Progress Report of Asparagus Research
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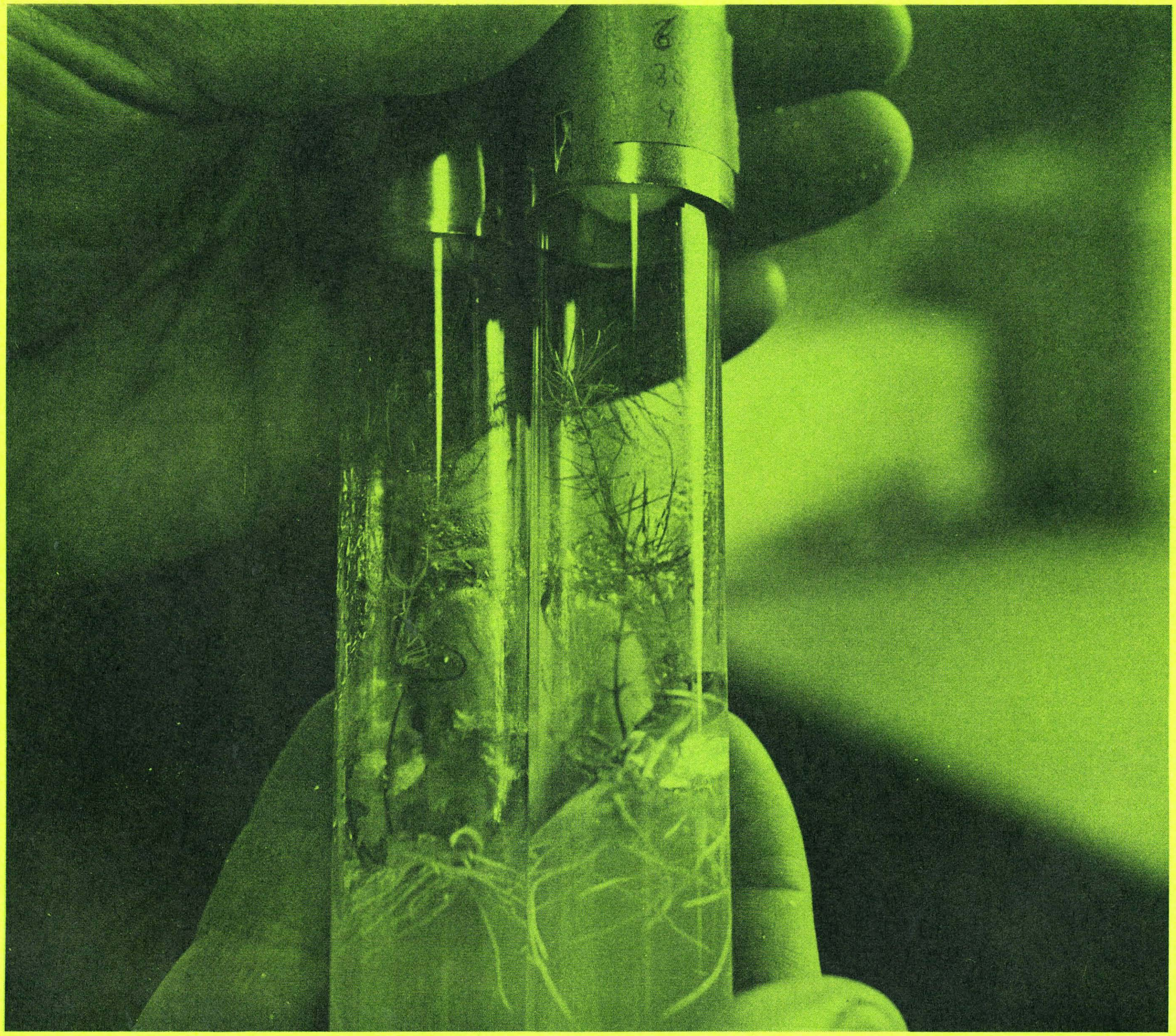
Progress Report of Asparagus Research[1]



Progress Report of Asparagus Research[1]

INTRODUCTION

The asparagus industry in Michigan is rapidly growing and has increased in acreage from 10,960 acres in 1959-63 to 18,493 in 1972.[2] With sales of $6 million in 1972, asparagus is one of the most important vegetable crops in Michigan and the state ranks third among all others in production.

Three quarters of the growers have 20 acres or less of asparagus. A quarter of the total acreage is 3-years-old or less with almost 2,000 acres planted in 1972.

[1] Many of the projects discussed in this report are partially financed by funds from the Michigan Asparagus Research Committee through the American Farm Bureau Research Foundation.

[2] Statistics on acreage and production are from the Michigan Asparagus Survey, "Acreage, Production and Marketing 1972" published by the Michigan Crop Reporting Service.

Mention of chemicals which perform effectively in research does not constitute a recommendation for their use.

Most asparagus in Michigan is snapped by hand but a small percentage is harvested with a nonselective sled-type harvester.

Approximately 93% of the asparagus produced is processed and 6% marketed through fresh market sales. Most processed asparagus is canned with a cuts and tips pack being the most prevalent product.

The purpose of this report is to provide the asparagus industry with information on the progress of research that will help maintain the industry's competitive position and therefore, increase the availability of this nutritious vegetable to the consuming public. The research is being conducted in the following departments: Agricultural Engineering, Botany and Plant Pathology, Entomology, Food Science and Human Nutrition, and Horticulture.

The report is divided into 2 sections. One concerns research on culture and breeding and the second harvesting and post-harvest handling.

the desired spacing and the following year the crowns would be dug and transplanted to the proper depth of 6 to 8 in. Two types of transplanters which will perform this task were built in 1972 by the Department of Agricultural Engineering.

Plow transplanter. A three point hitch, single bottom, 16-in. moldboard plow was used as the basic unit for a machine to lower the direct-seeded asparagus plant to the desired depth. The machine has a 24-in. rolling coulter placed in a horizontal position to cut a ribbon of soil from underneath the crowns and carry them to the furrow made by the plow.

Since the 16-in. bottom plow will not plow the first furrow to a depth of 9-10 inches a disc plow will be added to relieve the pressure against the moldboard (Fig. 2).

Lifter-transplanter. This machine lifts a ribbon of soil containing the crowns and places it on a conveyor. While the crowns are on the conveyor, a middle buster forms a trench into which the crowns are dropped (Fig. 3).

