Some of these plants, as well as other plants, have specific site requirements. This means they will only grow in the right place. For example:aconiturn or Northern Monks Hood is a plant that only survives on north facing slopes in sink hole-like formations in Northeastern Iowa. Protection of such a rare and endangered habitat should be a management priority. Once extinct, such rare natural treasures can never be replaced.

A woodland community is not stagnant. Natural processes are constantly at work to mold the future of the landscape. The woodland community you see today will look very different fifty years from now. The trees and plants continue to grow. Some plant species will die out and be replaced by other plant species. This natural process is called "succession". Succession is the naturally occurring change from one plant community to another. A simplified model is as follows: bare ground, to lichen to mosses, to grasses, to conifer trees or fast growing shade intolerant deciduous trees (aspen, cottonwood, willows,...), to slow growing shade tolerant trees (oaks, hickories, sugar maples).

A close look at a woodland community can tell us a lot about the area. Plants can be an indicator of the quality of that site. Forest sites with red and white oak, jack-in-the-puplit, orchids are typically good quality sites. Forest sites with bur oak, black oak, black or honey locust, red
cedar and multiflora rose are typically poor quality sites or sites that have been abused or sites in early stages of succession.

With an understanding of the woodland ecosystem and of proper woodland management, a woodland owner can work within the directives and forces of nature so the forest will continuously yield the desired wood products and services.

**Study Questions**

1. Describe a healthy forest.
2. Describe the differences between a disturbed and undisturbed forest.
There are five basic types of forest communities in Iowa. The major forest types in Iowa are oak-hickory, or the central hardwoods; silver maple/cottonwood/ash, or bottomland hardwoods; and oak-maple-basswood, or northern hardwoods, riparian community, and some northern conifer-hardwoods. The book entitled, "Forest and Shade Trees of Iowa" by Peter van der Linden and Donald Farrar provides a good description of Iowa's forest communities. Those descriptions are given below.

Reprinted by permission from "FOREST AND SHADE TREES OF IOWA" by Peter van der Linden and Donald R. Farrar (c) 1984 by the Iowa State University Press, 2121 South State Avenue, Ames, Iowa, 50010. All rights reserved.

Most of the natural forest stands in Iowa can be placed in one of the five following communities.

1. The oak-hickory community occurs on dry uplands and on south- and west-facing slopes. Its canopy (uppermost layers of foliage) is usually dominated by one or more of the following trees: white oak, bur oak, black oak, Hill's oak (Northern pin oak), chinkapin oak and shagbark hickory. Other common canopy trees include: white ash, black cherry, quaking and bigtooth aspens, red oak, and basswood and, in southeastern Iowa, post oak, blackjack oak, shingle oak, and mockernut hickory. The understory (lower layers of foliage) is usually dominated by ironwood or chokecherry, though saplings of larger trees such as white ash, hackberry, elms, and hickories may also be abundant. Shrubby, thicket-forming species such as prickly ash, hazelnut, and dogwoods are often common in clearings or in stands with open canopies.

2. The oak-maple-basswood community occurs in moist but well-drained uplands, especially on north- and east-facing slopes and terraces in the larger stream valleys. Its canopy is usually dominated by some combination of red oak, hard maple, and basswood, with the maples decreasing and the other two species increasing from east to west. Hard maple drops out entirely in western Iowa and red oak in the extreme northwest. Other large trees frequently encountered in this community are white oak, shagbark and bitternut hickories, black walnut, butternut, white and black ashes, and formerly the American elm. The understory and shrub layers are often sparse, with ironwood and hard maple saplings the usual dominants. Hornbeam, bladdernut, serviceberries, dogwoods, witch hazel, Ohio Buckeye and the saplings of ashes and hickories are also common locally.

3. The bottomland hardwoods community occurs on primary floodplains and low-lying terraces in the larger stream valleys. Its canopy dominants are typically one or more of the following species: silver maple; green ash; hackberry; black walnut; cottonwood; and, in certain parts of Eastern Iowa, the river birch. American elm was once a conspicuous feature of this community but the large trees of this species are now scarce because of the Dutch elm disease. Many other species of large trees are also characteristic of this community though they seldom take up more than a minor part of the canopy: sycamore, honeylocust, Kentucky coffee tree, black and peachleaf willows, bitternut and shellbark hickories, pecan, pin oak, shingle oak,
swamp white oak, butternut, rock elm, and black ash. The understory is
commonly dense with woody vines and saplings of the canopy species, but where
the canopy is fairly open the understory is often replaced by tall herbaceous
plants such as jewelweed and nettles.

4. The riparian community forms a narrow belt on lakeshores, stream banks,
mud flats, and sandbars. It is usually dominated by one or more of the
following: cottonwood; silver maple; boxelder; river birch; and, sandbar,
rigid, black and peachleaf willows. Several other species from the adjacent
bottomland hardwoods community may also occur to a greater or lesser extent.

5. The northern conifer-hardwoods community occurs on steep, moist, usually
north-facing slopes in extreme northeastern Iowa. This community is centered
in the Great Lakes states and many of its most characteristic species drop
out in Minnesota or Wisconsin. The trees and shrubs that do range into Iowa
are more often found as minor constituents of the oak-maple-basswood or
oak-hickory communities than as a discrete community. They include white
pine, balsam fir, Canada yew, paper and yellow birches, mountain maple,
quaking and bigtooth aspens, black ash, speckled alder, highbush cranberry,
red elderberry, and red-osier dogwood.

Study Question

1. List the different woodland communities in Iowa.
What is a quality woodland? We know that a quality tree has a straight limbless trunk. It also does not have any areas of decay or injury. Therefore, a quality woodland must be a forest containing mostly good quality trees? In part, it is. However, for sawlog production, woodland quality also refers to composition of species in the forest.

Reducing the Quality of the Trees

Today, many of Iowa's woodlands are of poor quality. Land management practices have a great deal of influence on the quality of the site. Activities that compact the soil, eliminate fragile vegetation for long periods of time, and damage the trees will ultimately degrade the woodland area. The quality of the swlogs and veneer logs may also be reduced by grazing.

Grazing livestock in our woodlands is one of the major reasons for this problem. Some forms of recreation such as four-wheel driving and motor bike riding can also reduce the quality of the woodlot. Reckless timber harvesting can also reduce the quality of the trees in your woodlot. When a tree is cut down, it may fall and injure nearby trees. The removing of logs from a woodlot can also damage a tree. The wounds created are entry ways for diseases and insects. They also remain on or inside the tree as a defect.

Species Composition

Another way to look at woodland quality is from the standpoint of species composition. The landowner who is interested in marketing timber will want to have valuable trees. From his/her perspective a quality woodland is one with commercially valuable species.

Many of Iowa's woodlands have been converted to noncommercial species because of the lack of management consideration. According to Gary Beyer, District Forester, Department of Natural Resources, many of the woodlands in his district are being converted to ironwood and hard maple stands because of harvesting practices.

The selection harvesting technique has been used widely in Iowa for the past 100 years. Selecting only the best trees to sell, as is done in a selection cut, will eventually reduce the quality of the remaining trees. By removing the "best" trees, only the poorer quality trees are left to populate the forest. Eventually only poor growing stock is left to produce more poor growing stock. The woodland becomes a forest of scrubby trees.

To ensure a quality sawlog production, a management plan is needed. A silvicultural plan (regeneration strategies, intermediate cutting, pruning schedules, and harvesting strategies) should be developed by the landowner. Your District Forester can help you develop a woodland management plan.

Site Index

Just because a tree is growing on a site does not mean that is the best site
commercially. Foresters have developed a way to determine the quality of a 
site for growing a particular species. This system classifies the land by 
site index. Site index measures can only be determined on even-aged stands. 
A site index number or classification is given to each area analyzed. The 
higher the site index number, the more growth per year that species will 
 obtain. For more information, write to: Forestry Department, 251 Bessey 
Hall, Iowa State University, Ames, Iowa 50011. Foresters at Iowa State 
University have developed site indexes specific to Iowa.

Summary

To summarize, the best alternative is to develop a management plan to 
determine how the area should be cared for. Timber stand improvement, forest 
regeneration, and appropriate harvesting techniques should all be considered 
in the plan. Establishing roads and specific recreation areas can also help 
maintain a quality woodland area by reducing soil compaction. These actions 
will help improve the quality of your woodland area. Land use alternatives 
that reduce the quality of Iowa's woodlands include: grazing, heavy 
recreational use, driving vehicles in non-designated areas and timber cutting 
without a plan.

Study Questions:

1. List three land practices that reduce timber value.
2. List three land practices that improve timber value
3. Explain how species composition affects woodland value for sawlog and 
   veneer production.
DEFINITIONS OF TERMS

Block cut: See clearcut

Board foot: A unit of volume measure equal to twelve inches long by twelve inches wide by one inch thick.

Cleaning: A type of intermediate cut done in a sapling age stand of trees to release trees from competition.

Clear Cut: A harvest technique where all trees of all sizes are removed from the designated area. (Patch clearcut has an irregular shape. A strip clearcut has a linear shape. A block clearcut has a rectangular shape.)

Commercial thinning: A partial removal of trees for timber stand improvement and financial gain.

Competition: The struggle between trees for soil nutrients, water, and sunlight.

Coppice growth: The sprouts from roots and trunks of newly harvested trees. These sprouts are capable of regenerating the woodland area.

Coppice Management: A form of management accomplished by harvesting trees capable of coppice growth and using coppice growth as a means of regenerating the forest.

Crown: The top part of the tree containing branches, twigs, leaves and winter buds.

Cutting Cycle: A period of time between major timber harvests. Also called rotation age. Examples include: 40 year cutting cycle, 50 year cutting cycle, or 80 year rotation.

Cut and Sell Marketing: A marketing strategy where the landowner cuts the trees and sells the logs without assistance of a logger.

Diameter: The distance across the plane of a circular tree trunk. It can be calculated by measuring the circumference (distance around) an object and dividing by Pi (3.14). Foresters measure diameter at 4 1/2 feet above the ground.

District Forester: A professional forester who works one-on-one with the landowner to develop woodland management strategies.

Even-aged Stand: A stand of trees approximately the same age. Tree plantations would fit into this group.

Extension Forester: A professional forester who interprets research results and provides publications and information based on research results. They also provide Forestry Field Days to demonstrate woodland management practices.
Grade and Yield Marketing: A marketing strategy where the logger pays for the lumber after the harvest. The price is dependent upon the quality and quantity of the logs sold.

Group Selection: A harvesting technique where a small group of trees from a timber stand are removed.

Harvesting: The removal of trees from a wooded area.

Harvesting Technique: A method of removing trees. These techniques range from removing all the trees to only removing select trees. Examples include: clearcuts, seed tree, shelterwood and selection.

Improvement Cut: A type of intermediate cut where all junk trees, poor quality trees, and non-commercial species are eliminated. The purpose is to improve stand composition. This type of cutting is done in an immature stand of merchantable size trees.

Intermediate Cuttings: Cuttings made through the rotation period prior to harvest. This term is similar to the term timber stand improvement.

Liberation Cut: An intermediate cutting done in a young stand to release it from overhead competition by older poor quality "wolf" trees.

Mature Tree: A tree that is ready for harvesting. The size depends upon the species and the intended use. Typically, a tree should be greater than 20 inches in diameter.

Natural Regeneration: Re-establishment of a woodland after harvest by natural seeding from surrounding trees.

Non-commercial Thinning: The removal or girdling of trees to improve stand composition and to release competition.

Over-mature Tree: A tree that has reached its maximum growth potential and may even be starting to die.

Patch Cut: See clearcut.

Percent Cut Marketing: A marketing strategy where timber is harvested with a percent of the logs going to the logger and the remainder to the landowner.

Pole: A term used to describe a tree that is at least five inches in diameter and fifteen feet tall.

Planting: Manually placing tree seedlings in the ground.

Pruning: The act of sawing branches from trees to increase the value of the tree for sawlog and veneer production. For commercial timber, it is best to remove the branches before they reach three inches in diameter.

Reforestation: Planting trees to convert an area back to forest.

Regeneration: The establishment of young trees to replace older trees.
Regeneration Techniques: Ways to establish a young forest. Possible options are: natural regeneration, coppice management, and tree plantings.

Sanitation Cut: A cut made to remove dead or damaged trees from a timber stand.

Salvage Cut: A cut made to remove commercially valuable trees that are dead or have insect, disease, or other damage.

Sapling: A tree just beyond seedling stage. A sapling has a diameter greater than one half inch and less than five inches and is at least three feet tall.

Sawlog Quality: A tree that has the potential for producing lumber. The tree must be twelve inches in diameter and have a straight eight foot trunk with only a few small branches or no branches at all.

Seed Tree Harvesting: A harvest technique where all the trees are removed except a few superior trees that are left to naturally regenerate the area.

Seedling: is a tree that has just emerged from the seed or nut. A tree is considered a seedling until it reaches three to four feet tall and has a diameter greater than one half inch.

Selection Cut: is a timber harvest technique where single trees are selected and harvested from the timber.

Shade Tolerant: A tree that can survive in the shade of other trees.

Shade Intolerant: A tree that cannot survive in the shade of other trees.

Shelterwood Cut: is a timber harvesting technique where the tree are removed in a series of cuttings for the purpose of seeding and protection. It is used with stands of trees with an intermediate shade tolerance such as white oak. In a shelterwood cut, first large "wolf" trees, mature commercial trees, and non-commercial understory trees are removed to create adequate sunlight for the oak seedling to get established. Once the seedlings are established the remaining large trees are removed.

Silviculture: The art of producing and tending a forest.

Single-tree Selection: A timber harvest technique based on the merits of individual trees. It is a term synonymous with selection cut.

Snag: A term used to describe any damaged, dead, or dying tree.

Stand composition: The variety of tree species in the woodland area.

Stand vigor: The current health and subsequent growth potential of a group of trees.

Strip clearcut: See clearcut.

Stumpage Sale: A lump sum sale of trees prior to having the trees cut down.
Thinning: The act of cutting out unwanted trees from a timber stand to improve growing conditions for the remaining trees.

Timber Stand Improvement (TSI): Any intermediate cutting that would improve the growth potential and subsequent economic return of a given timber stand.

Tree planting: The act of placing trees into the ground.

Uneven-age Stand: A woodland with trees ranging in age from young seedlings to sapling to pole to mature, to overmature to dead.

