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Signature Dale Godfrey

Date 7/30/80

USE OF A GREENHOUSE IN TEACHING FIELD CROP PRODUCTION

by

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A professional paper submitted in partial fulfillment
of the requirements for the degree

of

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in

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ABSTRACT

This study was conducted by Dale Godfrey in 1980. It was a study of the competencies, operational procedures and methods of using a greenhouse in a high school vocational agriculture curriculum.

The purpose of this study was to determine the educational benefits of using a greenhouse in teaching principles of field crop production in agriculture classes in Montana, specifically in the areas of; Plant Growth, Development, and Production, Soils, Range Management, and Agriculture Chemicals and Pest Control.

Data for the study was collected from vocational agriculture departments in Montana, North Dakota, South Dakota, Colorado, Washington, and Idaho. Questionnaires were sent out to all schools using greenhouses in their vocational agriculture departments.

Some of the more significant findings were as follows:

1) The competencies needed in field crop production in Montana were being taught through the use of the greenhouse.

2) A greenhouse could be justified to teach a crop production class.

3) Students could learn many competencies needed in field crop production by raising and selling bedding plants.

Chapter 1

INTRODUCTION

The demands on students entering the world of work continue to change. The needs of the people and the country are continually changing. The challenge faced by vocational educators is to evaluate their programs constantly and make changes to keep pace with the demands of society. They are continually searching out better ways of teaching their students and making their programs interesting, but educational and meaningful.

One of the more recent additions to many vocational agriculture facilities is the greenhouse. Most of the greenhouses added to vocational agriculture programs are used in teaching Ornamental Horticulture. Information is needed about ways of using a greenhouse in Montana in a primarily production agriculture curriculum. To the researcher's knowledge there has been no formal research which deals with this general area, yet schools have indicated a desire to add a greenhouse to their school's vocational agriculture curriculum.

There are many ways a greenhouse might be used to teach those competencies needed by graduates in plant growth and development, soils, range management, and agriculture chemicals.

Several other uses, of a general education nature, can also be made by the addition of a greenhouse to the vocational agriculture curriculum. An example would be a unit on home gardening. The

educational benefits of raising bedding plants in a greenhouse could be very beneficial to any vocational agriculture program.

Purpose

The purpose of this study was to determine the educational benefits of using a greenhouse in teaching principles of field crop production in agriculture classes in Montana, specifically in the areas of: Plant Growth, Development, and Production; Soils, Range Management, and Agriculture Chemicals and Pest Control.

Statement of Need

Today's high school vocational agriculture students have more demands on their time than ever before. They have the opportunity to be involved in more and more activities all the time. This makes it more difficult for the teacher to obtain and hold the student's interest, to schedule field trips, and to carry out many other activities that make a program successful. The use of a greenhouse could become a teaching aid and could take the place of some of the field trips that the teacher would like to take but cannot schedule. "Hands on Experience' and 'Learning by Doing' have long been mottos of Vocational Education." (9:126-7) But, because of the short growing season in Montana, the teaching of crop production has been done primarily through lecture classes with few hands on activities. Greenhouses, where used, have enabled students to propagate vegetative materials, participate in

seedling transplanting, and learn techniques of pest and disease control.

Each year, more schools are building small greenhouses or adding gardens. With the increased cost of food, people are trying to raise more of their own vegetables. A greenhouse would be a very effective tool to teach these skills.

In order to justify the expense of acquiring and operating a greenhouse for teaching field crop production, research is needed concerning how they might best be utilized. Some schools have built greenhouses without first predetermining if the amount of use will justify the expense. Ornamental Horticulture is not a large industry in Montana compared to other types of Agriculture.(3) Montana vocational agriculture teachers would have to justify a greenhouse on the basis of the need and use in a production agriculture curriculum. This study will seek to determine if the greenhouse could be used to teach the competencies needed in Plant Growth and Development, Soils, Range Management, and Agriculture Chemicals and Pest Control.

Objectives

To accomplish the major purpose of this study, the following objectives were formulated:

1. To determine the operational procedures used by vocational agriculture teachers, in Montana and surrounding states, in utilizing a greenhouse in the vocational agriculture curriculum.

2. To determine if the greenhouse could be used to teach the field crop production competencies in the following areas:
   a. Plant Growth and Development.
   b. Soils.
   c. Range Management
   d. Agriculture Chemicals and Pest Control.
3. To determine those methods being used by vocational agriculture teachers, in Montana and surrounding states, to teach the competencies needed in field crop production through the use of a greenhouse.