This machine is more complicated than the plow-transplanter but more flexible. If the stand is not uniform, an operator could drop crowns in the blank spaces and make applications of fertilizer or herbicide.

Planting Seed in a Furrow

In California, where direct seeding has been commercially successful, seeds are planted in the bottom of a trench which is gradually filled in. A machine using this technique is being developed by the Department of Agricultural Engineering. It uses a middle buster to form a furrow into which the seed is planted (Fig. 4).

Less fertile soil in the bottom of such furrows has been encountered at other research stations so a device to lift a ribbon of top soil and place it at the bottom of the furrow will be developed. Other operations such as fertilizer placement and pesticide application can be accomplished at the same time.

Weed Control[5]

A major problem when establishing asparagus fields by direct seeding is to control weeds in the first season. Better chemicals or combinations of chemicals are needed.

Most annual broadleaved weeds are adequately controlled with pre-emergence herbicides, but perennial weeds such as common milkweed, horse-nettle, field

[5] Investigator: Dr. Alan Putnam, Department of Horticulture
Cooperator: Dr. Melvyn Lacy, Department of Botany & Plant Pathology

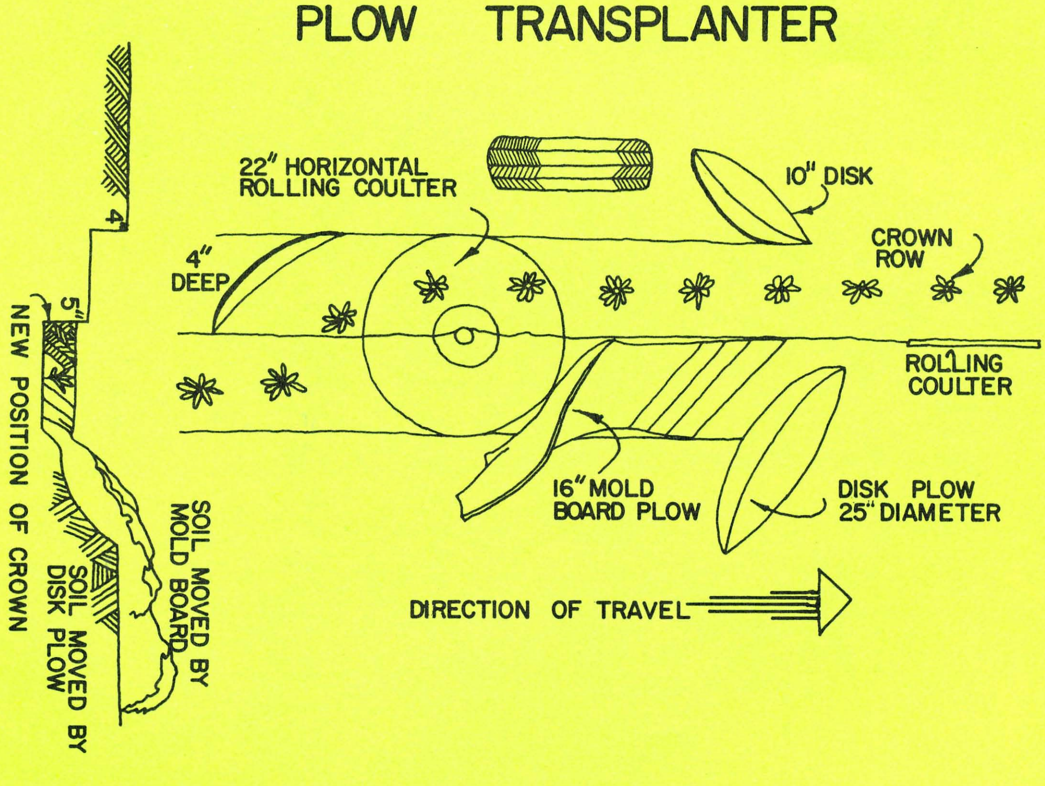


Fig. 2. Plow transplanter.

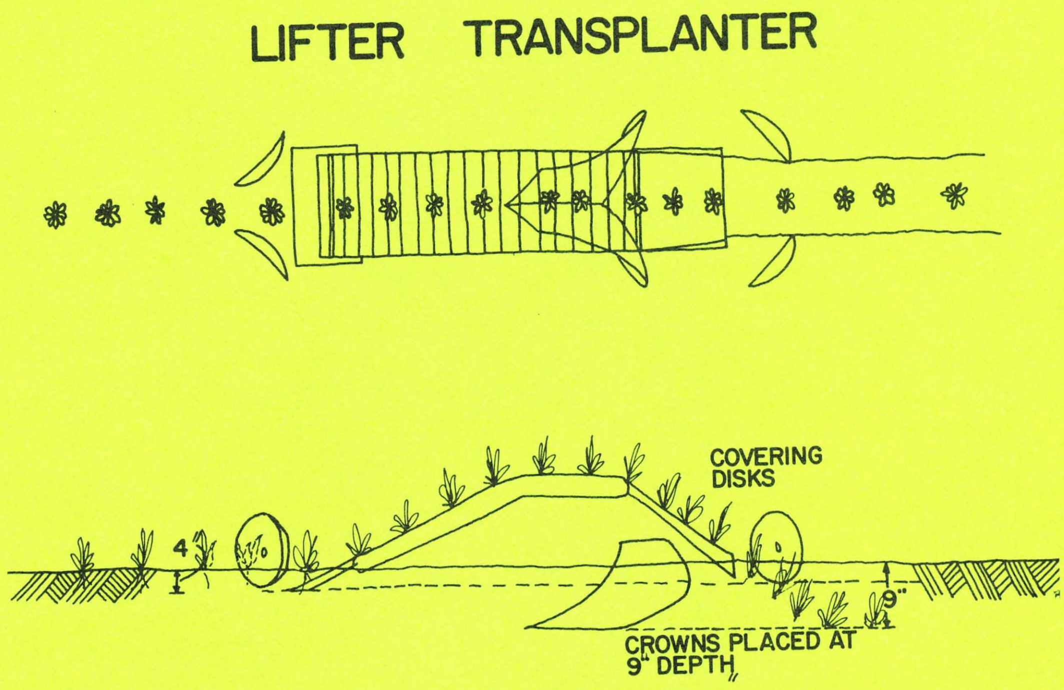


Fig. 3. Lifter transplanter.