Veneer Quality: The top quality log that will be peeled into thin layers of veneer. To be veneer quality, the tree should be at least twelve to eighteen inches in diameter depending upon species, tree condition, and current market. It should have a straight sixteen foot trunk containing no limbs.

Weeding: An intermediate cutting, done at the seedling stage to remove poor quality and invading non-commercial seedlings.

Wolf Tree: A large limby poor quality tree that occupies a large area of the woodland canopy.

Woodland Management: The art, science, and business of producing goods and services from a forest.

For more information refer to Iowa State University extension publication "Woodland Management in Iowa".

Study Question:

1. List four types of timber stand improvement.
What is Woodland management

Woodland management is the art, science, and business of working with the forest ecosystem to produce the desired products and services for today and for the future. It is the art of creating and maintaining the woodlands visual qualities; it is the science of learning how the woodland community grows - its ecological interactions; it is the business of deriving forest products or maintaining quality services from the woodland area.

Silviculture represents the heartbeat of woodland management. Silviculture is the art and science of producing and tending for the forest. It requires knowledge of how individual trees interact as a component of the woodland. The silvics or characteristics, life history, ecology of individual trees needs to be considered. It requires producing a favorable environment for growing a certain marketable species. It requires knowledge of the trees' shade tolerance and knowledge of how shade tolerance affects tree establishment and growth. It requires knowing characteristics of trees so you can establish a vigorous woodland area in either open fields or existing woodlands.

Foresters have answered some of these questions by developing silvicultural systems. A silvicultural system is simply the method selected to grow and reproduce the forest in a way that combines the biological needs of the species and the personal objectives of the landowner. A silviculture system is an integrated plan for: intermediate cuttings, woodland regeneration strategies, and harvesting strategies.

Long Range Planning Skills

Woodland management is not a get-rich-quick scheme. It requires investing time, effort, and capital for long periods of time, in most cases without any immediate financial returns.

Woodland management does have it's place on the balance sheets in agriculture businesses. If timberland is established on marginal cropland, woodland management may be the wisest investment a land owner can make. According to Jerry Kemperman, District Forester, Iowa Department of Natural Resources, one farmer made $23,000 in 1986 from selling walnut trees grown in timbered gullies. If you have timberland or idle land on your farm, woodland management or plantation establishment may provide an excellent agriculture diversification option.

Since forestry is a long term investment, it is important to develop a long-term plan for the woodland. The steps to developing such a plan include:

1. Protect the site.
2. Discuss woodland management strategies with a professional forester.
3. Develop a general inventory/map of your area.
4. As needed, divide the area into workable management units.

5. Develop a management plan. Your district forester provides woodland owners this service free of charge. Include a tentative time line for timber stand improvement strategies (intermediate cuttings), woodland protection strategies (insect, fire, and grazing), regeneration strategies, and harvest schedule.

Step 6. Follow through with your management plan.
   a) Complete your improvement cuts.
   b) Check for regeneration. If necessary, develop regeneration strategies.
   c) Harvest when appropriate.
   d) Make sure regeneration is adequate after the harvest.

Step 7. Re-evaluate the plan. Then go back to Step 6.

Following these ten steps will help you become a good woodland manager. There are additional support services available. Forestry Extension at 251 Bessey Hall, Iowa State University, Ames, Iowa (515) 294-1168 or (515) 294-4465 provides free information and publications on forestry and woodland management topics. They publish a "Woodland Owners Newsletter" and provide forestry field days around the state. For more information on when a field day will be held in your area, contact your local County Extension Office.

Your Department of Natural Resources District Forester provides landowners with one-on-one assistance in determining woodland management strategies and timber harvesting strategies. Call or write the state forester at (515) 281-5629 Wallace State Office Building, Des Moines, IA 50319 to find out who your district forester is.

For those people who would like to join organizations, try the following groups:

1. Iowa Tree Farm System, Box 297, Redfield, IA 50233 (Phone: 515-833-2412) c/o Howard Walsh.
2. Iowa Wood Using Industries, 900 Des Moines Street, Des Moines, IA 50309 (Phone: 515-266-2189)
3. Iowa Woodland Owners Association, 2404 South Duff, Ames, IA 50010 (Phone: 515-233-1161)

Study Questions:

1. Explain what woodland management is.
2. What steps should a landowner take to manage their woodlands?
3. Define the term silviculture and list three silviculture strategies.
Protection is a vital part of woodland management. Protection strategies include: fencing out livestock, developing fire breaks, controlling insect and disease problems, controlling wildlife populations, and controlling recreational use. Look at that listing again. Which protection strategy is the most important in Iowa?

If you answered, fencing out grazing livestock, you were correct. More than three-fourths of Iowa's woodlands are grazed. Grazing livestock damage the soil, injure the trees, and reduce the quality and quantity of vegetation. Grazing slowly ruins the site quality and reduces the growth and quality of the timber. Small seedlings and sapling trees are eliminated and the land eventually is converted to pastureland. For more information on the effects of grazing, obtain Forestry Extension Note F-350 "Grazing Iowa's Woodlands" from Forestry Extension, 251 Bessey Hall, Iowa State University, Ames, IA 50011.

Wildlife Over populations of wildlife can also cause problems. Like livestock they can compact soil, eat seedlings, and scar the trunks of trees. Deer compact the soil more than any other form of wildlife. They will use the trunk of trees to remove the velvet from their antlers and consume many seedlings. Many potential sawlogs have had their terminal bud eaten by a deer. Rabbits and mice, while they don't compact the soil, will strip the tender bark from young trees. They may even girdle the trunk and kill the tree. They pay no attention to whether or not the tree has the potential to be a veneer log. When wildlife get overpopulated, you can do three things. First, try to remove habitat such as brush piles or bushes. Removing their homes will encourage them to find a new place to live. Second, you could encourage hunting and trapping on your land. Finally, you could use a rabbit, deer, or rodent repellent on plantings.

Insect and Disease There are numerous insect and disease problems that may affect your trees. For example, oak has over 300 insect and disease problems. Maintaining a healthy tree stand is the best defense against insects and disease. Other prevention guidelines are listed below.

1. Maintain the vigor of your woodlot by eliminating grazing and performing regular thinnings.
2. Remove low vigor or diseased trees during intermediate cutting operations.
3. Leave snags for cavity nesting birds. They will help control harmful tree killing insect populations.
4. Do not leave piles of brush or logs in the woodlot during the spring and summer. These areas act as breeding grounds for insects and diseases.
5. Do not prune branches over two to three inches in diameter.
6. When possible plant genetically improved strains of species that are insect or disease resistant.
7. Find out what insects have been a problem in your area in the past few years. Contact Extension Plant Pathology, Extension Entomology, or Forestry Extension, at Iowa State University, Ames, IA 50011 or your
Observe your trees closely. Insects can bore holes in the trunk, eat the leaves, hollow out buds and roots, or suction out plant fluids. Diseases can cause leaves to wilt or become discolored and stems can become deformed with burls, cankers and witches broom. When you notice evidence of insect and disease problems, don't panic. All insect or diseases are not fatal. One form of fungi that attack the roots, is not harmful and actually help the plant absorb nutrients and water from the soil.

For an update on the major woodland insect problems in Iowa contact:
Extension Entomology, 109 Insectary, Iowa State University, Ames, Iowa 50011; Phone: (515) 294-1101. For an update on the major woodland disease problems in Iowa contact: Plant Pathology Extension, 12 Bessey Hall, Iowa State University, Ames, Iowa 50011; Phone: (515) 294-1160.

If a problem arises, it is best to contact the district forester or an experienced local grower and have them inspect the site. Together you should examine the plant carefully. Keep in mind that symptoms may appear at some distance from the actual site of the disorder. Look for any irregularities or injuries in lower portions of the plant.

A specimen that is believed to be affected should be sent to the state extension plant pathologist along with a completed Plant Disease Identification Form. The form looks as follows:

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**Plant Disease Identification Form**

Submit specimens to: Extension Plant Pathologist
105 Bessey Hall
Iowa State University
Ames, IA 50011

See reverse side of form for instructions on collecting and shipping plant specimens.

County _________________ Date _________________
Owner _________________ Address _________________
Collector _______________ Address _________________

Plant ___________ Variety ___________ Age _______ Size ___

No. of Acres/Distribution of symptoms in planting __________
Site and soil description ________________
Previous crop ________________ Chemicals used __________

Symptoms: ________________________________

Diagnosis and control recommendations: (Collector do not write in this space).
Make sure specimen is representative of condition in question. Include enough material to show all stages of the disease from healthy to maximum disease involvement. Wrap specimens in dry paper toweling or clean newspaper (Do not add moisture!) and pack loosely in a plastic bag to prevent excessive drying. Package in a strong carton for mailing. Send only freshly collected specimens by the most rapid transit method - undue delays can result in extensive deterioration of the specimen which makes diagnosis difficult or impossible. For woody plants send a branch specimen consisting of four to six pieces, six to eight inches long from branches one-half to one inch in diameter. Collect only from branches actively displaying symptoms. Dead, deteriorating branches are often worthless as specimens. Cankers may be sampled by cutting out a rectangular section of bark across the margin of the canker so that some healthy tissue is included with the margin and the central portions of the canker.

Recreation Uncontrolled use of recreational vehicles on the land can have effects similar to those caused by livestock grazing. Soils can become compacted. Tree roots and tree trunks can be damaged by vehicles scraping against them or driving over exposed roots. When excessive of recreation is allowed, it should be located in designated areas or on designated trail ways. Your guests should be asked not to carve into the trees. This also reduces the value of your trees.

Forest Fires In Iowa, forest fires are less of a problem than in other parts of the United States. Most of Iowa's forest fires are started by incendiary and debris burning.

The best defense for fires is a good offense. The development of firebreaks and access roads provide a good offense. The firebreak should be fifteen to twenty feet wide and within one half mile of one another. The access roads should be eighteen to twenty-five feet wide. Suggestions to prevent wildfires include:

1. During dry periods, ask your visitors not to smoke on your property.
2. Pick up old bottles and glass. Given the right conditions they have been known to act as a magnifying glass and start fires.
3. During dry weather, carry a fire extinguisher and a shovel along when using the chainsaw. If a spark from the exhaust creates a fire, you can quickly put it out.
4. Try to reduce the amount of limbs, brush piles, and other burnable materials that could act as ladders to allow the fire to go into the tree crowns.

For more information write to Roy Hatcher, Fire Specialist, Iowa Department of Natural Resources - Forestry Division, 2404 South Duff, Ames, Iowa 50011. You could also write for a copy of "Wildfire Safety Guidelines for Rural Homeowners" by J. Bruce Coulter from Colorado State Forest Service, Colorado State University, Fort Collins, CO 80521.

Study Questions:

1. What is the major protection problem in Iowa?
2. List three types of woodland protection you need to consider.
Inventory

Getting to know your woodland can be both a pleasureable and profitable venture. By inventorying the woodland resource and writing down notes you can develop a more thorough woodland management plan.

The first step in inventorying your area is to obtain a map. Either a soils map or aerial photograph will be suitable. Copies can be obtained from your local Soil Conservation Service or ASCS office.

Walk through the forest. Identify the trees as you walk along. Note the topography and soils. What direction are the slopes facing? Is the soil sandy, clayey or loamy? Record your findings on the map. Determine the types of forest communities your forest contains. Is it an oak/hickory, maple/basswood, bottomland, riparian, or northern conifer species? Outline the boundaries of each forest type on your map. Label the communities.

Look at the variety of tree sizes. Is it an even-aged stand with trees all about the same age or an uneven-aged stand with different ages of trees? It may be difficult to tell the difference. Some timber stands with trees all the same age may have different layers of trees. A professional forester can take a core sample to determine how old the trees are. From that sample the forester can tell if the stand is even age or uneven aged.

If the stand is an even-aged stand, try to identify the different layers of trees. Which trees are dominant (with one-third to one-half of their crowns exposed)? Which trees are co-dominant (with one-fourth of their crown exposed)? Which trees are intermediate or suppressed? It is the intermediate and suppressed trees that look younger than the trees that dominate the stand. See Figure 1.

Figure 1. Crown Classes
Determine what tree species dominate the forest. Take a few 100 foot circular sample plots and count the number of tree species. Record the trees possible age class. Count the number of seedling there are. For example:

<table>
<thead>
<tr>
<th>Plot #</th>
<th>Species</th>
<th>Dominant or Over-mature</th>
<th>Co-Dominant or Mature</th>
<th>Intermediate or Pole</th>
<th>Suppressed or Sapling</th>
<th>Seedling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Oak</td>
<td>1111</td>
<td>111</td>
<td>1</td>
<td>111</td>
<td>1111</td>
</tr>
<tr>
<td>1</td>
<td>Hickory</td>
<td>111</td>
<td>11</td>
<td>11</td>
<td>111</td>
<td>1111</td>
</tr>
<tr>
<td>1</td>
<td>Basswood</td>
<td>1</td>
<td>111</td>
<td>11</td>
<td>111</td>
<td>1111</td>
</tr>
<tr>
<td>1</td>
<td>H. Maple</td>
<td>111</td>
<td>1111</td>
<td>1111</td>
<td>1111</td>
<td>1111</td>
</tr>
<tr>
<td>2</td>
<td>Oak</td>
<td>111</td>
<td>11</td>
<td>1111</td>
<td>1111</td>
<td>1111</td>
</tr>
<tr>
<td>2</td>
<td>Ironwood</td>
<td>111</td>
<td>111</td>
<td>1111</td>
<td>1111</td>
<td>1111</td>
</tr>
<tr>
<td>2</td>
<td>Hickory</td>
<td>111</td>
<td>111</td>
<td>111</td>
<td>111</td>
<td>1111</td>
</tr>
<tr>
<td>2</td>
<td>H. Maple</td>
<td>111</td>
<td>111</td>
<td>111</td>
<td>1111</td>
<td>1111</td>
</tr>
<tr>
<td>3</td>
<td>Oak</td>
<td>1111 1111 1111111111</td>
<td>1111 111111111111</td>
<td>1111 111111111111</td>
<td>1111 111111111111</td>
<td>1111</td>
</tr>
<tr>
<td>3</td>
<td>Ironwood</td>
<td>1111 1111 111111111111</td>
<td>1111 111111111111</td>
<td>1111 111111111111</td>
<td>1111 111111111111</td>
<td>1111</td>
</tr>
</tbody>
</table>

Does the area have regeneration? Are the young seedlings the species you wish to have in the next generation of forest? See plot #1. This site has a good supply and variety of regeneration. There is also a variety of tree size. Plot #2 also has regeneration, but the landowner may not wish to have a future forest of ironwood and maple. Plot #3 does not have any regeneration. Since the trees are all mature to over-mature, the stand may eventually die out.