Assumptions

1. It is assumed a greenhouse could be used effectively in teaching field crop production competencies.

Limitations

1. The population was limited to vocational agriculture teachers teaching in the states of Montana, Wyoming, North Dakota, South Dakota, Washington, Idaho, and Colorado during the 1979-80 school year.
2. The research was limited to the curriculum areas of Plant Growth and Development, Soils, Range Management, and Agriculture Chemicals and Pest Control.

Definitions

1. Production Agriculture is defined as, "a combination of subject matter and learning experiences designed to teach basic principles and management decisions involved in the science and technology of producing, marketing, inspecting, and processing farm products." (11.6)
2. Field Crop Production is defined as the part of agriculture dealing primarily with producing plants for human or animal consumption.
3. Department is defined as a vocational agriculture program within a school.
4. SOEP or Supervised Occupational Experience Program would be defined as, "a series of learning experiences which are part of an instructional program and designed to develop competencies in agriculture. May utilize facilities of home, farm, school, or community business and industries. Programs may include some or all of the following types of experiences: farming, employment, observational, and school laboratory."(11:64)
5. Ornamental Horticulture is defined as those areas of agriculture such as landscaping, raising of bedding plants, turf management, flower arrangements, etc.

Procedure

Selection of Sample Population

A letter was written to the Head Teacher Trainer and State Supervisor of Vocational Agriculture in seven states asking for a list of departments in their state having or using a greenhouse. The states were as follows: Wyoming, North Dakota, South Dakota, Colorado, Washington, Idaho, and Montana with a total of fifty-one departments having greenhouses in the seven states. All fifty-one were sent questionnaires.

Instrument

An instrument based on the competencies in the Montana Curriculum guides was developed and validated by October 1, 1979. Five teachers in Montana were sent a copy of the questionnaire and asked to evaluate and return with comments or suggestions for its improvement. A draft of the questionnaire was then developed. The questionnaire was a combination open and closed form instrument. Questions were asked to indicate whether competencies were being taught through the use of a greenhouse, how effective the greenhouse was in teaching these competencies and how the greenhouse was used to teach the competencies.

Mailing and Follow-up

A questionnaire, with an accompanying letter of explanation was mailed to the respondents with a self-addressed, stamped envelope enclosed. When questionnaires were not received within fourteen days,

nonrespondents were sent postcards asking if they would please respond. After another fourteen days had passed, nonrespondents were sent a third questionnaire. After another fourteen days, the results were tabulated.

Chapter II

REVIEW OF LITERATURE

The review of literature disclosed limited material available concerning the use of a greenhouse in teaching field crop production in vocational agriculture. The researcher found little work has been done on this particular topic. However, considerable work has been done in the use of a greenhouse in the teaching of Ornamental Horticulture. Many of these findings would be of use in a production agriculture curriculum. Therefore, the researcher will try to relate the two.

Ornamental Horticulture is a large industry in many states, especially in those states with large populations and long growing seasons. Vocational agriculture departments in these states have extensive programs in Ornamental Horticulture because of the demand for trained people to enter the work force in this area. According to the Montana Manpower Study, Ornamental Horticulture industries increase in work force is small compared to that in the other agriculture fields.(3) Thus there has been limited emphasis placed on it in Montana's high schools.

Vanada suggests that once a need for a greenhouse is established and a curriculum is designed, the instructor may have to get some work experience if not trained in the use of a greenhouse. The state university or a local greenhouse business would be an excellent source. Vanada also suggests that plant lights could be set up in the back of

a classroom for a less extensive program.(10:138)

The Oregon Teachers Association, realizing a need for some guidelines in Ornamental Horticulture, formed a group to develop a curriculum guide. They met with people from industry and prepared a curriculum guide including student outcomes, suggested learning activities, and selected references.(7:31-2)

This important question needs to be answered: "What are the educational benefits of using a greenhouse?" There are many articles that relate to this point. Abraham suggests the use of plants in other classes as an interest getter. He showed how keeping daily charts on plant growth and determining the percentage of daily growth as compared to the total growth taught mathematics.(1:5;-4)

"Hands on Experience' and 'Learning by Doing' have long been mottos of Vocational Education."(9:126-7) What better way to create interest and motivation than to allow the students to learn plant science in this way.(Ibid.)