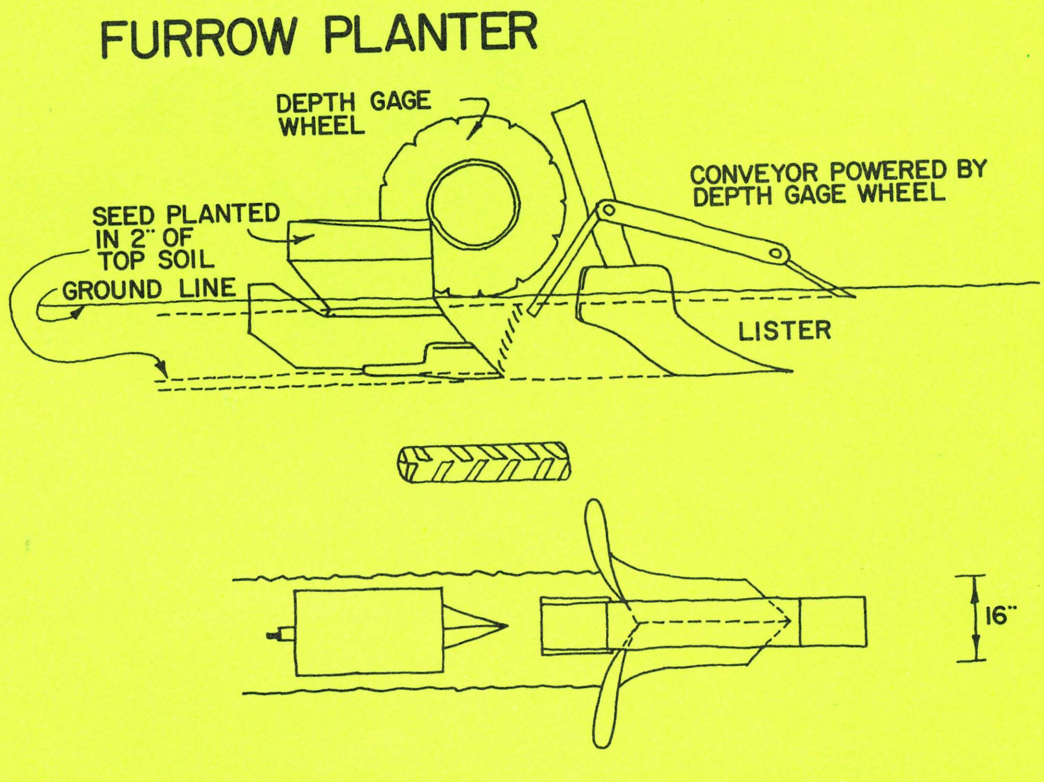


Fig. 4. Furrow transplanter.

bindweed, horsetail, Canada thistle and swamp smartweed are tolerant and have become more prevalent.

Annual grasses such as large crabgrass, sand bur, stink grass and fall panicum have also become serious problems in recent years. These weeds have seriously reduced crown vigor and in severe cases caused crown death in the field.

Control of Annual and Perennial Weeds[6]

Research has been directed at developing effective chemical control for the problem perennials and annuals as well as assisting in the securing of federal or state clearance of these chemicals for use by Michigan growers.

Numerous herbicides have been tested in East Lansing and several out-state locations with several being effective against perennial weeds while doing little or no damage to the asparagus. Dicamba (Banvel-D) and glyphosate (Roundup) gave good control of common milkweed, horse-nettle, swamp smartweed, and field bindweed when applied to foliage late in the harvest season.

The safety margin was good if the chemicals were applied immediately after a harvest, but there was considerable crop injury if applied later when fern growth was present.

Terbacil (Sinbar) or metribuzin (Sencor) applied in the spring, gave good season-long control of annual weeds, particularly the problem grasses. Terbacil also gave good to excellent control of horse-nettle and swamp smartweed.

Residue samples have been submitted to help obtain clearances for the most promising chemicals. Research in this area will be continued so that effective weed control of our problem perennials and annuals will be achieved.

In seeded asparagus, a new herbicide, methazole (Probe) gave excellent weed control with no crop injury. Season-long control was also obtained with preemergence applications of linuron (Lorox) + chloramben (Vegiben), linuron + DCPA (Dacthal), linuron + methazole, chloramben + DCPA, and chloramben + methazole.

Zero-Tillage System Improves Asparagus Growth and Yields

Cultural practices usually include a disking prior to the harvest season and often a second disking after harvest, prior to fern growth. These disking operations do a considerable amount of damage to emerging spears and to crowns which results in yield losses.

In addition, if shallow direct seeding is done, it would be impossible to use tillage equipment to incorporate dead fern or control weeds.

Research was conducted to compare zero-tillage versus the normal tillage practices in experimental plots in East Lansing. Asparagus (Calif. 711) grown from both seed and 1-year-old crowns was maintained in a zero-tillage system for 4 years and compared with that grown in a conventional tillage system. Yields of asparagus produced from crowns were increased 27% in the zero-tillage system for the first 3 harvest seasons (Table 2).

Table 2. Total asparagus yield and average spear size from crowns planted in 1967 and maintained under two cultural systems.

Year	Cultural system	Total yield* (lb. per A)	% of yield* over 3/8" diam.	Average wt.* per spear (g)
1969	Zero-tillage	692	72.5	11.8
	Disked	545	70.3	9.3
1970	Zero-tillage	1444	72.3	12.1
	Disked	1114	71.2	10.9
1971	Zero-tillage	1642	83.2	10.5
	Disked	1313	78.5	9.0
Average	Zero-tillage	1259	77.0	11.47
	Disked	991	74.2	9.73

*F value for each comparison within years is significant at the 5% level.

Yield after the third year was as high from seed as from crowns, but spear size was appreciably smaller (Table 3).

Table 3. Total asparagus yield and average spear size from seed planted in 1967 and maintained under two cultural systems.

Year	Cultural system	Total yield* (lb. per A)	% of yield* over 3/8" diam.	Average wt.* per spear (g)
1969	Zero-tillage	284	14.2	4.3
	Cultivated	278	16.1	4.3
1970	Zero-tillage	1055	30.1	5.1
	Cultivated	1039	34.9	4.9
1971	Zero-tillage	1908	50.8	5.4a
	Cultivated	1687	49.7	5.1b
Average	Zero-tillage	1083	40.9	4.93
	Cultivated	1001	41.5	4.77

*F value for comparisons within years not followed by the same letters are significant at the 5% level.