Look at the woodland area. Try to imagine what the stand of trees will look like in 50 years.

Try to determine woodland quality. Look at the individual trees. What form are they (short and limby or tall with straight trunks)? What condition are they in (healthy or damaged by wind, water, fire, disease or grazing)?

Look at the forest as a community. Are the trees spaced far enough apart to eliminate competition? Are they too far apart? (This can be determined by looking at the tree form. If the tree is short, with large limbs and a trunk that has a quick taper, then the trees are too far apart.) As a rule of thumb three to five feet between tree crowns is a good spacing.

Keep track of the things you observe. Record forest type; species composition; your judgement of woodland quality; stand vigor or growth rate; and long term appearance of the forest. With this information you are now ready for the planning stage.

Planning

Work with a professional forester to determine if the area has potential for sawlog or veneer production. Some woodlots in Iowa are of such poor quality that firewood may be the only best product. In these cases, clearing the land and starting a new stand of trees might be the best option.

The planning stage consists of making decisions. You need to decide what species of tree you wish to manage the area for. Review your inventory
notes. Which species are marketable? Select the species accordingly. Research the "silvics" of the species you wish to grow. What soils does that tree species prefer? What type of shade tolerance does it have? What kind of seed dispersal does the tree have? These characteristics will help you decide on the types of harvest/regeneration strategies that should be done.

Your Iowa Department of Natural Resources District Forester or a consultant forester can help develop a written management plan for your land. Work closely with him or her. The success of your sawlog production will depend on how thoroughly you think through the long-term process of woodland management.

To develop a plan yourself use the following suggested list of what to include:

1. Descriptive Information (your name, land's legal description, and date)
2. Landowner's Goals and Objectives
3. Resource Map
4. Inventory Data [Consult with a forester.]
5. Special Features/ Problems
6. Management Actions (including intermediate cuts, regeneration strategies and harvesting strategies). [Consult with a forester.]

Study Questions:

1. What is the first thing you should do, to help you develop a woodland management plan?
2. List three the things you might want to include in an inventory.
3. List five things that a management plan should include.
Many activities can be done to improve the quality of your woodland. These activities include intermediate care or timber stand improvement and pruning. The type of action the landowner takes will depend on the condition of the woodlot. Stands can be in three conditions: poorly stocked, adequately stocked, and over stocked.

**Understocked Stands**

Three-fourths of Iowa's woodland are understocked, according "Iowa Forest Resources Plan 1985" written by the Iowa Conservation Commission (renamed the Department of Natural Resources). An understocked stand does not use the site fully and tends to be composed of trees with short trunks, sever taper, and many limbs. This tree form reduces the quality and value of the woodland area. Consult with a professional forester to see if your timber stand is poorly stocked.

The main reason Iowa's woodlands are understocked is the grazing pressures. Protection of the woodland from grazing would encourage establishment of natural regeneration. This would be the best solution to the problem of understocking due to grazing.

Where grazing is not the reason for understocking, plantings would be helpful. By planting commercially valuable shade tolerant to intermediate tolerant seedlings under the forest canopy you would improve stocking levels. This alternative is a more costly.

A final option is to clear the area and establish a new stand. Regeneration strategies could include: natural regeneration from neighboring woodlands, direct seeding, or planting.

**Over-stocked Stands**

Some timber stands in Iowa are over stocked. These stands have too many trees too close together. The trees may have straight trunks, but they are not reaching their greatest potential for diameter growth.

Intermediate cuttings are cuts to improve or maintain the desired stand composition and structure of the stand. They also improve the growth, vigor, and quality of the remaining trees. If the stand is overstocked, competition can be reduced by eliminating non-commercial, poor quality, and diseased trees.

Methods of intermediate cuttings include: weeding, cleaning, improvement cut, thinning, liberation cut, and sanitation/salvation cut. Weeding is the removal of all woody or herbaceous growth that may be competing with desired seedling. Cleaning is the removal of non-commercial and poorly formed seedlings or saplings that are trying to dominate desirable sapling sized trees. An improvement cut is made to improve stand composition and vigor by removing undesirable non-commercial, diseased and poorly formed trees. It is
done in both an even-age and uneven-aged stand that is pole size or older. A thinning is a harvest done for immediate income and to remove competition. It is typically done in even-aged stands when the tree crowns begin to overlap. It is best to thin the trees so that three to five feet remains around the future crop tree's canopy. A liberation cut is the removal of older dominating "wolf" trees. A sanitation cut is the removal of disease and insect infected trees in order to prevent spread of disease. If the trees are of commercial or sellable size the cut is called a salvage cut. See Figure 1.

TIMBER STAND IMPROVEMENT
1. WEEDING
2. CLEANING
3. IMPROVEMENT CUTTING
4. LIBERATION CUTTING
5. SANITATION CUTTING

Figure 1. Types of Intermediate Cuts or Timber Stand Improvement

Intermediate cuttings are typically done in five to ten year intervals. This could allow the stand to produce intermediate crops of firewood, pulpwood, chips or posts.

Intermediate Care - Pruning to Improve Quality

Pruning is removing branches from the trunk of a tree. It is done to help improve the quality and value of that tree. From a commercial standpoint, walnut may be the only species in Iowa that it is economically wise to prune. Pruning should be done on a three to five year schedule.
For the pruning of forest trees, it is best to prune the branches before they reach three inches in diameter. Remember that each time you prune a branch you are creating a wound which the tree must heal. The smaller the wound the less time it takes for that tree to heal and the smaller the defect in the log produced.

Use a pruning saw or pole pruner to remove the branch. To prune a tree, look for the natural collar on the tree. Cut to the outside or toward the branch to remove the limb. See Figure 2. If you must remove larger branches, use a three cut system. First, make an undercut about a foot from the trunk. Then make an overcut to remove the major part of the tree branch. Next remove the remaining branch stub. For larger branches make a slight undercut so the bark is not stripped off as the branch stub breaks away. See Figure 3.

Figure 2. Where to Prune a Tree Figure 3. Pruning - A Three Cut Method

Pruning of forest trees can be done any time of the year, but the preferred time to remove live branches is during the dormant season (late fall or early winter). Avoid pruning oak trees between March 1 and July 1 to reduce the risk of infection by the oak wilt fungus. Maples should not be pruned in the spring, because of excessive sap drainage from pruning wounds.

Study Questions:
1. List two options for improving a poorly stocked woodland.
2. List three types of intermediate cuttings.
3. Explain how to prune a tree.
4. What time of year should a tree be pruned?
5. It is best to remove a branch before it reaches what diameter?
Regenerating the woodland is one of the more neglected events in woodland management. The lack of concern for regeneration had contributed to the reduction in woodland quality. Regeneration strategies should be considered many years before the area is harvested.

There are basically four types of regeneration strategies including: natural regeneration, manual seed dispersal, coppice management, and plantings.

**Natural regeneration** This type of regeneration occurs when the forest continues to rejuvenate itself without people assisting. Seeds are dispersed by wind, animals, and water. This regeneration involves no investment of money. However, it may require a longer investment of time. A person selecting natural regeneration should realize the risks involved. First, trees do not always produce a large crop of seed each year. The seeds that are produced might be consumed by insects, disease and wildlife. The seeds that develop into seedlings might be consumed by wildlife or livestock. These seedlings may have to compete with grasses to survive. Actually, only about one percent of the seedlings that are produced will develop into a mature tree. Refer to "Seeds of Woody Plants in the United States", Agriculture Handbook #450, USDA Forest Service for list of species and their regeneration characteristics. Or contact Forestry Extension at Iowa State University for more information.

**Manual Seed Dispersal** Seeds can be gathered and manually distributed over a prepared area. To prepare the area, the ground needs to be "roughed up". A bulldozer, disk, rake, or hoe can be used to prepare the area. Intentionally roughing up the site when removing harvested logs, can also be used to prepare the site. Seeds should be collected when ripe and dispersed at the appropriate time. The manual seed dispersal technique has been done in Iowa with limited success.

**Coppice Management** Many trees found in Iowa have the ability to grow sprouts from their stumps and roots after they have been cut. This sprouting is called coppice growth. The type and vigor of coppice regeneration varies by species. Oaks, maples, chestnuts and basswoods are the most vigorous of the stump sprouters. In many oak forests, as much as 75 to 80 percent of all the trees are the result of stump or seedling sprouts. Green Ash, hickories, sycamore, cottonwood, alder, willow and elm are good stump strouters at young ages but lose much of this potential as they age. Walnut and hackberry sprout well only as seedlings and saplings.

As a general rule of thumb, sprouting is most vigorous from juvenile trees (before trees reach the age of seed production). For coppice oak regeneration, the number and vigor of sprouts produced increases up to stump diameter of six to eight inches. Beyond that size the capability for and growth potential of sprouts decline gradually to zero at an age of 100 to 150 years.

Selection of sprouts to grow and removal of non-selected sprouts is referred to as coppice management. This type of management is usually done for
firewood, but may be used for sawlog production as well. Sprouts are selected according to their vigor and angle of attachment to the stump. Sprouts that are close to the ground and attached to the base of the stump are considered superior. Root suckers are also considered superior. All but a few good sprouts should be removed. For more information obtain Forestry Extension Note F-327 "Coppice Management of Iowa Hardwoods".

Planting  One of the most common forms of forest regeneration is tree planting. This method is preferred because of the higher survival rate, faster plantation establishment, less risk, more control over final species composition. Tree planting provides the landowner with the option of changing the site from one species to a more desirable species.

In forest operations, bare root planting stock is the most efficient option. Below are some tree planting suggestions.

1. Plant trees from March 15 to May 1.
2. Plant trees when ground is tillable.
3. Keep the tree roots damp at all times.
4. Keep the roots away from sunlight and wind.
5. Separate and sort trees before planting.
6. Plant trees at the depth they grew in the nursery.
7. Never put water in the hole before planting the tree.
8. Don't bunch or curl the roots when planting.
9. If the soil is high in clay content, be sure to rough up the sides of the planting hole.
11. Water the tree after planting, if possible.

For more information on tree planting refer to the "Tree Planting Instructional Unit" or Iowa State University extension publication Pm-496, "Tree Planting in Iowa" both from Forestry Extension at Iowa State University, Ames, IA 50011.

If you are interested in trying to grow your own planting stock write for Forestry Extension Note F-304, "Growing Seedlings From Seed".

Study Question:

1. List three methods of forest regeneration.
There are basically four types of harvesting systems that could be used in Iowa. They are the selection system, shelterwood system, seed tree system, and clear-cut systems. Figure 1 below gives a visual representation of each system.

Harvest timber in the summer, spring or fall during dry periods or in the fall and winter after the ground is frozen. Harvesting timber during these times helps minimize the impacts on the woodland environment. Harvesting should be avoided during wet periods.

Figure 1. Harvesting Options For Iowa
Selection System

This system involves removing individual or a small cluster of trees at about five to ten year intervals. Trees are selected based on individual quality. This system is used in uneven-age timber stands. It encourages the dominance of shade tolerant species such as ironwood or sugar maple. While sugar maple has commercial value, ironwood does not. Caution should be exercised in using this harvesting technique. Make sure you are not converting your woodland into a noncommercial stand of trees.

The advantages to this system include:

1. Minimum disturbance to view,
2. Providing continuous site protection,
3. Minimizing alterations to ecological conditions,
4. Helping maintain an uneven-aged stand (an uneven-age stand is less susceptible to insect and disease problems), and
5. Providing regular income.

The disadvantages of this system include:

1. If done improperly, it increases the risk of "high grading" the area (High grading refers to the long term effect of removing the best quality trees and leaving the poor quality trees to regenerate the area),
2. Increasing logging costs,
3. Increasing the risk of damaging remaining trees during logging,
4. Requiring a well planned, permanent road system, and
5. Requiring extreme care and careful thought for each consecutive harvest.

Many of Iowa's woodlands have been harvested using the selection system. Improper use of this system has caused a "high grading" or lowering of the quality of Iowa's woodlands. Walnut may be appropriately harvested using this system; high quality walnut may be scattered throughout a stand. Consult with your district forester before using this system.

Shelterwood System

The purpose of the shelterwood system is to establish a new stand of trees under the shelter of the older trees. The best application of shelterwood system is with species that need partial shade in the earlier stages of their growth. This system is recommended for shade intolerant and shade intermediate trees. They need direct sunlight to become established and grow well. Examples of such trees in Iowa include the oak/hickory and maple/basswood communities.

This system requires a two to three cut process. The first cut is the "preparatory cut." It is used to scarify the site and open the stand to increased sunlight. The increased sunlight should stimulate seed production and promote regeneration and growth of seedlings. For the first cut, trees are selected according to quality, species and location within the canopy. Poor quality non-commercial suppressed or intermediate trees are eliminated. Some of the poor quality dominant trees and non-commercial dominant and co-dominants are removed. About twenty-five to thirty percent of the trees are removed. This thinning allows the remaining trees to spread their crowns
and increase their root systems, therefore becoming wind firm and more vigorous. The remaining overstory trees will shade most of the area for at least part of the day and, thereby, protect shade tolerant and intermediate species from excessive sunlight. These trees also provide the seed source to naturally regenerate the area.

Three to ten years after the first cut, the second cut or "seed cut" is made after adequate regeneration is established. This cut removes all but the very best seed trees and increases the exposure of sunlight. This promotes the rapid growth of seedlings. Spacing of the remaining trees should be from 30-40 feet, depending upon site. A closer spacing is needed in frost pockets or on south slopes.

The final cut of overstory or removal is made after the seedlings are at sapling stage, and there is an adequate number of saplings with terminal leaders above the deer browse level. This final cut removes the remaining mature trees and creates an even-age stand.

The advantages of the shelterwood system include:

1. Assuring regeneration of the area,
2. Protecting site and visual qualities,
3. Allowing genetically superior trees to be selected and regenerate the woodlot.
4. Providing revenue from thinnings, and
5. Adding growth to remaining trees after each successive thinning.

The disadvantages of shelterwood system include:

1. Increasing logging cost and management complexity;
2. Requiring careful logging, slash disposal, and site preparation to spare desirable trees; and
3. Requiring roads for efficiency and site protection.

Seed Tree System This harvesting technique includes removing all trees except a few scattered superior quality trees. These trees are called seed trees and they produce seed for a new crop. The seed tree system is used to regenerate shade intolerant trees such as Iowa's bottomland community.