Beam suggests that the greenhouse can give a talented student a chance to formulate extensive research, experimentation, problem solving and student creativity.(4:32) On the other hand, Cross tells how the Melwood Horticulture Training Center in Maryland finds this an excellent place to train the handicapped and disadvantaged. He stated that most of these people enjoy watching things grow and benefit from the program. They are able to place most of these students at jobs after completion

of the course.(6:63-4)

The follow-up by Walton of the Bath County Horticulture Program came up with the following conclusion. He found that most of the students were not employed in the field of horticulture. The students had enrolled in horticulture for personal development rather than as a means of livelihood. They felt it was a very beneficial program. The study showed that one can't measure the success of a program completely by job placement.(12:142-3) Adhern had a similar experience. He told how he had met a student who graduated from high school thirty years ago. He was a former Vocational Agriculture student but never had worked in the area of agriculture. He said, however, his training was invaluable as the skills he had learned in home food production have served him well. He raises an excellent garden each year. The former student stated that Vocational Agriculture educators are doing their students an injustice by not providing them with basic skills in home fruit and vegetable production. This provides lifetime useful skills regardless of employment. (2:137)

Montario indicated that a greenhouse opened a whole new horizon and that the uses were almost unlimited. He said that even when students did things wrong, they learned from their mistakes. Many of the uses he gave as examples could be used in production agriculture. Some of the examples are listed here:

1. Vegetative propagation.

2. Soil compaction
3. Over fertilization.
4. Under fertilization.
5. Over watering.
6. Coloring fertilizer and then checking the roots for color to note fertilizer uptake.
7. Use of growth retardants to make short, stalky plants.
8. Effects of day length.
9. Effects of humidity and temperature.
10. Plant tissue tests to spot soil deficiencies.

Montario's title said it well: "Something New Under the Sun -- Expecting the Unexpected."(8:132-3)

Conclusions

In order to implement the use of a greenhouse into a field crop production agriculture curriculum, the local administrator and school board will have to be shown some justification for the expenditure. In order to do this, educators will have to show how the greenhouse will be used. One way of doing this is by showing the competencies needed in field crop production and how they could be taught through the use of a greenhouse. No research was found dealing with teaching field crop production competencies through the use of a greenhouse. The literature, however, does show many of the competencies needed in crop production are being taught through the use of a greenhouse.

Chapter III

PRESENTATION OF DATA

Questionnaires were sent to all of the vocational agriculture teachers in North Dakota, South Dakota, Colorado, Washington, Idaho and Montana who used greenhouses in their departments. Wyoming teachers were to be a part of the study, however, it was determined that none of the Wyoming teachers were using greenhouses in their instructional program. A total of fity-one questionnaires were sent.

TABLE 1

SUMMARY OF RESPONSES

N=35

State	Number of Questionnaires Sent	Number of Questionnaires Returned	Percent of Response
North Dakota	15	9	60
South Dakota	5	3	60
Colorado	7	7	100
Idaho	6	4	66
Washington	15	10	66
Montana	3	2	66
TOTAL	51	35	68

As indicated in Table 1, 35 of 68 percent of the sample returned a usable questionnaire. One respondent indicated he had discontinued the greenhouse and a second respondent returned the questionnaire stating

that a greenhouse could not be justified as a means of teaching field crop production in agriculture. Several of the respondents commented that a small greenhouse would be more than adequate as a means of teaching field crop production principles. It should be noted that, of the 35 questionnaires returned, some were returned incomplete.

Operational and Maintenance Procedures

In order to plan for the use of a greenhouse in a field crop production curriculum, the teacher needs to know such things as the cost of operation or how many extra hours of his time will be required. The data in Table II speaks to these points.

TABLE II

SUMMARY OF RESPONSES TO OPERATIONAL AND MAINTENANCE PROCEDURES

N=33

Question	Range	Average
Number of students served by the greenhouse	6-115	46
Size of greenhouse	120-5,736 sq.ft.	1,304 sq.ft.
Years of use	1-15	4.6
Cost of operations per year	$50-$4,000	$1,113
Extra hours per week of teacher's time to operate the greenhouse	0-20	7

The data in Table II show a large variation in numbers of students

being served by the greenhouse. On the average, there were 46 students. The size of the greenhouses varied from 120 to 5,736 square feet with 1,304 square feet being the average. Of the 33 respondents, 4.6 years was the average number of years in use with a range from 1 to 15. The cost of operations ranged from $50 to $4,000 with $1,113 being the average cost. Teachers said they spent an average of seven extra hours each week operating the greenhouse.

Construction

In constructing a greenhouse, a variety of materials are available for use. Table III shows the three different responses to this question.