[6] Current weed control suggestions are found in E-433, Chemical Weed Control for Horticultural Crops.

Paraquat in combination with either simazine (Princep), monuron (Telvar), or terbacil (Sinbar) provided excellent weed control in the zero-tillage system during each growing season and with no injury to the asparagus. Rotary chopping returned mature brush to the soil satisfactorily. Advantages from zero-tillage included improved late season grass control, less mechanical injury to crowns and buds and a reduction in volunteer asparagus seedlings. (Fig. 5).[7]

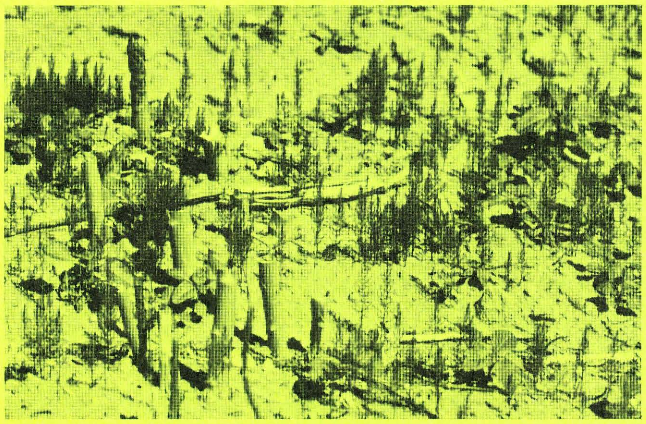


Fig. 5. View of soil surface in a 5-year-old asparagus planting. (a) Spring disking + simazine (note asparagus seedlings).

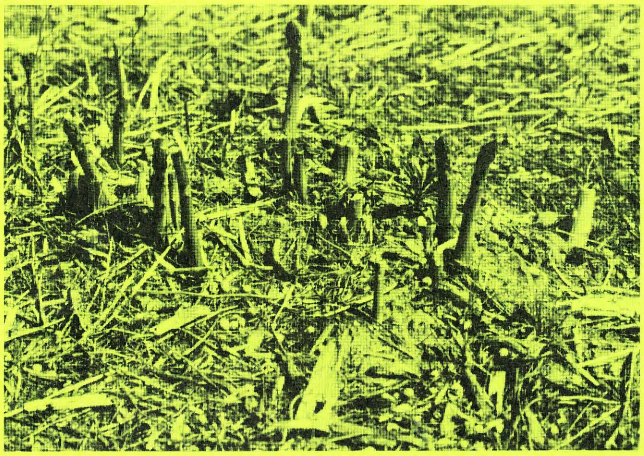


Fig. 5(b). Zero tillage receiving paraquat + simazine.

To evaluate this system on a commercial basis, experimental plots of 2 acres in size were established in Hart and Keeler, Michigan with plantings 10 to 13 years old. Three systems were investigated at each location: a) zero-tillage, b) spring tillage, and c) spring plus post-harvest tillage. The plots were harvested 21 times in 1972.

A 10% increase in yield was obtained with zero-tillage at the Hart location. This increase occurred in the early harvest period which probably indicates there was damage to emerging spears in tillage plots. There were no differences in yield at the Keeler location.

A more vigorous late-season fern growth was observed at both locations when post-harvest tillage was omitted. Late-season weed control was also superior in the zero-tillage areas (Fig. 6). Sand burs, crabgrass, and fall panicum were much less prevalent than in adjacent tillage plots.

Fig. 6. Late-season weed control in asparagus. Left — normal tillage. Right — zero tillage.

Differences in efficiency of fertilizer use, absorption of herbicides by decaying organic matter, excessive compaction on heavier soils as well as changes in disease and insect problems will be closely monitored in the future. Dr. Melvyn Lacy in the Department of Botany and Plant Pathology is attempting to determine if *Fusarium* root rot is more prevalent in tillage plots than zero-tillage plots.

DISEASE CONTROL[8]

A serious root rot problem exists in Michigan asparagus that can cause thinning of established stands and a serious decline in vigor of the surviving plants. Research was begun in 1972 to establish the nature of root rot and to gather information to enable establishment of a control program.[9]

[7] For a more detailed discussion consult the Journal of the American Society for Horticultural Science 97:621-624 (1972).

[8] Investigator: Dr. Melvyn Lacy, Department of Botany & Plant Pathology
Cooperators: Dr. Grant Vest, Department of Horticulture
Dr. Alan Putnam, Department of Horticulture

[9] Current disease control suggestions are found in E-312, Control of Insects, Diseases and Nematodes on Commercial Vegetables.

Identification of the Pathogen

The first step in this program was to find what *Fusarium* species are in Michigan fields. Several diseased asparagus crowns were tested for the presence of pathogenic fungi in 1972 and all yielded cultures of *Fusarium*, the cause of root rot.

There are two species of *Fusarium*, that cause root rot in Michigan, *Fusarium oxysporum* f. sp. *asparagi* and *Fusarium moniliforme*. A culture of each *Fusarium* species was tested on Michigan Select asparagus at soil temperatures of 61°, 68°, 75° and 82° F. Root rot severity increased with soil temperatures up to 82° for both cultures.

Seed Treatment

While developing a program for resistance to *Fusarium* it was discovered that seedlings which were not inoculated with *Fusarium* also became infected. *Fusarium* root rot organisms were carried on the surface of the seed.

A sample of Michigan Select seed from the Sodus Horticultural Experiment Station was found to have 10% to 20% of the seed carrying *Fusarium*. Much of the seed produced today may already carry the *Fusarium* organism on the seed surface and unless the seed is treated, fields could be inoculated with the organism.

Methods of seed treatment to control the *Fusarium* organisms were tested. A 20 minute soak in a 20% chlorox solution freed the seed of *Fusarium*. Fungicides, including Captan, Arasan and Benlate were tested for control of *Fusarium* and injury to the seedlings. Captan appeared to be best but work will continue to verify the best treatments.

Screening for Resistance and Tolerance of Fusarium

A screening test is being devised to determine resistance and tolerance of cultivars to *Fusarium*. There will be tests for tolerance or resistance to both strains of *Fusarium*. Already, seedlings of Michigan Select, Calif. 500, Calif. 309 and Calif. 66 asparagus were inoculated with *F. oxysporum* f. sp. *asparagi* and *F. moniliforme* and all four were susceptible to the cultures used in greenhouse tests.