Usually from 1-10 trees per acre are left. One major problem with this system is the susceptibility of the seed trees to wind throw. To counter this problem, small groups of trees may be left instead of scattered individual trees.

Once adequate regeneration is established the seed trees can be harvested. Realize, however, that logging could damage younger trees. This system works best for species that produce large numbers of light seeds that are able to regenerate in open conditions.

The advantages of the seed tree system include:

1. Providing the most economical logging operation.
2. Eliminating the risk of damaging future tree crops.
3. Providing a good system for timber stand improvement.
4. Providing easy planning and supervising.
5. Creating habitat for deer, quail, and open field using birds.
6. Allowing regeneration of genetically superior trees.
7. Providing income is spread over two periods.
8. Providing a slightly more visually pleasing than clear cuts.

The disadvantages of the seed tree system include:

1. Producing a visually unpleasing vista.
2. Providing no revenue for long periods of time, except when seed trees will be harvested.
3. Inviting the invasion of grass and weeds, shrubs, and possibly undesirable fast growing tree species.
4. Changing the micro-climate of the forest.
5. Creating a potential for erosion problems for three to five years.
6. May take more time to get established due to the unreliability of natural regeneration.
7. Creating a situation where seed trees are more susceptible to wind throw.

Clearcut System This harvesting technique removes all the trees in a given area, including poor quality trees. This technique is necessary for regenerating shade intolerant to intermediate tolerant species. Clearcuts can be made in different sizes and shapes. A linear shaped clearcut is called a strip clearcut. Small irregular shaped clearcuts are called patch clearcuts. A square or rectangular shaped cut is called a block clearcut. This patchwork of clearcuts can help provide regeneration and diverse habitat for wildlife. A new crop of trees is obtained by natural regeneration, plantings, or coppice growth. Clear cuts should not be conducted on easily eroded soil or within 50 feet of waterways or areas of heavy recreational use. This system is needed for the regeneration of shade intolerant species such as bottomland species.

The advantages of the clear cut system include:

1. Providing the most economical logging operation.
2. Eliminating the risk of damaging future tree crop.
3. Providing a good system for timber stand conversion.
4. Providing easy planning and supervising.
5. Creating habitat for deer, quail, and open field using birds.

The disadvantages of the clearcut system include:

1. Producing a visually unpleasing vista.
2. Providing no revenue for long periods of time.
3. Inviting the invasion of grass and weeds, shrubs, and possibly undesirable fast growing tree species.
4. Changing the micro-climate of the forest.
5. Creating potential for erosion problems for three to five years.
6. Increasing re-establishment time due to the unreliability of natural regeneration.

Study Questions:

1. List four timber harvesting strategies and explain the pros and cons.
There are four types of timber marketing in Iowa: stumpage, percent cut, cut and sell, and grade and yield. Each strategy has good points and bad points.

**Stumpage**

A stumpage sale refers to selling the trees as they stand. It does not mean the land is sold. It is simply granting a logger permission to come onto your land and remove those trees designated. For this type of sale you will need to estimate the total volume of timber within the designated area. A professional forester can provide this service. Once timber has been marked and the value has been estimated, publicize a notice of timber sale and wait for the bids. You typically expect the highest bid and to enter into a written timber sale contract. See the enclosed contract. In this contract, you can specify environmental concern such as allowable maximum tractor rut to be left or "off limits" areas that might contain rare woodland flora and fauna.

The landowner receives a total lump sum payment prior to the logging operation. Arrangements can be made to receive partial payments both before and after the logging operation. However, it is to the advantage of the landowner to receive the money prior to logging.

The advantages of this system include:

1. Increasing revenue potential by contacting more buyers.
2. Reducing risks involved with cutting down trees yourself.
3. Providing a written agreement for legal purposes.
4. Getting lump sum payment prior to logging.

The disadvantages of this system include:

1. The bidding process may take extra time.
2. Extra time and effort is needed prior to the sale of timber.

Iowa State University extension pamphlet, Pm-413, "Marketing Iowa Timber," provides useful guidelines for this marketing option.

**Percent Cut**

A percent cut is a marketing strategy where the landowner gets a percent of the timber harvested and the logger gets the remaining percent. It is used to reduce the amount of capital needed by the logger. The logger is granted permission to cut down specified trees.

The advantages include:

1. Providing smaller logging operations an opportunity to compete with
larger operations.

The disadvantages include:

1. Landowner has less control over logging operation.
2. Landowner must rely on honesty of logger to determine final percent.
3. Landowner shares in the risk of timber harvesting (loss of logs during harvesting, decayed and hollow trees).

Grade and Yield

In this marketing system trees are cut from the timber and paid for as logs. The price provided depends upon the grade of logs and number of board feet produced from those logs.

The advantages of this system include:

1. Landowner receives best compensation if the logs are high quality.

The disadvantages of this system include:

1. Landowner assumes part of the risk of timber harvesting (hollow trees, logs damaged during harvest...).
2. Landowner must rely on the honesty of the logger to determine grade and yield.
3. Landowner may not get as large of revenue if the logs end up being low quality.

Cut and Sell

This marketing strategies requires no logger to assist. The trees are cut by the landowner and sold by the landowner. The landowner assumes all risks and gains all profits.

The advantages of this system include:

1. Landowner gets all profits from the sale of logs.
2. Landowner does not have to deal with a second party prior to sale of logs.

The disadvantages of this system include:

1. Landowner takes all the risks of timber harvesting including the risk of health and safety hazards.
2. Non-professional logger may not cut logs into most valuable log sections, therefore, losing extra revenue.
3. Landowner may not have appropriate equipment to do logging.
4. May take the landowner longer to harvest timber than professional logger.
5. Lack of knowledge of logging could increase damage to woodland environment.
6. Lack of knowledge of logging could increase damage to final product during felling process.

Harvest strategies should always consider regeneration strategies. Determine what species the forest should have after the harvest. Do you wish to
maintain the existing species or will you convert the stand to another species? Research the "silvics" of that tree species. What is it's level of tolerance to shade? What type of site does it grow well on? What are it's seed producing habits? Can it successfully regenerate the area? Inventory the regeneration on the site. Is there adequate regeneration (average of about 20 seedlings and 15 saplings per 100 feet diameter circular plot.) If not, determine how regeneration can be established. Review the types of harvesting systems (clear cut, seed tree, shelterwood, or selection). Then select the appropriate system.

Study Question:

1. List four marketing strategies and list the advantages and disadvantages of each strategy.
LEAF IDENTIFICATION CHARACTERISTICS

LINEAR  ELLiptical  LOBED  ROUND

HEART-SHAPED  TRIANGLE-SHAPED

LEAF SHAPE
LEAF IDENTIFICATION
CHARACTERISTICS

OPPOSITE

ALTERNATE

WHORLED

LEAF ARRANGEMENT
LEAF IDENTIFICATION CHARACTERISTICS

SMOOTH
FINELY TOOTHED
TOOTHED
DOUBLE TOOTHED
COARSELY TOOTHED
LOBED & TOOTHED
LOBED

LEAF MARGINS
LEAF IDENTIFICATION
CHARACTERISTICS

SIMPLE

COMPOUND

DOUBLY COMPOUND

LEAF TYPE
OTHER TREE IDENTIFICATION CHARACTERISTICS

TEXTURE

DIAMOND SHAPED

SMOOTH

DEEP GROOVES

COLOR

WHITE

GRAY

RED/ORANGE

BROWN

NEAR BLACK

BARK
OTHER TREE IDENTIFICATION
CHARACTERISTICS

SIZE

BROWN
RED
YELLOW

SHAPE

COLOR

ONE
FEW
MANY

NUMBER OF SCALES

SINGLE
CLUSTERED

ARRANGEMENT

WINTER BUDS
OTHER TREE IDENTIFICATION CHARACTERISTICS

THORNED VS. UNTHORNED

SIZE

USUAL

STAR

PITHS

CHAMBERED

TWIGS
OTHER TREE IDENTIFICATION CHARACTERISTICS

LOCATION OF TREES
COMMON COMMERCIAL TREE SPECIES

OTHER: HARD MAPLE, RED ELM, BUR OAK, SILVER MAPLE, COTTONWOOD, GREEN ASH, BLACK OAK, HICKORY
PARTS OF A TREE

- CROWN
- BUD
- LEAF
- TWIG
- BRANCH
- TRUNK
- OUTER BARK
- INNER BARK
- CAMBIUM
- HEARTWOOD
- SAPWOOD
- LATERAL ROOT
- TAPROOT
- ROOTHAIR
CALCULATING BOARD FOOT VOLUME

1. MEASURE TREE DIAMETER

2. MEASURE MERCHANTABLE HEIGHT

2½ LOG MARK ON STICK

LINE OF SIGHT

STUMP HEIGHT

2½ LOGS (40')

3. TABLE:

<table>
<thead>
<tr>
<th>DIAMETER (D.B.H.) (inches)</th>
<th>NUMBER OF 16-FOOT LOGS IN TREES</th>
<th>VOLUME IN BOARD FEET</th>
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<tbody>
<tr>
<td></td>
<td>⅓ 1 ⅓ 2 ⅔ 3 ¾ 5</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>21 34 44 55</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>30 52 68 85 98</td>
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</tr>
<tr>
<td>14</td>
<td>42 74 99 124 143 162</td>
<td></td>
</tr>
</tbody>
</table>

CONSULT A VOLUME TABLE
TREE CONDITIONS INDICATING DECAY

- FUNGI or CONKS
- OPEN WOUNDS or Holes
- OPEN BRANCH STUBS
- UNUSUAL SWELLING
TREE SHAPE/BRANCHING
VS. TREE QUALITY

PULP or FIREWOOD QUALITY
SAWLOG QUALITY
VENEER QUALITY
FIREWOOD

SAWLOG

VENEEER/SAWLOG*

TREE QUALITY - FROM VENEER TO FIREWOOD

*Depending on quality & size.
TREE LIMBS PRODUCE KNOTS
DISTURBED VS. UNDISTURBED

UNDISTURBED

DISTURBED
PRESENT USES OF IOWA WOODLANDS

OTHER USES:
- NUT PRODUCTION
- MAPLE SYRUP
- CHRISTMAS TREES
- WILDLINGS

WILDLIFE HABITAT

SOIL CONSERVATION

RECREATION, EDUCATION & NATURAL BEAUTY

WINDBREAKS

FIREWOOD

LUMBER & VENEER
PRACTICES THAT AFFECT TIMBER VALUE

GOOD
- Woodland Management
- Pruning Trees
- Controlling Pest Problems
- Silvicultural Treatments

POOR
- Grazing
- Unrestricted Recreation
- Careless Timber Harvesting
- "High Grading"
STEPS FOR SAWLOG VENEER PRODUCTION

1. PROTECT THE SITE
2. DISCUSS MANAGEMENT STRATEGIES WITH A PROFESSIONAL FORESTER
3. INVENTORY YOUR WOODLAND
4. DIVIDE WOODLAND INTO MANAGEMENT UNITS
5. DEVELOP A MANAGEMENT PLAN
   (a) do intermediate cutting, as needed
   (b) check stand for regeneration
   (c) harvest, when appropriate
   (d) recheck area for regeneration
6. RE-EVALUATE PLAN
SILVICULTURE STRATEGIES

TIMBER STAND IMPROVEMENT

HARVESTING STRATEGIES

PRUNING

REGENATION STRATEGIES
WHERE TO PRUNE

LOOK FOR "BRANCH-BARK RIDGE"

CUT HERE
PRUNING - A THREE CUT METHOD

1. UNDER CUT
2. UPPER CUT
3. FINAL CUT
TIMBER STAND IMPROVEMENT

1. WEEDING

2. CLEANING

3. IMPROVEMENT CUTTING

4. LIBERATION CUTTING

5. SANITATION CUTTING

BEFORE CUTTING

Overlay for Timber Stand Improvement
TIMBER STAND IMPROVEMENT

1. WEEDING

2. CLEANING

3. IMPROVEMENT CUTTING

4. LIBERATION CUTTING

5. SANITATION CUTTING

AFTER CUTTING
<table>
<thead>
<tr>
<th>FOUR TIMBER</th>
<th>SELECTION</th>
<th>CLEARCUT</th>
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<tr>
<td>HARVESTING</td>
<td>SHELTERWOOD</td>
<td>SEED-TREE</td>
</tr>
<tr>
<td>TECHNIQUES</td>
<td></td>
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## PROS & CONS OF TIMBER HARVESTING

<table>
<thead>
<tr>
<th>SELECTION</th>
<th>CLEARCUT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROS:</strong> visually pleasing; site maintains protective vegetative cover.</td>
<td><strong>PROS:</strong> cost efficient; best for regenerating shade intolerant species; provides openings for certain wildlife.</td>
</tr>
<tr>
<td><strong>CONS:</strong> costly; could reduce overall woodland quality; not possible to regenerate shade intolerant species.</td>
<td><strong>CONS:</strong> may not be visually pleasing; one time harvest income; possible short term erosion problems.</td>
</tr>
</tbody>
</table>

### SHELTERWOOD

<table>
<thead>
<tr>
<th>PROS: allows for regeneration of intermediate shade tolerance species; it is a good option for oak; site remains protected.</th>
<th><strong>CONS:</strong> logging costs higher, more complex.</th>
</tr>
</thead>
</table>

### SEED-TREE

| **PROS:** same as clearcut. | **CONS:** same as clearcut; natural regeneration may not be reliable; remaining trees susceptible to wind damage. |
THINNING PAYS

THINNED

NOT THINNED

THINNED TOO LATE
FOUR TIMBER MARKETING STRATEGIES

1. Stumpage Sales
2. Grade & Yield
3. Percent Cut
4. Cut & Sell
TIMBER SALE CONTRACT

This contract made and entered into this ______ day of _________________. 19____ by and between
__________________ of _______________________________, hereinafter referred to as the seller, and
__________________ of _______________________________, hereinafter referred to as the buyer.

WHEREAS: The tract of timber located in ______ Section ______, T ______ N, R ______ W.
__________________ County, Iowa.

NOW THEREFORE THIS AGREEMENT WITNESSETH:

The seller for and in consideration of the sum of $____________ on or before ________________ to be paid as
hereinafter provided.

THE SELLER FURTHER OFFERS AND THE BUYER AGREES:

1. To enter upon and allow access to the above described tract for the purpose of cutting and removing therefrom such
timber as is included in the terms of this contract.
2. That all said marked logs shall become the property of the buyer.
3. This contract (does) or (does not) include the rights to the residual and/or tops less than 8 inches in diameter remaining
after the logs are removed.