TABLE III

TYPE OF CONSTRUCTION

N=22

Question	Fiberglass	Glass	Plastic
Types of Construction	14	6	2

Departmental Operational Procedures

Once the decision has been made to construct a greenhouse, other decisions have to be made such as who will receive the profit from the sale of plants if any are sold. The instructor may want to have some of the students use the greenhouse for their supervised occupational experience pro-

gram. The data in Table IV will show how the respondents answered these questions.

TABLE IV

SUMMARY OF RESPONSES TO DEPARTMENTAL OPERATIONAL PROCEDURES

Question	No.	Yes	%	No	%	Special Response
Use of solar heat	31	8	25.8	23	74.2	
Used by other departments	33	6	18.1	27	81.9	
Used for FFA money making project	33	21	63.6	12	36.4	
Used for SOEP. number in 1978-79	32	24	7.5	8	25.0	13.5 Average
Used primarily for horticulture	33	30	90.9	3	9.1	
Used primarily for field crop production	33	3	9.1	30	90.9	
Greenhouse partially self-supporting	33	18	54.4	15	45.6	
What % self-supporting						54.6 Average

It can be noted in Table IV that solar heat is being used to heat 25.8 percent of the greenhouses in vocational agriculture departments. Greenhouses are not solely used by vocational agriculture departments, as the data show 6 or 18.1 percent of the departments share their greenhouse with other departments in the school. Twenty-one vocational agri-

culture departments reported they used the greenhouse to raise money for the FFA. Greenhouses are used by schools to provide opportunities for students to conduct supervised occupational experience programs (SOEP). Twenty-four or 75 percent were used for that purpose with 13.5 being the average number of students for each school. Thirty of the respondents stated the greenhouse was used primarily for ornamental horticulture while three schools used the greenhouse primarily for teaching field crop production. Finally, Table IV showed 18 school greenhouses were expected to be partially self-supporting through the sale of bedding plants. The average percent, self-supporting was 54.6%.

Plant Growth Competencies

Table V contains a list of competencies needed in plant growth, development and production as found in the Montana curriculum guide. The table shows how many teachers were teaching these competencies through the greenhouse and how effective they felt they were.

TABLE V

PLANT GROWTH, DEVELOPMENT AND PRODUCTION COMPETENCIES TAUGHT THROUGH THE USE OF A GREENHOUSE

Competency	No.	Yes	%	No	%	Low Effectiveness 1	2	3	4	High 5	Mean
Plant propagation	32	31	96.8	1	3.2	2	2		4	19	4.3
Planting and transplanting	33	30	93.7	2	6.3	3			5	20	3.5
Plant breeding & reproduction	31	16	51.6	15	48.4	4	4	5	2	2	2.4
Plant selection	30	20	66.6	10	33.4	1	3	8	3	2	3.1
Stages of growth	33	30	90.9	3	9.1	4	2	3	9	9	3.6
Soil fertilization & plant nutrition	13	12	92.3	1	7.7	2	2	7	5	10	3.7
Crop adaptation to climate and soil	30	13	43.3	17	56.7	1	3	4	2	2	3.2
Weed and seed identification	33	15	45.4	18	54.6		3	4	1	5	3.6
Seedbed preparation	32	21	65.6	11	34.4	1	1	5	4	8	3.9
Planting rate, depth and date	30	25	83.3	5	16.7		1	6	6	10	4.1
Germination tests	32	28	87.5	4	12.5	1	3	5	8	8	3.8
Recommend crop varieties	30	8	26.6	22	73.4		1	2	1	4	4.0
Salesmanship of farm crops	27	9	33.3	18	66.7	1	1	2	2	2	3.4

The data in Table V indicates that schools were using the greenhouse in teaching plant growth, development and production competencies. Plant propagation was the competency taught by 96.8 percent of the schools, followed by planting and transplanting with 30 or 93.7 percent. The competency receiving the lowest rating was recommending crop varieties with 8 or 26.6 percent of the schools having taught this competency. The data in Table IV show that all thirteen competencies needed to be taught in field crop production are being taught using a greenhouse. The degree of effectiveness varied between competencies. Plant propagation received the highest rating with a 4.3 effectiveness average followed by planting rate with a 4.1. Plant breeding and reproduction had the lowest effectiveness rating with a 2.4. It is shown that even though a competency may not be taught by many schools it may still be very effective. This was shown with recommending crop varieties. It was the least taught but had the third highest effectiveness factor.