A plot of land at the Botany and Plant Pathology farm was inoculated with both *Fusarium* species and planted with asparagus. This plot will be a testing ground for determining resistance of asparagus selections.

The effect of tillage vs. no-tillage systems on *Fusarium* root rot severity are being evaluated with the cooperation of Dr. Alan Putnam of the Department of Horticulture.

INSECT CONTROL[10]

In the spring of 1971 and 1972 a heavy infestation of white cutworms *(Euxoa scandiens)* and the bristly cutworms *(Lacinipolia renigera)*, caused considerable damage to emerging asparagus in Oceana County (Fig. 7). Initial spray applications of insecticides were unsuccessful, so a program was begun to study the insect, its life cycle and its control.[11]

Fig. 7. White cutworm *(Euxoa scandiens)* on asparagus.

Study of the Insect's Life Cycle

The pupation of these cutworms begins in early June, and is followed by the adults depositing eggs. They feed on small volunteer seedlings in early fall. Based on the white cutworm moth flight activity shown in Fig. 8 its larval populations reach a peak between mid- and late August. This suggests the use of fall applications for control of these insects.

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[10] Investigator: Dr. Donald Cress and Prof. Arthur Wells, Department of Entomology

[11] Current insect control suggestions are found in E-312, Control of Insects, Diseases and Nematodes on Commercial Vegetables.

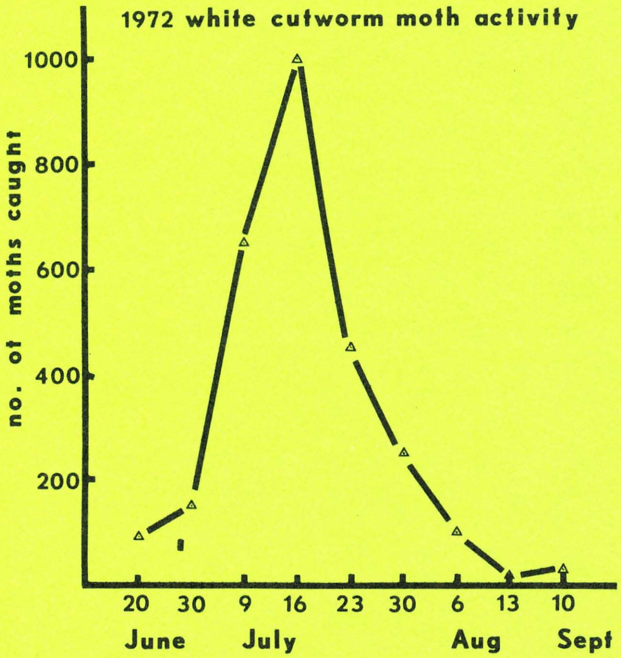

Fig. 8. Moth activity in Oceana County of the white cutworm *(Euxoa scandiens).*

However, a more complete study of the seasonal development of the white and bristly cutworms will help plan the best controls for these insects. The following information is needed:

1) Adult behavior and response to black light traps to establish population area distribution.

2) Mating and egg laying habits upon asparagus fern vs. other vegetation.

3) Larval development, including fall overwintering and spring activities to determine timing for insecticide application.

4) Where, when and what is the duration of pupation.

Insecticides and Formulations

Since initial spray applications of Sevin and Methoxychlor with boom and air blast applicators were unsuccessful, other insecticides, formulations and methods of application were investigated.

Bait formulations of Sevin and several other insecticides provided some control of the cutworms. Unfortunately, Sevin is the only insecticide registered and the bait formulations were difficult to obtain. Of the "inert" portions of the baits examined, citrus and apple pomace were much more effective than corn cobs. Yet, the corn cob bait with Sevin was the only type of bait readily available.

Granule and wettable formulations of several insecticides were examined for possible fall application and dead larvae were observed as a result of several of these.

Future research will include the following:

1) Biological control of the cutworms through natural predators and parasites and diseases such as *Bacillus thuringiensis.* Ten percent of the larvae were parasitized in the spring of 1972.

2) A detailed study on the effect of changing cultural practices such as zero-tillage vs. tillage and their effects on the surface feeding insects.

3) Evaluation of insecticides for pest management including granular formulations on the soil surface or incorporated, spray formulations on the surface, bait formulations as attractants for larval control and methods for application of materials.

Influence of Soil Aeration on Productivity of Established Asparagus[12]

A lack of soil aeration may be involved in the decline of asparagus yields, especially in older fields and heavier soils. As a result, the following work has been initiated.

Survey of Soil Oxygen Levels

A method for removing gas samples close to asparagus crowns was developed and sampling stations were established at the Sodus Horticultural Experiment Station. Laboratory analysis of gas samples determined the oxygen and carbon dioxide levels at crown depth and changes were monitored during the season.

Soil atmosphere samples were taken both near and at some distance from the crowns. Preliminary results showed little change in oxygen content close to the crown, but carbon dioxide levels increased up to fourfold during the harvest season. Carbon dioxide levels appeared to decrease after the harvest season when fern growth began and stabilized at about 0.4%. This study will be continued to gather more information concerning the soil atmosphere at crown depth.

Furrow Amendment Study

In an attempt to improve the soil structure and increase the oxygen content in the soil, the following treatments were compared when applied to the bottom of furrows and incorporated lightly before planting 2-year-old crowns (cv. Mary Washington).

1) peat moss — 3 tons per A

[12] Investigator: Dr. Hugh Price, Department of Horticulture
Dr. Robert Carolus, Department of Horticulture
Cooperator: Prof. C. M. Hansen, Department of Agricultural Engineering.

2) mushroom manure — 3 tons per A

3) turface (coarse) — 3 tons per A

4) no treatment

The furrow amendment plots will be maintained and data collected concerning the effects of the treatments on the asparagus.

Subsoiling to Improve Soil Aeration

The possibility of using subsoiling to improve or increase soil aeration will be investigated in commercial fields with the cooperation of Professor C. M. Hansen of the Department of Agricultural Engineering.