THE BUYER FURTHER AGREES:

1. To cut only the _______ trees marked with yellow paint.
2. To make payment for each tree unnecessarily cut or wantonly injured as provided in Section 658.4 Code of Iowa.
3. To leave all streams free of logs, brush, and other obstructions.
4. To assume liability for damage to fences, crops, cropland, and other property.
5. To travel to and from and work in the timber only when the ground is firm.
6. That all timber included in this agreement shall remain the property of the seller until paid for in full.
7. That the buyer has inspected the area and timber concerned, has estimated to his own satisfaction the quantity, quality,
and value of the timber to be removed and accepts the goods with all faults.
8. Unless an extension of time is granted by the seller, this contract shall terminate on ________________, 19____.
after which all logs and trees remaining on the tract revert to the ownership of the seller unless otherwise specified in
paragraph 9.
9. Special provisions:

______________________________

In witness whereof the parties hereto have executed this contract this ______ day of _________________.
19______.

Signature of Seller

Signature of Buyer

Post Office Address

Post Office Address

Witness

Witness

Cooperative Extension Service

Iowa State University

Ames, Iowa 50011

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DIRECTIONS:
FILL IN THE BLANKS with the word or phrase that best describes the part of the tree designated.

PARTS OF A TREE
How A Tree Grows

Match the word on the left with its function on the right. There may be more than one answer for each blank. You can use the letters at the right more than once.

- xylem
- phloem
- cambium
- leaf
- heartwood
- sapwood
- outer bark
- annual rings
- root hairs
- meristem
- primary roots

A) growth area for new leaves, twigs, and flowers
B) photosynthesis (making food for trees by combining carbon dioxide, water, and sunlight.
C) support
D) stores starches
E) absorbs water and dissolved minerals
F) core of inactive cells
G) area where sap rises from roots to crown
H) place where food for seed production and new tree growth are stored.
I) layer of cells that divide and grow to produce a new layer of bark and wood each year.
J) protects tree from weather, insects, disease, fire, and animals
K) one year of diameter growth
L) cells that transport sugars and starches to roots
Purpose: The purpose of this activity is to make students aware of the complexity of the woodland community as compared to other plant communities.

General Directions: You will need to take a field trip to do the Micro-plot Activities #1 & #2. You should take a micro-plot at: 1) an ungrazed woodlot; 2) a grazed woodlot; 3) a corn field; and at least one of the following: urban or school yard, pasture, or prairie area.

Micro-plot Activity #1 Use a wooden stake with a ten foot string attached to make a circular micro-plot. Mark the boundaries of the plot. Use Micro-plot Activity Worksheet #1 to record the plants and organisms at each site. Start with the organic layer of soil (if one exists). Identify or describe the plants, plant parts, and organisms found in that layer. Record your findings on Micro-plot Activity #1 Worksheet. Now dig a hole at least ten inches deep by ten inches square and look for plant life and organisms. Again, record your findings on the worksheet. Next record all the layers of plants starting from the ground up. When recording trees, identify the species and determine what part of the canopy they occupy (suppressed, intermediate, co-dominant, dominant). See the figure below.

CROWN CLASSIFICATION

D = DOMINANT  C = CO-DOMINANT
I = INTERMEDIATE  S = SUPPRESSED

Micro-plot Activity #2 Using the Micro-plot Activity #2 Worksheet draw a land profile of each area. Use Micro-plot Activity #1 Worksheet for that information. Then write a comparative description of the area including soil condition, plant communities and animal life. Explain the differences between that area and the other areas observed. This should be done after all the microplots have been completed.
### MICRO-PLOT Activity Worksheet #1

- ungrazed forest
- grazed forest
- cropland
- prairie
- pasture
- urban yard

<table>
<thead>
<tr>
<th>Location Within Plot</th>
<th>In Soil Layer</th>
<th>Organic Layer</th>
<th>Identification or Description</th>
<th>Number Found</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 5'</td>
<td>5'-15'</td>
<td>&gt; 15'</td>
</tr>
</tbody>
</table>

S=suppressed; I=intermediate; C=Co-dominant; D=dominant
MICRO-PLOT Activity Worksheet #2

LAND PROFILE - Description and Sketch

<table>
<thead>
<tr>
<th>15'</th>
<th>10'</th>
<th>5'</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ungrazed Woodland
Grazed Woodland
Cornfield (specify)

Description  Description  Description  Description
Objective:

Measure regeneration in a given area and determine what the future forest will look like. Also to compare land use practices and see how they affect the amount of regeneration on the site.

Materials Needed For Each Group:

- peg with a 50 foot string attached
- notebook
- tally sheet
- pencil

Preparation:

Try to locate a grazed woodlot and an ungrazed woodlot to take regeneration plots in.

On-site Procedure:

Randomly select regeneration plots in an ungrazed woodlot. Have groups of students count all the trees below two feet tall. They should record the number of trees per species for each 100 foot circle.

Discuss what the forest will look like in fifty years. (Realize that even in the best situation, not all seedlings will develop into a mature tree.)

Duplicate this procedure in a grazed woodlot. Discuss the differences between the two sites. Compare the number of seedlings at each site. Emphasize the importance of wise land use practices in woodland areas.
<table>
<thead>
<tr>
<th>Number of Seedlings</th>
<th>Number of Seedlings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>Species</td>
</tr>
</tbody>
</table>

Group ____________________  Plot # ______
Description of Plot ____________________

---

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Forest Regeneration Plot Study

Tally Sheet
WOODLAND MANAGEMENT TERMS
Crossword Puzzle

ACROSS
1. Art, science, and business of producing goods from forest areas
2. Variety of tree sizes and species
3. Converting an area back to forest
4. Tree capable of producing thin sheets of wood
data from forest areas
5. Natural, coppice, and plantings
6. A type of regeneration
7. Removing dead or damaged trees
8. Ability to survive in the shade of other trees
9. Producing and tending a forest
10. A type of clear cut
11. A type of clearcut
12. Distance across the plane of a circle
13. Removing trees for profit and pleasure
14. Removal of wolf trees from timber stands
15. Silent struggle for water, sunlight, and minerals
16. Selection of groups of trees for harvesting is called ___________ selection.
17. A type of regeneration
18. Intermediate cutting in sapling stand
19. Removing undesirable branches
20. Cutting single-trees from a woodlot
21. Leaves, twigs, and branches
22. Tree capable of producing lumber
23. Tree health
24. Harvesting damaged or dead trees for money

DOWN
1. Art, science, and business of producing goods from forest areas
2. Variety of tree sizes and species
3. Converting an area back to forest
4. Tree capable of producing thin sheets of wood
data from forest areas
5. Natural, coppice, and plantings
6. A type of regeneration
7. Removing dead or damaged trees
8. Ability to survive in the shade of other trees
9. Producing and tending a forest
10. A type of clear cut
11. I2"xI2"xI2"
12. Intermediate cutting in sapling stand
13. A type of regeneration
14. Removing undesirable branches
15. Tree health
16. Placing trees into the ground
17. A large limby tree
18. Harvesting damaged or dead trees for money
Situation #1: Two foresters go out to help a landowner develop woodland management strategies. The landowner wants to manage an existing woodlot for sawlog or veneer log production. As the foresters walk along they see a timber stand of mature white oak, and hickory on the hillside. The clayey soil is well drained. The timber has a park-like appearance with little or no young trees. They called this Site #1.

Farther down the hill they noticed many changes. The soil was poorly drained. There were fewer oaks and hickories, but many 12"-15" diameter willows, boxelders, and cottonwoods. There were even a few slow growing and poorly formed walnut trees with about an 8" diameter. This area is Site #2.

As they crossed a small creek and ventured up a small embankment and across a fence, they noticed another change. The soil was a dark black well-drained soil. This site had mostly good quality 20"-25" diameter bur oak, black walnut, and ash. There was also some 12"-15" mulberry, elm, and dying boxelder interspersed. In an opening there is quite a bit of walnut and ash regeneration. In other areas there is white oak, elm, and hackberry regeneration. The whole site has a layering of vegetation. Our foresters called this Site #3.

QUESTION SET #1 - WALNUT PRODUCTION

Question #1: Does any of this woodlot have potential for growing walnut? Why or why not?

Question #2: Where should walnut management be considered, if at all? Why?

Question #3: Assuming that you are going to manage Site #3 for walnut, would you need to do any planting of walnut seedlings within the woodlot? Why or why not?

Question #4: Would you suggest any other woodland management strategies?

Question #5: Should any timber stand improvement or timber harvesting be done? If so, what tree species need to be removed?
A Day with The Foresters
Student Worksheet #2

SITUATION: Two foresters go out to help a landowner develop woodland management strategies. The landowner wants to manage an existing woodlot for sawlog or veneer log production. As the foresters walk along they see a timber stand of mature white oak, and hickory on the hillside. The clayey soil is well drained. The timber has a park-like appearance with little or no young trees. They called this Site #1.

Farther down the hill they noticed many changes. The soil was poorly drained. There were fewer oaks and hickories, but many 12'-15" diameter willows, boxelders, and cottonwoods. There were even a few slow growing and poorly formed walnut trees with about an 8" diameter. This area is Site #2.

As they crossed a small creek and ventured up a small embankment and across a fence, they noticed another change. The soil was a dark black well-drained soil. This site had mostly good quality 20'-25" diameter bur oak, black walnut, and ash. There was also some 12'-15" mulberry, elm, and dying boxelder interspersed. In an opening there is quite a bit of walnut and ash regeneration. In other areas there is white oak, elm, and hackberry regeneration. The whole site has a layering of vegetation. Our foresters called this Site #3.

QUESTION SET #2 - OAK PRODUCTION

Question #1: Does this woodlot have a potential for growing oak? Why or why not?

Question #2: Where should oak production be considered, if at all? Why?

Question #3: Assuming you chose Site #1, would you need to suggest any woodland management strategies? If so, what strategies? If not, why?

Question #4: Assuming you chose Site #1, would you need to do any planting of oak seedlings? Why or why not?

Question #5: Should any timber stand improvement be done? If so, what tree species need to be removed?

Question #6: What type of timber harvest scheme(s) could be considered?
Situation #1 - Walnut Production

Question #1 & #2

Site #3 has potential for walnut production. The soil is well drained loamy soil. The site is just above the flood plain (on a first terrace). The fence and the layers of vegetation suggest the site is protected from grazing livestock. This site would be ideal for walnut production. The well established walnut trees and existence of walnut regeneration also suggests this would be a good site for walnut. If the description had suggested that the walnut on the site had slow growth and poor form, then the site might not have been suited for walnut production. Using this logic Site #2 would probably not be a highly recommended area for walnut production, even though there are presently walnut trees growing there. Note that the walnut trees are sparse and of poor form. The soils is also not well drained and the area is subject to frequent flooding. Walnut trees do not survive well in areas that are subject to long-term flooding.

Question #3

This question can be answered a number of ways. If the student says, "no", make sure they point out the presence of walnut regeneration in the openings. They should further realize that regeneration strategies will need to be considered in selecting harvesting techniques. Since black walnut is shade intolerant, the harvesting strategy would need to create openings wide enough to allow ample sunlight to reach the walnut seedlings. A 150 foot minimum width for the harvest should be used. Ask the student if natural regeneration or plantings should be used to reforest the area. Either response is acceptable. However, plantings would probably provide faster more efficient results.

If the student answers, "Yes, walnut seedlings will need to be planted", ask the student additional questions. Where are those plantings needed? Remind the student that adequate regeneration already exists in the open areas. Ask the student if these plantings should be done before or after timber clearing or timber harvesting is done? Remind the student that black walnut is a shade tolerant tree species.

Question #4

Other management strategies could include: weed control if planting is done, timber stand improvement, and timber harvesting and regeneration.

Question #5

Timber stand improvement is a possibility for Site #3. Commercial TSI is one possibility. An improvement cut could be used to remove the larger bur oak, ash and poor quality black walnut. This would release the competition for light, water, and nutrients needed by the better quality black walnut. However, there is a risk of damaging the black walnut trees during the logging process. A noncommercial TSI could also be used. Some of the larger
trees could be killed and left for wildlife habitat. Weeding or removal of all small non-commercial species of trees less than 15" in diameter could be applied. In this stand the black cherry, hackberry, mulberry, elm, and boxelder would be removed. It is important that you help the students realize that too much thinning can also have harmful effects. To much thinning creates openings for sunlight to reach the ground. This will encourage weeds and grasses to invade the area. These plants will compete with tree seedlings trying to get established.

Situation #2 - Oak Production

Questions #1 & #2

Site #1 has potential for oak production. It is an upland site with an established stand of oak and hickory. The soil is well-drained which is suitable for white oak. Given this, Site #1 would be suitable for oak production.

Question #3

Site #1 appears to be grazed. The park-like appearance with little or no regeneration are clues to this. White oak is very sensitive to soil compaction. Therefore, one management strategy that should be implemented is to eliminate the grazing component in this site.

Question #4

Yes, since the stand is already mature and there is no adequate regeneration, planting is necessary. Oak has intermediate tolerance to shade. So planting seedlings underneath existing trees is possible. Waiting for the trees to naturally regenerate the area is not a wise decision. First, the area is compacted because of grazing. Even if grazing were eliminated, it would take a few years for the site to readily regenerate. Second, once the site is rejuvenated, you would be dependent upon the cyclical production of acorns. An oak tree produces a good crop of acorns about once in every five years. Since oak is intermediate in shade tolerance it is important to get young seedlings established prior to harvesting. When this is not possible a tree planting in an open area may also be successful.

Question #5

With a mature stand of oak, it is too late for timber stand improvement. A pre-commercial thinning may be advantageous, providing that grazing has not reduced the quality of the stand to below sawlog quality. In that case, harvesting and plantation establishment would be the best option.

Question #6

Since oak has intermediate shade tolerance, there are two possible harvesting options. A shelterwood system combined with underplantings of oak is the first option. The second option is a clearcut with plantation establishment.
Matching

In the blank provided, place the letter in front of the appropriate response on the right.