Methods of Teaching Plant Growth Competencies Using the Greenhouse

After the teachers were asked if they taught a competency and its effectiveness, they were asked to tell what method was used to teach it. Not every teacher responded to this area. Following is a list of the responses given to the question that asked how the greenhouse was used to teach these competencies:

Plant Propagation

- Use of propagation bench with mist and heat
- Observation of growth characteristics
- Propagate by seed, softwood cuttings, hardwood cuttings, layering, budding and grafting
- Thinning and planting
- Division
- Use of antifungal agents and rooting chemicals
- Growing flowers by sexual and asexual means
- Bulbs, air layering

Planting and Transplanting

- Allows students to see germination faster and clearer
- Potting rooted cuttings and repotting
- Replanting existing plants
- Effects of root hormones
- Effects of planting depth
- Spring bedding plants to grow and sell
- Different types of pots and flats
- Effects of planting depth on germination

Soil Fertilization and Plant Nutrition

- Show effects of poor soil fertility
- Keeping plants fertilized
- Checking plant growth and color
- Experiments with various fertilizer rates
- Hydroponics

- Show nitrogen and phosphorus deficiencies in sand cultures
- Soil testing

Plant Breeding and Reproduction

- Cross breeding tried on flowers
- Genetic experiments
- Layering, cuttings, etc.

Plant Selection

- Ornamental identification
- Selection of healthy plants
- Noting differences in varieties
- Thinning plants

Stages of Growth

- Observe stages of growth on plants
- Identifying plants in various growth stages
- Start from seed germination showing stages
- Effects of pruning on growth and flowering and root production
- Use of growth retardents

Crop Adaptation to Climate and Soil

- Plant response to different PH
- Use different soil types
- Change humidity and temperature
- Effect of temperature on germination

Weed and Seed Identification

- Grow weed seeds and use for ID
- Controlling weeds in flats

Seed Bed Preparation

- Mix soil from potting soil and vermiculite
- Prepare flat for seeding--check for firmness
- Control weeds

Planting Rate, Depth and Date

- Plant seeds to proper depth in flats
- Plant bedding plants so they will be ready in spring
- Mark rate and depth on planting stake

Germination Tests

Count seeds planting in a flat and see how many grow

Recommend Crop Varieties

- Use recommended varieties for area
- Grow different varieties to compare them
- Students explain difference in varieties to customers

Salesmanship of Farm Crops

- Students sell bedding plants

Soil Competencies Taught

The data in Table VI show the number of schools that were teaching soils competencies through the use of a greenhouse and how effective

it was in teaching these competencies.

TABLE VI

SOILS COMPETENCIES TAUGHT THROUGH THE USE OF A GREENHOUSE

Competency	No.	Yes	%	No	%	Low Effectiveness 1	2	3	4	High 5	Mean
Timing and placement of fertilizer	31	20	64.5	11	35.5	2	5	1	3	6	3.4
Amounts per acre	27	6	22.2	21	77.8		2	1	1	1	3.2
Substitute as to economic conditions	21	3	14.2	18	85.8		1	1			2.5
Take soil samples	29	14	48.2	15	51.8		1	3	3	5	4.4
Soil PH	30	20	66.6	10	33.4		3	4	4	5	4.0
Water movement in soil	29	20	68.9	9	31.1	2	2	3	7	5	3.6
Irrigation and drainage problems	29	18	62.0	11	38.0	1	1	3	4	5	3.8

Soils competencies were being taught with the use of a greenhouse. Teaching water movement in the soil was the competency with the highest percentage. It was taught by 68.9 percent of the respondents with teaching PH second with 66.6 percent. Substitute as to economic conditions received the lowest percentage taught with 3 or 14.2 percent having taught this competency. Substituting as to economic conditions also had the lowest effectiveness factor with a 2.5 on a one to five point effec-

tiveness scale. Taking soil samples had the highest effectiveness factor with a 4.4, while soil PH was second most effective with a factor of 4.

Methods of Teaching Soils Competencies Using the Greenhouse

The response to the question, "How is the greenhouse used to teach this competency?" was very poor. Teachers said yes, they were teaching it and in many cases quite effectively but many didn't tell how. Following are the responses that were given to how the soils competencies were taught, using the greenhouse:

Timing and Placement of Fertilizer

- Applying fertilizer at proper times to greenhouse plants
- Recognizing plants that need fertilizer
- Running fertilizer trials on bedding plants
- Using time release fertilizers

Amounts Per Acre

- Fertilizer trials on bedding plants

Substitute as to Economic Condition

- Use of mulch, manures, and compost

Take Soil Samples

- Students sample plots and bring samples from home to test - (Many indicated this was taught in the classroom)

Soil PH

- Check PH of potting soil

Water Movement

- Use glass growing shields to watch water movement
- Use different soil types
- Watering techniques in raising bedding plants
- Leaching of pots

Irrigation and Drainage Problems

- Use of different soil types in experiments
- Use of different systems such as drip, mister, or by hand
- Each student waters his own plants - it helps attendance - if student is gone his plants wilt
- Subject plants to standing water to determine strength and effect of plant to meadowland

Range Competencies Taught

Can range management competencies be taught with the use of a greenhouse, is a question the researcher would like answered. The data in Table VII shows how many schools were teaching range competencies through the use of a greenhouse.