HARVESTING AND POST-HARVEST HANDLING

Growth Characteristics and Prediction of Time of Harvest[13]

Although most of Michigan's asparagus crop is hand harvested, there may be a shift to nonselective sled-type harvesters. Growers with large acreages may have no choice but to change over if asparagus prices were to decline and/or if labor becomes less available and more expensive.

Experience of growers and researchers with the sled harvester has shown that timing of harvest is very important for obtaining high yield and quality of asparagus. This is especially true during hot weather when growth of asparagus is very rapid. As a result, a project was initiated to develop a method growers could use to estimate time of harvest based on predicted temperatures and known growth rates at those temperatures.

Growth of individual asparagus spears was determined from measurements taken between 8-9 a.m. and 4-5 p.m. on 500 spears at the MSU Horticultural Research Center between May 8 and June 6, 1972. Hourly air temperatures were taken and the average air temperature calculated.

It was found that rate of spear growth increased as the average air temperature increased. It was also found that the taller a spear was the faster it grew. There was an average temperature below which spears would not grow and the taller the spear the lower this temperature had to be.

There was a definite day-night difference in growth rate (Table 4). When the temperature was above 55° F, spears grew more between 8 a.m. and 4 p.m. (8 hours) than from 4 p.m. to 8 a.m. (16 hours). Asparagus growing at temperatures averaging above 70° F appeared to grow more slowly than when the temperature was in the 60° to 70° F range.

[13] Investigator: Dr. Larry Segerlind, Department of Agricultural Engineering

Table 4(a) Growth of asparagus spears in inches as related to spear height and average air temperature (80% level)[b]

Initial Height, Inches	AVERAGE AIR TEMPERATURE, °F 50 day[c]	50 night[c]	60 day[c]	60 night[c]	70 day[c]	70 night[c]	80 day[c]
5.0	0.45	0.65	2.00	1.30	2.55	1.85	2.35
6.0	0.55	0.80	2.35	1.55	2.85	2.05	2.55
7.0	0.70	1.00	2.70	1.80	3.20	2.30	2.80
8.0	0.80	1.15	3.05	2.00	3.55	2.55	3.05
9.0	0.95	1.35	3.45	2.25	3.85	2.75	3.30

[a] Based on data taken at East Lansing, Michigan and not necessarily applicable to other regions.

[b] Eighty (80) percent of the spears will grow less than the amount indicated in the table.

[c] Day growth between 8 a.m. and 4 p.m. (8 hrs.)
Night growth between 4 p.m. and 8 a.m. (12 hrs.)

The next step is to collect more data, develop easy, quick field sampling techniques and use the data to develop tables or graphs to predict time for mechanical harvest.

Toughness of Asparagus

Next to appearance, fiber content is the most important quality factor in asparagus. Fiber develops in the fibrovascular bundles and the pericycle of the asparagus stem with development at its greatest near the basal portion of the spear.

Hand snapping the spear, theoretically, leaves most of the fibrous material in the field with the spear breaking at the point where fiber content becomes objectionable. In practice, most hand harvesters snap the spear near the ground resulting in spears with varying degrees of fibrousness at the butt end.

In addition, the potential increase in use of the nonselective sled-type harvester might result in fibrous asparagus since it would cut all asparagus at the same height. The amount of fibrousness would depend upon the height of the asparagus and the cutting bar level.

Fiber Determination[14]

To study the effect of spear length and diameter on fiber content, asparagus was harvested at nine different times during the 1970 season from a commercial field near Jackson, Michigan. The spears were cut at ground level and sorted into length categories of 4-6 in., 6-8 in., 8-10 in., 10-12 in. and 12-14 in.

[14] Investigator: Dr. Robert C. Herner, Department of Horticulture

Within each length category, spears were subdivided further into diameter categories of less-than-3/8 in., 3/8-1/2 in., 1/2-5/8 in. and 5/8-3/4 in. Samples were taken from three distinct areas giving three replications in each category for each harvest. Five spears in each category were frozen, later cut into 1-in. segments and analyzed for fiber.

Other investigators have shown that the percentage of fiber and not absolute amounts of fiber correlated best with taste panel tests for toughness. The percentage fiber as related to length and diameter is shown in Fig. 9.

In all cases, smaller diameter spears had a higher percentage of fiber than larger diameter spears. For instance, spears less than 3/8 in. in diameter had up to 3 times the percentage of fiber as those with 3/4 in. at a comparable distance from the tip.

Asparagus with 0.25% fiber or above was considered objectionable. As can be seen in Fig. 10, long spears had more usable spear with low levels of fiber (less than 0.25%), but also had more inches at the fibrous basal end.

A sled-type nonselective harvester would cut all spears 2.5-3 in. from ground level. This means spears taller than 10 in. would have considerably higher levels of fiber in the basal ends of the spears. Growers using a sled-type harvester should harvest the asparagus at the proper time to minimize the number of spears greater than 10 in. in height.

It was observed that low temperatures occasionally increased the fiber content but this effect was not consistent. Probably many other environmental factors affect fiber development besides temperature.

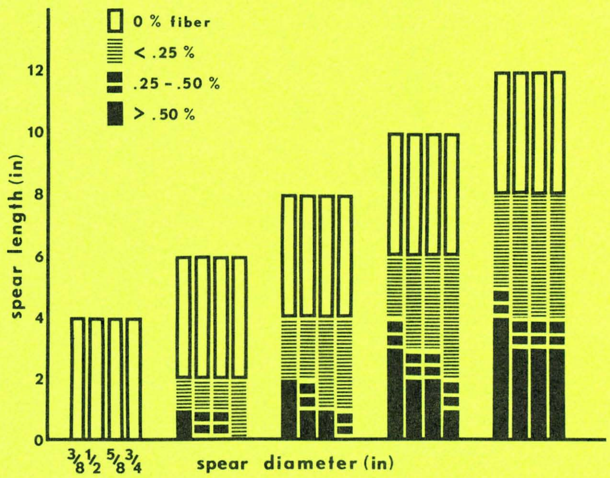

Fig. 10. Fiber content of spears. Percentage fiber greater than 0.25% is undesirable.