_____ woodland management  A. root and stump suckers
_____ silviculture  B. a new crop of trees
_____ pruning  C. removing unwanted branches
_____ regeneration  D. a timber harvest done in phases
_____ coppice  E. art, science, and business of producing and maintaining woodland areas for future benefits and services
_____ clearcut  F. removing all trees during harvest
_____ shelterwood  G. planting trees to convert an area back to forest
_____ selection  H. art and science of growing and caring for trees
_____ reforestation  I. managing an area for more than one benefit
_____ multiple use  J. harvesting only the "best" trees
_____ timber stand improvement  K. thinnings or cuttings done to release competition and improve growing conditions for remaining trees.

Short Answer

1. You've just learned that grazing a woodlot reduces the value of your timber. You're hopeful that you can convince your parents why grazing is harmful. You burst into the house and unload your new found knowledge. Your father gets a little uneasy and says, "You show me how grazing has damaged the timber and maybe, just maybe, I'll listen." What will you point out to your father as you walk through the woods?
2. While hiking through the woods you notice three 30 inch diameter walnut trees that have at least one sixteen foot veneer log. Unfortunately, they are in your neighbors ungrazed woodlot. You point them out to your father.

A. With the volume table and timber prices information provided, determine how many board feet the trees contain. Then estimate the value of the trees. (There is no defect in the logs).

B. You point out three walnut tree on your land. They are only 24 inches in diameter and contain only one eight foot log each. Upon closer examination you notice that one tree has a large punky (soft) area near its base. The other trees have about 10 and 20 percent defect. How many board feet of lumber might you get out of the trees on your land?

C. What is the difference in value between your trees and your neighbors?

3. Congratulations! You have convinced your parents that woodland management is a good idea. They've decided to let you manage the south forty for timber production. List the steps you'd need to consider in management for sawlog/veneer production.
APPENDIX G - REFORESTING IOWA - ESTABLISHMENT AND CARE OF TREE PLANTINGS
REFORESTING IOWA
The Establishment and Care of Tree Plantings

Written by: Reinee Hildebrandt
4-H and Forestry Departments
Iowa State University

Goal:
Students will know how to plan, implement, and maintain a tree planting.

Unit Objectives:
1. Plan a tree planting, given a specific management objective.
2. Plant trees correctly.
3. Care for and maintain a tree planting.

Visual Masters:
1. Steps in Establishing and Maintaining a Tree Planting
2. Develop a Layout or Plan Before Planting
3. Match Tree Species to Site
4. Criteria for Matching Species to Site
5. Tree Planting Suggestions
6. Tree Planting Methods
7. Two Methods for Hand Planting with a Spade
8. Steps for Hand Planting with a Spud or Bar
9. Eight Rules of Tree Planting
10. Planting Trees the Right Depth
11. Root Placement
12. Watch Out for Biological Problems
13. Controlling Weeds in Tree Plantations

Activities:
1. What's wrong with these tree plantings

Topic 1: Planning A Tree Planting

Objectives
1. Define the terms: site preparation, tree spud, match species to site.
2. List five reasons or purposes for tree plantings.
3. List six steps in establishing a tree plantation.
4. Develop a five year tree planting plan for a specific site.
5. Explain what needs to be done to protect a site before planting trees.
6. Given a site, be able to match species to site.
7. Given the purpose for the tree planting, determine appropriate planting spacing.
Interest Approach/Teaching Activities

1. Use the teacher information sheet "Why Reforest Iowa" to introduce the unit. Start by asking students reasons for reforesting Iowa.
2. Have a local nursery operator, district forester, or urban forester as a guest lecturer or as a member of a panel to discuss the value of trees, different types of tree plantings, tree planting purposes, selecting trees to plant, or different species to plant and why.
3. Have the students read the section on "Planning a Tree Planting".
4. Discuss "Planning a Tree Planting" using visuals #1 and #2.
5. Have students read the section on "Species Selection".
6. Summarize information using visuals #3 and #4.
7. Have the class analyze various school sites to determine what trees would grow best there OR take a field trip to sites with different topographical levels and soil types. Have the class determine the types of tree that would grow best there or have your district forester go along to help them decide which to plant.
8. Have the class develop a tree planting for your school or a selected area. Have the class get involved in the Trees for Schools program. (Contact Paul Wray, Forestry Extension, 251 Bessey Hall, Iowa State University, Ames, IA 50011).

Topic 2: Planting Trees

Objectives

1. List eight tree planting hints.
2. Explain what needs to be done to prepare the site for planting trees.
3. Draw a diagram of how to correctly plant bare root seedlings.
4. Explain why tree roots should not be exposed to drying winds.
5. List the steps for planting trees with an ordinary spade.
6. List the steps for planting trees with a tree spade.
7. List the steps for planting balled and burlap or containerized trees.
8. Explain how to transplant trees using a mechanical tree spade.

Interest Approach/Teaching Activities

1. Divide the class into five groups and assign different sections of the written materials on "Tree Planting" Parts I-V to each group. Have each group develop a presentation or demonstration of their assigned section. (You may need to help them secure visuals and props for their demonstrations).
2. Summarize the student information on "Planting Trees" using Visuals #5 -#12.
3. Have a field day where students get hands-on tree planting experience.
4. Raise money by hiring out as an FFA tree planting crew. Provide this service for a Christmas tree grower. You could also develop a tree plantation where only a small part is planted each year OR as a community service project help plant trees for the local recreation area.
Topic 3: Care and Maintenance of Tree Plantings

Objectives

1. List biological problems that could affect tree plantings.
2. Explain how to control animal damage to trees.
3. List three techniques of weed control.
4. List three types of chemical control.
5. Develop a maintenance plan for checking quality of trees in your planting.

Interest Approach/Teaching Activities

1. Lead a discussion on the care and maintenance of tree plantings.
2. Take a field trip to a local timber and then to a tree plantation. Observe biological problems. Have a scavenger hunt for insect and disease problems. Also observe the management practices. Is there a maintenance plan? Is one needed?
3. Adopt an existing forest or park and get permission to practice maintenance techniques.
4. Have students divide up into eight groups. Have each group read and report on one of the sections on "Tree Plantation Maintenance and Care".
5. Summarize information using visuals #13-#14.

Suggested References:


Iowa is faced with a diminishing forest resource. According to the 1832-1859 Surveyors Notes, Iowa originally had 6.68 million acres of timber (Thomson, 1980). In 1954, there were 2.3 million acres of commercial forest land in the state (Thornton et al., 1959). The last tally in 1974 indicated Iowa had 1.56 million acres of timber (Ostrom et al., 1974). This represents an overall decline of 5.12 million acres or over 76 percent of Iowa's original forest cover.

One reason for Iowa's diminishing forest resource is land use conversion. Iowa's woodlands have been converted to cropland, pastureland, or residential areas. Forestry is just one of the many land use alternatives which compete for Iowa's fertile lands.

Many areas on soil classes V-VIII, which should have been kept in woodland and grasses, have been converted to crops. Severe erosion problems have resulted because of this change in land use. According to the Iowa Forest Resource Plan for 1985, a state goal to increase Iowa's woodland areas to three million acres would be the equivalent of 84% of the lands in the USDA Soil Conservation Service land-capability classes V, VI, and VII. Converting this land to forest land would protect the basic soil resources and yield products and amenities for all Iowans on a continuing basis.

Grazing also contributes to the decline of woodland quality and quantity. Grazing of Iowa's woodlands brings about a slow sometimes inconspicuous decline in our woodlands. It is usually noticeable only when it is too late for the woodlands to rejuvenate. By this process, a woodland area originally characterized by wide plant diversity can be converted to a pastureland after about 100 years of grazing.

A factor that contributes to the diminishing woodland problem is landowners attitudes toward forested areas. Some Iowa landowners seem to dismiss the values and benefits of our woodland areas. These natural areas can provide numerous benefits to the landowners and the general public. Yet, often both the non-economic and economic benefits of forested land are overlooked.

Benefits of Iowa's Woodlands

Woodlands can provide soil protection against both water and wind erosion. Iowa croplands lose an average of 9.4 tons of soil per acre per year. On our ungrazed woodlands only 1.02 tons of soil are lost per acre per year. On grazed woodlands 4.42 acres of soil are lost per acre per year (Natural Resource Inventory, 1982). This is an increase of 3.4 tons per acre per year because of grazing.

Woodlands provide wildlife habitat, which in turn provides recreational opportunities to landowners and others. The Iowa Department of Natural Resources has sold over 225,000 hunting licenses per year since 1982 (Iowa Conservation Commission, 1986). This income helps support wildlife habitat
improvement in Iowa. Woodlands also help maintain better water quality for fish habitat. Trees along streams provide shade and cooler water conditions needed by fish such as trout.

Woodlands provide an aesthetic quality to an otherwise monotonous landscape. Trees aid in the purification and enhancement of our air quality. They take in carbon dioxide and release oxygen.

Our woodlands also add to Iowa’s economy. Since 1982, Iowa has been one of the top three states in the nation for exporting top quality (veneer) walnut logs. We have 224 wood using industries, 87 sawmills, 1 veneer mill, and 1 pulp mill. There are 400 tree farms containing 29,126 acres of timber land. Iowa’s woodland industry contributes to Iowa’s economy. According to the Annual Survey of Manufacturers, our lumber and wood products industries; pulp, paper, and allied products; and furniture and fixtures industries employ 14,300 Iowans annually which represents $3.73 million dollars of taxable income per year and 5.8% of the 246,000 people employed in Iowa’s industries.
Topic 1: Planning a Tree Planting

Subtopic 1: General Information

Student Information Sheet

Planting trees can be a fun activity, but it can end with disastrous results if it is not done correctly. Proper planning and maintenance of tree plantings can help landowners develop healthy stands of trees. A little time spent in planning your planting project could mean the difference between a successful planting and a failure. You should begin planning in late summer or early fall for planting the following spring.

Determine if a tree planting machine can be used on the site or if the trees must be planted by hand. Consult with a district forester or county extension director about the possibility of using planting machines.

Protecting the Planting

Determine fencing needs to protect planting from grazing. Livestock will trample seedlings and compact the soil.

Plan plantation layout, access ways, and firebreaks. Leave an access way 25 feet wide around the entire plantation. If the planting is over 300 feet wide, leave an 18-foot access way or fire break down the middle at 300-foot intervals.

Planting Design or Layout

Some Common Spacing Recommended for Iowa

<table>
<thead>
<tr>
<th>Type of Planting</th>
<th>Tree Spacing</th>
<th>Number of trees per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christmas trees</td>
<td>5' x 5'</td>
<td>1,740</td>
</tr>
<tr>
<td>Christmas trees</td>
<td>5' x 6'</td>
<td>1,450</td>
</tr>
<tr>
<td>Timber, pulpwood</td>
<td>8' x 8'</td>
<td>680</td>
</tr>
<tr>
<td>Timber, pulpwood</td>
<td>8' x 10'</td>
<td>540</td>
</tr>
<tr>
<td>Black walnut veneer</td>
<td>10' x 10'</td>
<td>450</td>
</tr>
<tr>
<td>Black walnut veneer</td>
<td>10' x 12'</td>
<td>360</td>
</tr>
</tbody>
</table>

Rectangular spacing may be more satisfactory than square spacing. Wider spacing between rows will result in faster planting, less wear on equipment, easier maintenance, and better access. Closer spacings tend to cause the lower branches to die back in 8 to 12 years on average sites. Closer spacings are also desirable for Christmas tree plantings because the trees do not need as much growing space due to earlier harvesting. Wider spacings are recommended for black walnut. Black walnut trees need individual attention as they mature. They also need more growing space for development of veneer quality trees on a relatively short rotation.

Study Questions

1. What two tasks should people think about to help them develop a healthy stand of trees?
2. List two protection techniques to incorporate in your planting?
3. Is a close (5' x 5') spacing recommended for Black Walnut?
4. What spacing should a Christmas Tree Plantation be and why?
There are two important factors in selecting tree species. They are: determining the purpose of the tree planting and matching the tree species to the site.

**Purpose of Tree Planting**: The purpose of the tree planting will help determine which species to plant. A landowner needs to determine what their objective or reason is for the tree planting. Tree planting purposes include: erosion control, sawlog production, wood for energy, windbreaks, Christmas tree production, recreation purposes, wildlife habitat, or existing timber stand improvement. The type of tree planting chosen will determine the species selected and the type of planting stock selected.

Tree species for erosion control need to be fast growing species to provide quick cover and protection. They also need to be well adapted to the planting site. Along rivers aspen, cottonwood, willows, and silver maple would be appropriate. On the hillsides basswood, hackberry, and oaks would be possible selections.

When planting for sawlog/veneer production, the landowner needs to consider the commercial value of the tree species. Some examples include: black walnut, red oak, white oak, hard maple, cottonwood, and ash.

For a Christmas tree plantation, Iowans tend to purchase more scotch pine, white pine, and red pine than any other species. These trees need a well drained to drier site.

When the planting purpose is for urban forests and recreation areas, the trees fall colors, overall shape, and wildlife values is important. Trees and shrubs have many pleasing characteristics all year long. In the winter, conifer trees and shrubs can add green to the landscape. Deciduous trees can provide interesting silhouette designs against sidewalks and buildings. In the spring there are flowering trees and early foliage producers. In the summer, vegetation can soften harsh reflections of sunlight from buildings and other concrete objects. In the fall, foliage can color the landscape beautiful with reds, oranges, yellows, and maroons. Many plants have attractive fruits and nuts on them in the fall.

There are several reference books that provide information on seasonal appearance of trees and shrubs. Suggested references include:

Matching Tree Species to Site: It is important to remember that the tree should be suitable to the proposed site. One of the causes of mortality of tree plantings is not matching tree species to site. Trees have requirements for the site where they grow best. Trees have definite soil, moisture, and light requirements for best growth. First, the site should be analyzed. Note soil type and present ground cover. On what soils series will the tree planting be located on? What is the soil's pH, drainage, compaction potential? A soil test may be desirable. What is the topographical location (riparian zone, flood plain, hill side, hill top)? Is the area subject to flooding? Is the area subject to salt drainage from roads? Second, select a tree species that will survive on that site. How much sunlight does the area receive? Trees have varying abilities to withstand light. A shade tolerant tree has the ability to survive without full sunlight. Examples include: sugar maple and ironwood. Trees that survive best in full or nearly full sunlight are called shade intolerant. Cottonwoods, willows, boxelder, and silver maple are shade intolerant trees.

In Iowa some species occur naturally at various topographical levels. See Figure 1. Whenever possible plant trees where they have occurred naturally.

Figure 1. Relationship of Topography to species Distribution
Pines, oaks, and walnut trees are the most frequently planted trees in Iowa. Therefore, additional information is included about planting these species.