TABLE VII

RANGE COMPETENCIES TAUGHT THROUGH THE USE OF A GREENHOUSE

Competency	No.	Yes	%	No	%	Low Effectiveness 1	2	3	4	High 5	Mean
Plant ecology and environment	30	13	43.3	17	56.7	1	3	4	1	3	3.2
Identify range plants	30	3	10.0	27	90.0		1	1		1	3.3
Range condition	28	1	3.0	27	97.0			1			3.0
Range trend	28	1	3.0	27	97.0			1			3.0
Range utilization	28	1	3.0	27	97.0			1			3.0
Grazing systems	28	1	3.0	27	97.0				1		4.0
Range modifications	28	1	3.0	27	97.0				1		4.0

The data in Table VII reveals work done in range management through the use of a greenhouse. As can be noted, plant ecology and environment was the major competency taught using the greenhouse. It was taught by 13 or 43.3 percent of the instructors with an effectiveness rating of 3.2. Ten percent or 3 out of 30 instructors, taught range plant identification using the greenhouse with effectiveness factor of 3.3. Only one instructor, or 3 percent, taught the following competencies: range condition, range trend, range utilization, grazing systems, and range modification. Grazing systems and range modifications had the highest

effectiveness rating with 4.

Methods of Teaching Range Competencies Through the Use of a Greenhouse

No response was given to using the greenhouse in teaching range management.

Agriculture Chemical and Pest Control

The data in Table VIII will identify the number of schools in this survey that were teaching agriculture chemical and pest control competencies through the use of the greenhouse.

TABLE VIII

AGRICULTURE CHEMICAL AND PEST CONTROL COMPETENCIES TAUGHT THROUGH THE USE OF A GREENHOUSE

Competency	No.	Yes	%	No	%	Low Effectiveness 1	2	3	4	High 5	Mean
Identify insects & crop diseases	29	22	75.8	7	24.2	1	2	2	6	8	3.9
Identify and classify insect damage	28	21	75.0	7	25.0	3	2	2	3	7	3.5
Identify seed borne diseases	28	9	32.1	19	67.9	1	1	3		2	3.1
Weed, pest and disease control	28	20	71.4	8	28.6	1	1	2	9	5	3.9
Weed growth habits	29	12	41.3	17	58.7	1	2	1	3	3	3.5
Recommend proper chemicals	28	17	60.7	11	39.3	1	2	1	5	5	3.8
Avoid residue problems	28	12	42.8	16	57.2	3	1	1	1	3	3.0
Advise customers as to chemicals	27	7	25.9	20	74.1	1	2		1	3	3.4

The data in Table VIII indicate the number of schools which taught agriculture chemical and pest control related competencies. Identifying insects and crop diseases were taught by 22 or 75.8 percent of the teachers and 21 or 75 percent taught students to identify and classify insect damage. Advising customers about chemicals had the lowest response with

7 teachers or 25.9 percent teaching it through the use of a greenhouse. Identifying insects and crop diseases and weed pest and disease control had the highest effectiveness rating with a 3.9 factor. Avoid residue problems had the lowest rating with an effectiveness factor of 3.

Methods of Teaching Agriculture Chemical and Pest Control Competencies With a Greenhouse

Following is a list of ways teachers said they were using the greenhouse to teach the competencies in Table VIII. Very few instructors responded to this part.