Physical Measurements of Toughness[15]

To further investigate the relationship between spear length and temperature during growth with

[15] Investigator: Dr. Larry Segerlind, Department of Agricultural Engineering

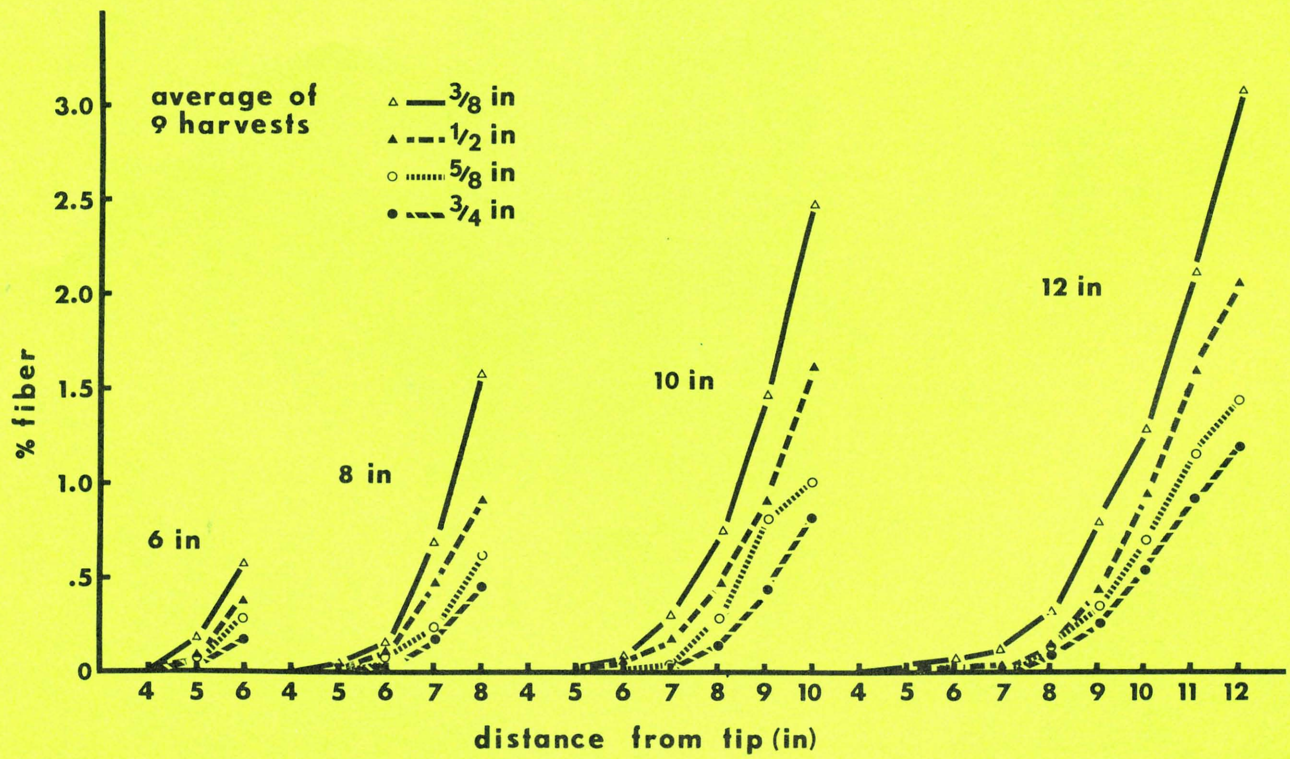

Fig. 9. Comparison of % fiber, length of spear, and diameter of spear.

fiber, asparagus spears were cut at ground level when their heights were between 8 and 15 in. The asparagus was harvested in 1971 and '72 at the MSU Horticultural Research Center and temperatures were recorded continuously.

Toughness of spears was measured by monitoring the force required to cut through them with a ⅛ in. blade by use of a Kramer shear cell. The speed of the blade, 5 in. per minute, was controlled by an Instron testing machine.

Cuts were made at 1.0 in., 2.5 in., 4.0 in., 5.5 in., 7.0 in., 8.5 in., 10.0 in., 11.5 in., 13.0 in., and 14 in. from the basal end. The shear force needed at various distances from the base of a typical spear is shown in Fig. 11.

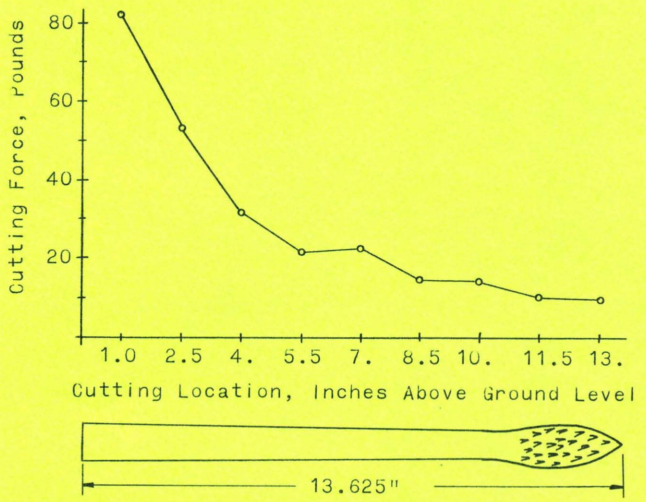

Fig. 11. Cutting force in pounds versus the distance above ground level of the cut.

The percentage of the 1.5-in. segments which contained unacceptable levels of fiber is related to the height of spears as shown in Table 5. The results of all data indicate no consistent trend between average growth temperature and the fiber content of asparagus. The percentage of unacceptable pieces, however, was directly related to spear height. There were almost five times as many unacceptable pieces in spears 10.5-12.0 in. long as those 9.0-10.5 in.

The cutting height would be very important since lowering it from 2.5 in. to 1.0 in. above ground would cause a very large increase in the percentage of unacceptable pieces. This suggests that lowering the cutting height of the sled-type harvester or improper snapping at ground level could greatly increase the percentage of fiber in the asparagus.

When long spears were trimmed back to a length of 7.5 in., the percentage of unacceptable pieces was greatly reduced. The percentage of unacceptable pieces of spears in 10.5-12.0 in. or 12.0-13.5 in. categories could be reduced to 0.6% and 0.1%, respectively. This suggests that trimming of long spears would help reduce toughness in the final product.

Table 5. Relationship between the average growth temperature and the percent of unacceptable segments. Values in parentheses include the cut made at 1 inch above the ground while other data excludes this cut. 1972 data.