**Walnut** Select a site that is well-drained and not subject to long term flooding. A first or second terrace is usually preferred over the floodplain area. Walnuts are intermediate to shade intolerant so it is best to plant them in open areas.

**Oaks** Select an upland site for oaks since they have little tolerance to flooding. Red oaks prefer a more moist site than white oaks. Nearly all oak species are intermediate in shade tolerance when they are at seedling stage and become less shade tolerant as they grow older.

**Pines** Select a site that is not subject to flooding. A silty or clayey soil is preferred over a sandy soil. Pines are shade intolerant, so plant them in large open areas.

**Study Questions:**

1. What two factors should be considered before a species is selected?
2. List 4 purposes or reasons for planting trees.
3. Explain what is meant by "match species to site"?
When to Plant

The planting season in Iowa is generally from about March 15 to May 1st (March 20 in northern Iowa counties). The soil condition is just as important as the date of planting. DO NOT attempt to PLANT in frozen or snow-covered soil or when the ground is wet and sticky.

Ordering Planting Stock

Planting stock is available from local nursery growers and from the State Forest Nursery in Ames.

The State Forest Nursery provides only bare root growing stock. Trees may be purchased with the restriction that their use be for erosion control or wildlife cover. Shrubs for wildlife planting are also available from the State Forest Nursery. These are supplied at nominal charge with only minor use restrictions. Trees or shrubs obtained from the State Forest Nursery may not be used for:

1. Ornamental purposes
2. Resale as living trees
3. Sale as balled stock
4. Urban windbreaks

The stock is selected for rapid height growth and early self-pruning of lower branches and is not suited for ornamental planting. Commercial nurseries select stock of desirable color and form specifically for ornamental planting as well as forestry purposes. When ordering from commercial nurseries, follow the same general steps as when ordering from the State Forest Nursery. To assist landowners in ordering forest stock from commercial nurseries in Iowa, extension publication Pm-956 (Rev.), "Directory of Iowa Nurseries That Deal in Forest and Ornamental Planting Stock" can be obtained from your county extension director or Forestry Extension, 251 Bessey Hall, Iowa State University, Ames, IA 50011.

Study Questions

1. When should trees be planted in Iowa?
2. Where can planting stock be obtained?
3. What, if any, are the restrictions on use for the planting stocks listed from the above sources?
There are four types of planting stock - bare root, containerized, balled and burlapped, and tree spaded materials.

Bare root planting stock: Bare root materials are two to five year-old seedlings that are sold with no dirt around their roots. Typically, bare root stock is used for erosion control, sawlog production, Christmas tree production, and energy plantations.

Caring for Bare Root Stock Many plantings have failed because of improper care of planting stock upon arrival. This has probably resulted in more plantation failures than any other factor. Be careful when storing and handling bare root stock. The roots must not be allowed to dry out. Pick up the trees as soon as you are notified the trees have arrived. For best results, the planting stock should be planted as soon as possible.

If the trees can be planted within one week after arrival, you should take the following precautions. First, inspect the bundles or crates for heating or drying damage, immediately after receiving the trees. Second, thoroughly water the stock by: (a) cutting the bundle open, watering it, and rerolling it loosely, or (b) dipping the entire bundle in water, open and reroll loosely. Third, store the trees in a cool, dark, damp place such as a milk house, basement, or the shade of a building. Make sure you plant them within one week after the trees have arrived.

Sometimes it is not possible to plant trees within a week of their arrival. If the trees cannot be planted within one week after arrival, keep them in cold storage (35-40 degrees F). Cold storage facilities are often available in many small cities and towns where eggs and poultry are stored. Planting stock can be safely held in cold storage for four to five weeks, if the following precautions are taken:

1. Keep the temperature at about 35 degrees F, as constantly as possible - never higher than 40 degrees F.
2. Do not stack bales or bundles of stock on top of each other; place them separately on shelves. If stock is received in two or more deliveries from one or more nurseries, write the date each bundle is placed in cold storage on the shipping tag. Plant first the stock held in cold storage the longest time.
3. Water the stock once each week. Watering can be facilitated by attaching a perforated metal tube to the end of a hose, and inserting the tube about halfway into the bundle of seedlings.

If cold-storage facilities are not available and it is necessary to keep stock for more than a week before planting, the trees should be "heeled-in." This is done by digging v-shaped trenches in a well-drained shady location on or near the planting site. Trees usually come from the nursery tied in small bunches of 25 to 50 trees. Untie these bunches, lay the trees in layers three or four trees deep along the sloping side of the trench, and then pack soil around the roots. Trees may be removed from the trench as required. The trenches should be kept moist but not soaked. If necessary, most
hardwood species can be left heeled-in for four or five weeks. Avoid placing the trench in direct sunlight.

**Containerized Stock:** Containerized materials are 3-10 year old trees grown and sold in potting containers. The root systems of containerized materials should be checked to make sure they are not rootbound or growing together in a massive ball. Avoid purchasing root bound materials. A rule of thumb is to get materials with a root to shoot ratio of one. This means the size of the root system is equal to the size of the branches, twigs and leaves. Containerized plantings are used for urban plantings in parks and recreation areas or as yard and street tree plantings.

**Balled and Burlapped or Tree Spade:** A tree spade is a mechanical device that cuts through the ground in a triangular shape and lifts a tree for transporting and transplanting. Balled and Burlapped planting trees are trees that have a large ball of soil around the roots and are wrapped in burlap so the roots won't dry out. Before you buy balled and burlapped planting stock check to make sure: 1) the roots are not growing in a ball; or 2) that the dirt mass surrounding the roots and the roots themselves are not dried out. When planting balled and burlapped materials remove all twine and burlap since it may contain nylon. Nylon will not deteriorate and will eventually strangle the tree roots.

Tree spaded material should be root pruned the year prior to transport and then transported and transplanted in one day's time. Root pruning will help the tree adjust to living with less root system than it had before. It also gives the tree a chance to adapt to this situation by developing a new fiberous root system within the spaded area. Moving a tree can cause transfer shock which, in turn, could stress to the tree to the point of killing it. Having a newly developed root system will help the tree adapt better to a new location. Balled and burlapped and tree spade planting materials are typically used for plantings in recreation areas or urban tree plantings.

**Study Questions:**

1. List 3 types of tree planting stock.
2. List two conditions that would be reasons to reject balled and burlapped planting stock.
3. Explain the importance of root pruning.
Tree Planting Tools and Their Uses

There are four basic tree planting tools: a tree spud, a hand spade, a mechanical tree planter, and a mechanical tree spade. See figure 1. The tree planting technique you use will depend upon the type of stock you are planting.

TREE PLANTING METHODS

- **Tree Spud** (40 trees/hr)
- **Hand Spade** (40 trees/hr)
- **Mechanical Tree Planter** (1,000 trees/hour)
Bare root planting stock can be planted with a tree spud, a hand spade, or by using a mechanical tree planter. Figures 2-3 diagram planting techniques for bare root planting stock.

**STEPS FOR HAND PLANTING WITH A SPUD OR BAR**

1. Insert spud straight down and push forward to an angle of about 30 degrees.
2. Lift spud slightly in the same plane.
3. Push spud down at same angle to obtain a new bite.
4. Pull spud toward you until it is straight up; this will make a hole that is wide at the bottom.
5. Set tree at correct depth and remove spud.
6. Insert spud about 2 inches from hole.
7. Pull handle back slightly to close bottom of hole.
8. Push handle forward to close top of hole.
9. Insert spud 2 inches from last hole.
10. Push forward and then backward by stamping with heel.
11. Fill in last hole by stamping with heel.
2 METHODS FOR HAND PLANTING WITH A HAND SPADE

1. Take out a V-notch of soil. *
2. Set it aside.
3. Lay tree in hole.
4. Replace V-notch of soil.
5. Heal in the soil.

* If soil is clayey, scarify (scratch) sides of the hole.

1. Dig a hole. *
2. Place tree in hole at correct depth.
3. Replace dirt.
4. Compact soil slightly.
Planting machine  Planting machines are usually limited to areas that can be 
worked with farm equipment. Some of the heavier machines pulled with a 
crawler tractor can plant in heavy brush or rough terrain. These machines 
plant at the rate of 800 to 1,000 trees per hour, so it is practical to use 
them only on large plantings.

There are several types of planting machines. Before starting, get 
instructions on the use of the machine from the local forester or the owner 
of the machine. Familiarize yourself with the machines operations and 
planting procedures before starting.

Be sure that the machine used opens an adequate planting slit and that it 
packs the trees in firmly. If planting is to be done on a custom basis, be 
sure the operators are trained and experienced. Check the quality of their 
work. Observe the planting depth, tree spacing, and packing of soil around 
the trees.

Planting Larger Stock

Containerized planting stock is usually planted with a shovel or shade. 
Balled and burlapped planting stock can be planted with a shovel, hand spade, 
or mechanical tree spade. Tree spaded materials are re-planted using tree 
spade. Figures 5 shows the planting technique to use.

Study Questions

1. List four tree planting techniques.
2. Explain one tree planting technique and tell when it is appropriate 
to use this technique.
Site preparation consists of eliminating weeds and unwanted woody vegetation, breaking ground for planting trees, and preventing erosion problems. Before you begin site preparation, you must consider the soil type you will be working with. On light soils with no sod or very light sod, usually no site preparation is needed. If a planting machine is used, a scalper is not necessary.

On medium and heavy soil with sod cover, site preparation is necessary. When hand planting, reduce sod cover by plowing furrows as shallow as possible. When furrowing is not possible, make an 18-inch by 18-inch scalp by peeling the sod back with a grub hoe or shovel. When using a tree planting machine, be sure the scalping attachments are functioning properly. The use of herbicides in strips 18 inches wide on both sides of the row is also recommended instead of furrowing or scalping. If scalping is used on sloping ground, do it on the contour.

With some soil conditions, various herbicides can be as effective as scalping to reduce sod competition. Herbicides are superior and recommended on slopes where erosion is a problem. They can be used as pre-planting treatment or with the use of specially equipped tree planting machines. Herbicides are also an effective way to control weeds after trees are planted. Information about rates and methods of application can be obtained from your local forester or the extension forester at Iowa State University in Ames.

Study Questions

1. Define site preparation.
2. What is the difference between site preparation on light soil versus heavy soil?
RULE 1: KEEP THE TREE ROOTS DAMP at all times, regardless of planting method used. Carry the trees in a bucket with three to four inches of muddy water or in a box with the roots under wet moss or burlap. Take out only one tree at a time when planting.

RULE 2: DO NOT EXPOSE ROOTS TO SUNLIGHT OR DRYING WINDS. This will cause drying out of the roots.

RULE 3: SEPARATE AND SORT THE TREES BEFORE PLANTING. You can save time and prevent root injury if you separate and sort the trees before planting. Sort trees in a shady place protected from the wind.

RULE 4: PLANT TREES THE DEPTH THEY GROW IN THE NURSERY. The old soil line can be recognized by the paler colored bark on the stem and also a slight bump or swelling at this point. Conifers are especially sensitive to deep planting, and they often die as a result. Some broadleaf species can tolerate deeper planting.

Planting too shallow is also a mistake since parts of the root systems will dry out if above or near ground level. They can also be damaged by wind whipping the tops.

RULE 5: PREVENT CURLING OR BUNCHING OF THE ROOTS. The hole or slit should be deep enough to prevent curling or bunching of the roots. For three to four year old stock with roots exceeding 12 to 15 inches, root pruning may be necessary.

RULE 6: NEVER PUT WATER IN THE HOLE BEFORE PLANTING. Air pockets will form that can result in severe root damage.

RULE 7: CLOSE THE BOTTOM OF THE PLANTING HOLE AS WELL AS THE TOP.

RULE 8: PACK SOIL FIRMLY AROUND ROOTS AFTER PLANTING.

Study Questions

1. List the eight tree planting rules.
2. Explain how bare root stock should be cared for during planting.
Topic 3: Care and Maintenance of Tree Plantings

Subtopic 1: The Planning Stage

Student Information Sheet

Tree care and maintenance should be considered from the time you decide to do a tree planting project. It needs to be included in your planting plan.

Care and maintenance of your trees can be reduced by matching tree species to the appropriate site. When a person doesn't match the species to site they are planting trees "off site". Planting trees "off site" puts the tree under additional stress. Although the trees may grow "off site," they typically will not grow as tall or remain as healthy as they would have been if they were planted on site. Trees grown off site are more susceptible to insect and disease problems.

Once the trees are planted, they should be cared for. While the trees may grow all right on their own, they will have better height and diameter growth if weeds and unwanted woody vegetation are controlled. Young trees need time to establish adequate root systems and grow to a height where they are not shaded by other plants. Grasses and some woody plants have an advantage over newly planted small trees in competing for sunlight, moisture, and nutrients. Control of unwanted vegetation is especially important in the Midwest. Lack of sufficient light caused by excessive growth of unwanted vegetation can kill trees and shrubs, even when there is a surplus of moisture.

As trees mature they begin to compete with one another for sunlight, nutrients, and water. Periodic thinnings need to be included in the maintenance plan so this competition can be reduced.

Study Questions

1. What is meant by planting a tree "off site"
2. What should be considered in a tree planting maintenance plan.
There are three major methods for controlling unwanted vegetation: chemicals (herbicides), cultivation, and mowing. See figure 1.

CONTROLLING WEEDS IN TREE PLANTATIONS

Mowing

Cultivation (3-5 times/season)

Chemicals

Figure 1. Methods of Weed Control

The best time to control weeds and grasses is just before or during their seedling stage. Newly germinated seeds and small seedlings can be killed easily with chemicals or by cultivation. Begin control measures when the first grass and weed seeds start to grow. Chemical control usually requires only one treatment in the early spring (or fall with pre-emergent chemicals) each season.
Chemicals (herbicides)

Several chemicals can be used to control grass and weed competition including Princep (simazine), Goal (oxyfluorfen), Surflan (oryzalin), Poast (sethoxydim), and others. They are available from most distributors of agricultural supplies. For more information contact the DNR State Nursery, 2404 South Duff, Ames, IA 50011.

If you use herbicides, apply them only when needed and handle them with extreme care. Follow the directions and heed all precautions on the container label. Pesticides are especially dangerous when handled or applied improperly. They may be injurious to humans, domestic animals, desirable plants, wildlife, and fish, and can contaminate water supplies.