- Pest control in the greenhouse
- Soil sterilization and seed sterilization
- Raise weeds for identification
- Identify insects on bedding plants
- Students spray for insects

Chapter IV

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

Conclusions

Based on the data presented in Chapter III, the following conclusions have been formulated:

1. Vocational agriculture teachers operate greenhouses in many different ways. The conclusions on operational procedures were as follows:
   a. An average of 46 students, per program, utilized the greenhouse.
   b. School greenhouses ranged in size from 120 to 5,736 square feet.
   c. Greenhouses in vocational agriculture departments surveyed have been in use an average of 4.6 years.
   d. It cost an average of 1,113 dollars ($1,113) to operate a school greenhouse.
   e. An average of seven extra hours of the teacher's time per week was needed to operate the greenhouse.
   f. Fourteen out of 22 respondents had a greenhouse with a fiberglass covering.
   g. Solar heat was used by 25.8 percent of the schools greenhouses.
   h. The greenhouse was shared with another department in the school by 18.1 percent of the schools.

i. The greenhouse was used to help raise money for the FFA by 63.6 percent of the schools.

j. Seventy-five percent of the schools used their greenhouse for student's SOEP projects. An average of 13.5 students, per school, used it for their SOEP project.

k. Thirty out of 33 respondents used their greenhouse primarily for teaching Ornamental Horticulture. The other three schools used the greenhouse to teach primarily field crop production.

l. Eighteen schools out of 33 indicated their greenhouse was partially self-supporting. The average percentage self-supporting was 54.6 percent.

2. Competencies needed in field crop production were being taught through the use of the greenhouse.

3. There are many methods of using the greenhouse in teaching field crop production competencies. Methods of teaching the competencies in the four major areas of Field Crop Production studied are listed in the table of contents. Following is a list showing the number of methods returned in each of the four areas.

   a. Plant growth development and production had fifty-three different responses to methods used.

   b. Soils competencies had seventeen different methods returned. The seven soils competencies had 101 "yes" responses indicating in Table VI that schools were teaching the competencies

yet not many told what methods they were using.

c. No response was received concerning methods of teaching range management through the use of the greenhouse.

d. Teaching agriculture chemicals and pest control competencies had five different responses returned.

Implications

1. Extra teaching staff may have to be added to handle the extra time needed to operate the greenhouse.
2. The total vocational agriculture operating budget would have to be increased.
3. Students could learn many competencies needed in field crop production by raising and selling bedding plants. This would depend on the location in Montana and other greenhouses in the area.
4. Students could use the greenhouse for their occupational experience program.
5. The poor response to the methods of teaching soils competencies indicates that soils are taught as a result of working with plant growth in the greenhouse.

Recommendations For Further Study

The following recommendations are based on the researcher's findings and his knowledge gained from his study.

1. A curriculum guide for implementing the use of a greenhouse into

a Field Crop Production agriculture program in Montana needs to be developed.

Recommendations For Program Implementation

1. A greenhouse can be justified to teach the competencies needed in field crop production within a vocational agriculture program in Montana.
2. The size of the greenhouse would be determined by the finances available, community size, number of local greenhouses, and whether bedding plants were to be raised for sale.
3. Use of solar energy should be considered as a source of supplemental heat for the greenhouse.
4. If the greenhouse is of sufficient size, the students should raise bedding plants to sell. Many of the competencies they need to learn for Field Crop Production will be learned by doing this.
5. A double period should be allowed for the extra amount of student time required for working in the greenhouse. It might be found that there would be enough interest to offer a special Horticulture class. This would also help get some of the work done in the greenhouse and not put such a load on the crop production class.
6. A time table would have to be developed so that plants would be ready when needed for classroom use. Also, plants that were to

be sold would have to be ready when the public wanted to buy them. This would take some planning and would be a problem the first year.

7. Different types of field crops should be grown so they could be utilized in the field crop production class for such things as stages of growth or plant identification.
8. A special area could be set aside to grow perennial plants that could be used to show such things as types of leaves or types of reproduction.

APPENDIX

Robert G. Raver, Principal
Fergus High School

FERGUS HIGH SCHOOL
412 6th Ave. South
(406) 538-3448

LEWISTOWN JUNIOR HIGH
914 West Main
(406) 538-5168

GARFIELD SCHOOL
415 East Boulevard
(406) 538-3288

HIGHLAND PARK SCHOOL
1312 7th Ave. North
(406) 538-3942

LEWIS AND CLARK SCHOOL
212 Crystal Drive
(406) 538-8134

Ronald B. Mattson, Ed.D.
Superintendent of Schools
215 7th Ave. South
(406) 538-8777

School District No. 1

Lewistown Public Schools
Lewistown, Montana 59457

I am in the process of gathering information to develop guidelines for using the greenhouse in teaching field crop production in a high school vocational agriculture program in Montana. At the present time Montana has no established guidelines for the use of a greenhouse in a high school vocational agriculture program.