Length of spear	Number of Segments	AVERAGE TEMPERATURE 49-54	55-59	60-64	65-69	Average
7.5- 9.0	4	1.9 (20.0)	0.0 (15.6)	0.0 (18.0)	0.7 (10.6)	0.7 (14.1)
9.0-10.5	5	2.0 (16.0)	0.0 (14.8)	0.0 (14.7)	1.0 (13.7)	1.0 (14.6)
10.5-12.0	6	7.7 (20.5)	5.1 (18.0)	4.2 (17.3)	4.4 (16.6)	5.4 (18.0)
12.0-13.5	7	7.1 (18.1)	9.9 (21.2)	9.0 (19.7)	8.6 (19.5)	8.7 (19.7)
13.5-15.0	8	14.8 (24.2)	15.6 (25.0)	5.7 (16.2)	13.3 (22.9)	13.1 (22.8)

Fiber in Processed Asparagus[16]

Asparagus was harvested five times from a commercial field in Jackson, Michigan in the same manner as in the fiber determination study and subdivided into categories of length and diameter. The spears within each category were cut into 1.5-in. segments, which were grouped according to their linear distance from the tip of the spear, canned and later evaluated for fibrousness.

Every canned segment was evaluated using the USDA "fork test." The percentage of tough segments for each height are shown in Fig. 12.

The strong influence of cutting height on fibrousness is evident in processed asparagus. Although clear-cut relationships have been shown between the fibrousness and the factors of spear height and cutting height, additional data are needed to determine their effect on yield.

Sorting Fibrous and Non-Fibrous Asparagus[17]

The primary causes of fibrous pieces in asparagus appear to be: 1) spears longer than 7.5 inches and 2) spears which are harvested too close to the ground. Because asparagus grows very fast in hot weather,

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[17] Investigator: Dr. Larry Segerlind, Department of Agricultural Engineering

there are times when harvesting cannot keep up with growth and long spears result. It is also difficult to control the snapping height of hand harvested asparagus.

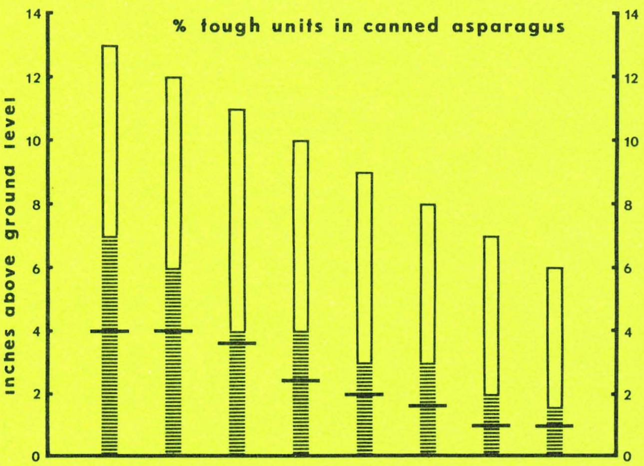

Fig. 12. Percentage of tough units in canned asparagus of spears of various lengths. Shaded portion indicates some tough units when these portions were processed. The horizontal bars indicates that those portions of the spear below it would contain greater than 10% tough units.

Possibly some method could be devised to sort out fibrous from non-fibrous pieces before processing. The following methods have been investigated.

1) Puncture Test — This test measures the force required to puncture an asparagus segment with a 0.013-inch diameter, square end probe. An Instron machine regulated the rate of movement (5) inches per minute) and measured the puncture force. Results indicated the puncture force was not a reliable method to separate fibrous and non-fibrous pieces.

2) Weighted Knife — This method used a weighted knife designed so that a tough part of a spear could pass through the cutting device without being cut into pieces. This method was also inconsistent in its results.

Controlled Atmosphere Storage of Asparagus[18]

In a preliminary test in the spring of 1971, asparagus was harvested from a commercial field and stored at 36° F under two atmospheres; normal air and controlled atmosphere with 5-6% CO_2 and 2-3% O_2. Samples were observed several times over a 4-week period. The controlled atmosphere appeared to benefit asparagus with respect to fibrousness, color, and disease control.

More controlled atmosphere storage studies were carried out in 1972 by the Department of Food Science and Human Nutrition with similar results. However, attempts to achieve microbial control through a pre-storage chlorine treatment were unsuccessful. Yet, storage with the basal ends of spears immersed in water was highly beneficial, particularly when combined with a controlled atmosphere.

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Cooperators: Dr. Clyde Burton, U.S.D.A., Department of Botany and Plant Pathology
Dr. Robert Herner, Department of Horticulture

Research Units of the Michigan Agricultural Experiment Station

(1) Upper Peninsula Experiment Station, Chatham. Established 1907. Beef, dairy, soils and crops. In addition to the station proper, there is the Jim Wells Forest.

(2) Dunbar Forest Experiment Station, Sault Ste, Marie. Established 1925, forest management.

(3) Lake City Experiment Station, Lake City. Established 1928. Breeding, feeding and management of beef cattle; and fish pond production studies.

(4) Graham Horticultural Experiment Station, Grand Rapids. Established 1919. Varieties, orchard soil management, spray methods.

★ Michigan Agricultural Experiment Station, Headquarters, 101 Agriculture Hall, MSU, East Lansing. Established 1888. Research work in all phases of Michigan agriculture and related fields.

(6) Muck Experimental Farm, Laingsburg. Plots established 1941, crop production practices on organic soils.

(7) South Haven Experiment Station, South Haven. Established 1890. Breeding peaches, blueberries, apricots. Small fruit management.

(8) W. K. Kellogg Farm and Bird Sanctuary, Hickory Corners, and W. K. Kellogg Forest, Augusta. Established 1928. Forest management, wildlife studies, mink and dairy nutrition.

(9) Fred Russ Forest, Cassopolis. Established 1942. Hardwood forest management.

(10) Ferden Farm, Chesaning. Plots established 1928. Soil management, with special emphasis on sugar beets. (Land Leased)

(11) Montcalm Experimental Farm, Entrican. Established 1966. Research on crops for processing, with special emphasis on potatoes. (Land Leased)

(12) Sodus Horticultural Experiment Station, Sodus. Established 1954. Production of small fruit and vegetable crops. (Land Leased)

(13) Trevor Nichols Experimental Farm, Fennville. Established 1967. Studies related to fruit crop production with emphasis on pesticides research.

(14) Saginaw Valley Beet and Bean Research Farm, Saginaw. Established 1971. Studies related to production of sugar beets and dry edible beans in rotation programs.

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