Cultivation

Cultivation with common farm implements is another good method of controlling weeds and grasses in tree plantings. Row cultivators, spring-tooth harrows, and other tractor-drawn equipment are all useful under various conditions. Three to five cultivations per season are normally adequate for new plantings. Fewer cultivations are needed as trees grow older. After seven to nine years the trees should not need cultivation in most circumstances.

When cultivating, remember:

1. Never ridge soil against the trees.
2. Never cultivate as closely as corn. Small trees cannot tolerate much mechanical damage to branches or surface roots.
3. Cultivate just deep enough to kill weeds and grasses - no deeper than three inches or you will be likely to cause major damage to surface roots.

Mowing

Mowing between tree rows combined with herbicide on the rows will provide satisfactory control for most vegetation. Mowing helps to reduce fire hazard by reducing fuel buildup. Mowing also helps prevent buildup of mouse and rabbit populations.

Mowing should begin when weeds and grasses are less than 18 inches tall, and it may be required several times during the spring and summer. Once a tree planting becomes thickly infested with weeds and grasses, especially during the middle of the growing season, it is not advisable to remove all vegetation. The sudden change in conditions may be too much for young trees and they will often be killed. High mowing to remove part of the overtopping weeds can be helpful when this situation arises in as little as one or two years.

Note: When mowing and cultivating, stay at least 6 inches away from small seedlings (less than 2 feet in height). Avoid hitting or bumping the tree stems as this will provide an excellent place for decay and disease-causing fungi and insect pests to enter the tree. These organisms could destroy your planting.
Study Questions

1. List three types of weed control.
2. Which type of weed control works well in Iowa.
The effect of grazing on the forest floor and the associated soils are detrimental to the woodland itself. Grazing causes: 1) reduced amounts of soil organic matter, 2) increased soil compaction, 3) increased soil erosion, 4) reduced soil fertility, and 5) a changed woodland environment.

**Reduced Amounts of Soil Organic Matter**

Investigations into other physical effects of grazing on soils supporting farm woodlands have shown that grazing reduces soil organic matter levels by as much as 25%. As the woodlot is grazed, understory plants are eliminated, crown density is reduced and tree growth declines. This results in less leaves and litter on the forest floor. With the crown opened, the forest floor becomes warmer, causing the organic matter and litter to decay faster. The increase in the amount of sod in the grazed woodlot contributes organic matter due to dying grass roots, but this addition is not enough to offset the decline of tree and understory vegetation litter.

**Increased Soil Compaction**

Grazing compacts the soil. Compacted soil has less air space and tunnels for water and air to travel through. This means less water can pass through the soil. When soils become compacted, they typically have a lower initial moisture content in the spring and a greater tendency to dry out in the summer or fall.

**Increased Soil Erosion**

Soil compaction leads to soil erosion. As soils are compacted, the fluffy litter layer disappears. Without this layer, raindrops splash directly onto the soil. They loosen small soil particles and carry them away. Because the soils are compacted, water does not pass through the soils as readily. However, it has to go somewhere, so it flows over the surface of the soil.

Research has shown that runoff from grazed forest floors (even with sod established under the remaining trees) averaged 344 cubic feet per acre per year over 7 years compared to less than 30 cubic feet per acre per year from comparable ungrazed woodlots. Severe erosion and soil loss can occur where woodlot grazing has been permitted and compaction has occurred. Other research shows that a grazed woodlot loses an average of 4.5 tons of soil per acre per year. A non-grazed woodlot will only lose an average of 1.7 tons of soil per acre per year.

**Reduced Soil Fertility**

In addition to physical effects, woodlot grazing affects the fertility of soil supporting farm woodlands. Grazing compacts the soil and causes addition removal of the forest litter layer by surface water runoff. When the litter layer is removed, woodlots have reduced fertility due to the lack of nutrient rich material available in the organic matter for leaching. Fertility reduction is critical because it occurs in the surface soil layers which
serve as seedbeds for natural regeneration.

A Changed Woodland Environment

During woodlot pasturing the trees and associated vegetation are also affected. The diversity of plants decreases, tree reproduction decreases or is eliminated, and the trees become stressed and diseased.

The deterioration of the site quality of the grazed woodlot reduces the growth and quality of the timber. With the elimination of reproduction, the stand opens up. The eventual result is the elimination of all trees and the development of open land. Permanent pasture may well be economically desirable from management goal and may be quite suitable to the landscape, but many years of transition from trees to pasture would create a situation where the land is not economically useful for grazing or the production of timber.

Study Questions

1. Explain what effect grazing has on the forest soils.
2. Explain what effect grazing has on the woodland environment.
Topic 3: Care and Maintenance of Tree Plantings

Subtopic 4: Animal Nuisances - Wildlife Damage

Student Information Sheet

For Tree Farmers, controlling wildlife eating habits is a crucial part of forest management. Even more than weather, animal browse is considered by many experts to be the leading cause of serious damage to young trees and seedlings. The problem is most acute in winter, when trees are the only thing readily available for animals to eat.

Animal offenders include deer, rabbits, porcupines and many kinds of mice. Researchers have done much in the last few years to develop products that will keep these animal species from harming trees. These items take the form of either chemical repellants or physical barriers that keep animals from reaching seedlings.

Chemical Repellants

Chemical repellants work by taste and/or odor. They don't hurt wildlife or trees. Deer and other browsers are thus encouraged to find something that tastes and smells better than seedlings to eat. Some products may discolor seedlings temporarily, but this is considered only a problem of appearance.

Although chemical repellants are designed to have no worse effect on animals than leaving a bad taste in their mouths, a word of caution is necessary. Never use repellants more frequently, or in greater volume, than the label recommends. Chemical repellants are classified as pesticides, and your state pesticide regulating agency or extension service can usually give you pointers on their proper use and storage.

Physical Barriers

Physical barriers such as plastic tubes, netting and paper bud caps must be installed carefully on young trees. If not done right, you can cut down on the amount of air and light reaching the trees. Plastic netting that is too tight can also cause heat build up in summer. However, if done properly these physical barriers offer the advantages of effectiveness and photodegradability (they break down naturally in light over a period of time). This means that some plastic netting barriers can be almost maintenance free, since they decompose and fall away as the tree grows above browse height.

Bud caps are another form of physical protection for young trees. When made of "Rite In The Rain" paper, bud caps are placed around the terminal bud of a young tree. The paper cap is left open at one end, and they do work. However, waxed paper or butcher paper is not effective material for bud caps.

Additional references available from Forestry Extension include: F-357 "Controlling Deer Damage in Tree Plantings"; WL-46 "Mouse Damage to Tree Plantings"; WL-47 "Rabbit Damage to Tree Plantings".

Study Questions

1. What animals might cause damage to a tree planting?
2. List two ways to control animal damage.
Firebreaks should be incorporated into the planting plan. In areas where fire hazard is great, construct a firebreak by plowing several furrows around the plantation and within the plantation. Interior fire breaks at least fifty feet wide and should be located every one half to three fourths mile apart. Fires need air, dry fuel, and an initial ignition. Make sure that excess slash and other burnable materials are not lying around in the plantation. This would provide one of the basic elements for fire.

The time to be most concerned about fires is during the dry, hot summer when the burnable materials are drying out and will ignite more readily. The top reasons for wildfires in Iowa are debris burning and incendiary.

Other fire prevention techniques include:

1. Mowing access roads and the edges of roads regularly.
2. Providing gravel, dirt and mowed parking spots for recreationist.
3. Picking up old bottles and glass. (Under the right condition they have been known to act as magnifying glasses in igniting fires.)
4. Prune trees in a plantation to nine feet to remove natural "ladders" that cause ground fire to climb into the crowns.
5. Reduce potential fuels by scattering slash or burning it.
6. Ask visitors not to smoke on your property during dry periods.

Study Questions

1. How can fire damage be reduced?
Check periodically from mid-spring until fall for signs of insects or diseases attacking the plantation. If any signs are apparent, samples of the damage information about the damage should be brought to the attention of the forester, extension pathologist, or extension entomologist. Look at the entire tree for: holes in the trunk or branches, unusual growth patterns, leaf deformation, and other symptoms. Report of your findings accompanying the sample.

Samples can be sent to the address below for identification and diagnosis.

Extension Pathology
105 Bessey Hall
Iowa State University
Ames, IA 50011

Below is a list of how to care for and send samples.

1. Cut a sample and send it in immediately if possible.
2. Keep sample in cool (56 degrees F) refrigerator if it cannot be sent in immediately.
3. Do not freeze the sample or the fungi may be killed.
4. Do not expose the sample to drying winds or hot temperatures or the fungi may be killed.
5. Include in a letter a brief history of the site the sample was taken: i.e. chemical use, nearby construction activity, problems with runoff from nearby roads, etc. Be specific.

Study Questions

1. When should a tree plantation owner check on their planting for insect and disease problems?
2. How can you get your insect and disease problems diagnosed?
STEPS IN ESTABLISHING and MAINTAINING a TREE PLANTATION

1. Select a planting site.
2. Match the species to the site.
3. Develop a planting layout with protection measures for grazing, fire, insects, disease, wild animal damage.
4. Prepare the site for planting.
5. Plant trees.
6. Develop a plantation maintenance schedule (weed control and thinning).
DEVELOP a LAYOUT or PLAN BEFORE PLANTING

12'-16'

FIREBREAK (every 6 to 10 rows)

tractor with mower

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<td>1037</td>
<td>910</td>
<td>686</td>
<td>725</td>
</tr>
</tbody>
</table>
MATCH TREE SPECIES to the SITE

HILLTOP
- white & black hills
- spruce
- red cedar
- red oak
- hickory
- pine

HILLSIDE and HILLTOP
- spruce
- pine
- cedar
- hard maple
- oak
- shagbark hickory
- basswood

TERRACE
- ash, walnut, elm, bitternut hickory, basswood, Kentucky coffeetree

FLOODPLAIN
- willow, cottonwood, sycamore, silver maple, boxelder

willow

cottonwood

elm

walnut

ash

FLOODPLAIN
CRITERIA for MATCHING SPECIES to SITE

1. Climate
2. Soils
3. Topography
4. Shade tolerance
TREE PLANTING SUGGESTIONS

1. Plant trees from March 15 to May 1.
2. Plant trees when ground is tillable (not frozen or wet).
3. Keep tree roots damp at all times.
4. Keep roots away from sunlight and wind.
5. Plant trees at the correct depth and don't bunch the roots.
6. If the soil is very clayey, be sure to rough up the sides of the hole.
7. Pack soil firmly around roots.
8. Water the tree.
TREE PLANTING METHODS

Tree Spud (40 trees/hr.)

Hand Spade (40 trees/hr.)

Mechanical Tree Planter (1,000 trees/hour)
2 METHODS FOR HAND PLANTING with a HAND SPADE

1. Take out a V-notch of soil. ♦
2. Set it aside.
3. Lay tree in hole.
4. Replace V-notch of soil.
5. Heal in the soil.

1. Dig a hole. ♦
2. Place tree in hole at correct depth.
3. Replace dirt.
4. Compact soil slightly.

♦ If soil is clayey, scarify (scratch) sides of the hole.
**STEPS FOR HAND PLANTING WITH A SPUD OR BAR**

1. Insert spud straight down and push forward to an angle of about 30 degrees.

2. Lift spud slightly in the same plane.

3. Push spud down at same angle to obtain a new bite.

4. Pull spud toward you until it is straight up; this will make a hole that is wide at the bottom.

5. Set tree at correct depth and remove spud.

6. Insert spud about 2 inches from hole.

7. Pull handle back slightly to close bottom of hole.

8. Push handle forward to close top of hole.

9. Insert spud 2 inches from last hole.

10. Push forward and then backward filling hole.

11. Fill in last hole by stamping with heel.
8 RULES of TREE PLANTING

1. KEEP THE ROOTS DAMP
2. DO NOT EXPOSE ROOTS TO SUNLIGHT or DRYING WINDS
3. SEPARATE and SORT TREES BEFORE PLANTING
4. PLANT TREES THE DEPTH THEY GROW IN THE NURSERY
5. PREVENT CURLING or BUNCHING of ROOTS
6. NEVER PUT WATER IN THE HOLE BEFORE PLANTING
7. CLOSE THE BOTTOM OF THE PLANTING HOLE AS WELL AS THE TOP
8. PACK SOIL FIRMLY AROUND ROOTS AFTER PLANTING
PLANT TREES
the
RIGHT DEPTH

look for a slight swelling

look for a change in color
ROOT PLACEMENT

too shallow

"J-root" bunching

correct

tangled roots

too deep
WATCH OUT FOR BIOLOGICAL PROBLEMS

Fire

Insects

Weed Competition

Disease

Animal Damage
CONTROLLING WEEDS
IN TREE PLANTATIONS

Mowing

Cultivation
(3-5 times/season)

Chemicals

KERB 50-W
Goal
Princep
Surflan
Roundup
Poast
Fusilade
What's Wrong With These Tree Plantings?

Directions: Fill in the blank with an appropriate description of "what's wrong with the tree planting".
SHORT ANSWER

Situation: You've decided to do a tree planting project as an FFA Forest Management Project.

1) You must convince your parents to allow you to do this project. List five reasons for planting trees and tell how each tree planting purpose fits into your families traditional agriculture operation.

2) Your parents decide to let you go ahead with the project if you can develop a plan of action. List the steps you need to do to establish a plantation.

3) Your parents decide you can plant red oak on an floodplain area. Should you do this? Justify your answer.

4) Describe the type of planting stock you should select. Which type would be most appropriate for a tree plantation of oak? Why?
5) You and a friend begin to plant the trees. You notice that he/she picks up a bundle of seedlings, shoves them into a back pocket, and begins to walk over to dig a few holes for the trees. Write below the tree planting suggestions you might share with your friend.

6) Once your trees are planted, you need to establish a maintenance plan. List the details you will need to consider in the plan.

TRUE AND FALSE

Circle T for True and F for False

T F 1. All trees that are planted will survive.
T F 2. A combination of mowing and cultivation is the best weed control.
T F 3. Christmas trees should be planted at a 10' by 20' spacing.
T F 4. Deer, rabbits, mice, and bluejays can all substantially damage a tree plantation.
T F 5. It is best to leave a firebreak around plantations that are larger than 400 feet in length and width.
T F 6. There are tree planting tax incentives to allow landowners to regain costs associated with tree planting projects.
T F 7. Grazing will not damage tree plantings or woodlots.
T F 8. Before you select a tree species for planting, you need to consider the purpose of the planting and the planting site.
T F 9. Trees can be planted in Iowa from February 15th to July 15th.