With your help I hope to accomplish this task. Your state Supervisor and teacher Educator indicated that you have a greenhouse in use in your school. I realize that most vocational agriculture programs are using their greenhouses primarily in teaching Ornamental Horticulture. I also realize that many of the things done in ornamental horticulture could be used in teaching production agriculture in Montana.

Enclosed you will find a questionnaire along with a stamped self addressed envelope. I would appreciate it if you would fill it out and return it to me as soon as possible.

Sincerely,

Dale W. Godfrey
VO-AG Instructor

Robert G. Raver, Principal
Fergus High School

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Ronald B. Mattson, Ed.D.
Superintendent of Schools
215 7th Ave South
(406) 538-8777

School District No. 1

Lewistown Public Schools
Lewistown, Montana 59457

I am in the process of developing guidelines for the use of a greenhouse in a production agriculture curriculum in Montana. I would like a list of the vocational agriculture programs in your state that have greenhouses.

I realize that most vocational agriculture programs are using their greenhouses primarily in teaching ornamental horticulture but that many of the things they are doing could be used in teaching production agriculture in Montana. I plan on sending questionnaires to vocational agriculture instructors in a seven state area in order to determine how greenhouses are being used. I will then use this information to develop a set of guidelines for integrating the use of a greenhouse in a production agriculture curriculum in Montana.

Would you please circle on the list enclosed, the vocational agriculture departments in your state that have greenhouses. If your state has guidelines or materials for the use of a greenhouse, I would appreciate a copy. Thank you for your time.

Sincerely,

Dale W. Godfrey
Vo-Ag Instructor

GREENHOUSE GUIDELINE SURVEY

Name _____ School _____ School Phone _____

1. Number of students served by the greenhouse? _____ 2. Size of greenhouse _____ 3. Number of years in use? _____ 4. Approximate cost of operation and upkeep per year? _____ 5. Do you use solar heat? Yes _____ No _____ 6. Type of construction? _____ 7. How many extra hours a week of your time does it require? _____ 8. Is it used by other departments? Yes _____ No _____ 9. Does your FFA use it for money making projects? Yes _____ No _____ 10. Is it used for students occupational experience programs? Yes _____ No _____ How many in 1978-79? _____ 11. Is your greenhouse used primarily in teaching horticulture? Yes _____ No _____ 12. Is your greenhouse used primarily in teaching field crop production? Yes _____ No _____ 13. Is your greenhouse expected to be partially self supporting through the sale of plants? Yes _____ No _____ What % _____.

Following is a list of curriculum areas taught in Montana Vocational Agriculture departments and some of the competencies, as indicated by producers that we should be teaching. Answer yes or no as to whether or not you are teaching these areas through the use of a greenhouse. If you answer yes would you give some brief ways you are teaching the competency. It would also be very helpful if you would send me a copy of any laboratory exercises you are using in teaching these areas. Finally rate the degree of effectiveness with 1 being low and 5 being highly effective.

PLANT GROWTH, DEVELOPMENT AND PRODUCTION

Competency	Yes	No	Effectiveness 1	2	3	4	5	How Greenhouse is used to teach Competency.
Soil Fertility (EXAMPLE)	x						x	Show nitrogen & phosphorus deficiencies in sand cultures
Plant propogation								
Planting & transplanting								
Plant breeding & reproduction								
Plant selection								
Stages of growth								
Soil fertilization & plant nutrition								
Crop adaptation to climate and soil								

Competency	Yes	No	Effectiveness 1	2	3	4	5	How greenhouse is used to teach competency
Plant ecology and environment								
Identify range plants								
Range condition								
(Range continued) Range trend								
Range utilization								
Grazing systems								
Range modifications								
Other								
Other								
Other								
AGRICULTURE CHEMICAL and PEST CONTROL								
Identify insects & crop diseases								
Identify & classify insect damage								
Identify seed borne diseases								
Weed, Pest & disease control								
Weed growth habits								
Recommend proper chemicals								
Avoil residue problems								
Advise customers as to chemicals								
Other								
Other								

Competency	Yes	No	Effectiveness 1	2	3	4	5	How greenhouse is used to teach competency
Weed and seed identification								
Seed bed preparation								
Planting rate, depth & date								
Germination tests								
Recommend crop varieties								
Salesmanship of farm crops								
Other								
Other								
Other								
SOILS COMPETENCIES								
Timing and placement of fertilizer								
Amounts per acre								
Substitute as to economic conditions								
Take soil samples								
Soil PH								
Water movement in soil								
Irrigation & drainage problems								
Other								
Other								
Other								
RANGE COMPETENCIES								

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BIBLIOGRAPHY

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