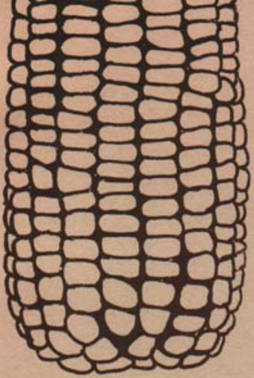
Michigan Corn Production Hybrid Selection and Cultural Practices
Michigan State University Extension Service
S.C. Hildebrand, E. C. Rossman, Crop Science; L.S. Robertson, Soil Science
Issued September 1964
8 pages



September, 1964
625.1

Extension Bulletin 436 Farm Science Series

Michigan Corn Production

HYBRID SELECTION AND CULTURAL PRACTICES

COOPERATIVE EXTENSION SERVICE
MICHIGAN STATE UNIVERSITY

S. C. Hildebrand and E. C. Rossman
Department of Crop Science
L. S. Robertson
Department of Soil Science

Corn is Michigan's most important field crop. To grow it profitably depends on doing many things correctly at the best time. Failure at any point in the time schedule results in a lower yield and frequently in lower quality grain.

Set a yield goal

A goal is desirable as a basis for making the best decisions for growing the crop. It takes more nutrients and a higher plant population for a 100-bushel per acre crop than it does for 75 bushels. A goal should be based on (1) past experience, (2) characteristics of the soil, and (3) the ability to use modern production practices. In setting a high yield goal, consider that the odds are high that lack of rainfall will limit yields.

Selecting corn hybrids

The main points to consider in selecting corn hybrids are: (1) yield, (2) maturity, and (3) lodging resistance. Whether the corn is to be used for grain or silage, or both, will determine which points to emphasize.

Information for selection may come from:

- Experience with hybrids on your or neighbor's farm.
- Local corn hybrid demonstrations.
- Tests conducted at out-state locations by Michigan State University.

Results from one field of corn should not be compared with another. Fertility variation in a field and plant population per acre can cause considerable differences in yield. Experience with local demonstrations has clearly shown that two hybrids grown in different parts of the same field should not be compared.

Results from corn performance trials conducted at 12 to 14 locations in Michigan are reported annually in Michigan State University Extension Bulletin 431, Farm Science series, Corn Hybrids Compared. Information on yield, maturity (as measured by moisture content of the grain at harvest), and the percent of stalk lodging are presented. In evaluating the test results, one year's data are only an indication and at least 2 years' data are necessary to make a good decision.

In Corn Hybrids Compared, consider maturity first, then refer to yield and lodging resistance. The map shows the state of Michigan divided into general zones based on maturity or growing season. Test locations are indicated on the map. Results are listed in the tables in order of maturity with the earliest hybrids first. For grain, select (1) the hybrids which have average or below average moisture and (2) the highest yielding with the lowest percent of stalk lodging from the early maturing group. See Table 1.

Table 1 — Performance of Corn Hybrids in North Central Michigan

Hybrid	% Moisture	Bushels per acre	% Stalk lodging
202	22	58	4
250	22	67	4
300	24	74	6
370	26	74	4
400	26	82	3
430	27	69	5
62	27	76	8
425	27	79	3
251	29	76	5
490	30	75	6
Averages	26	74	5

Note: Select highest yielding hybrids from the group enclosed in the box above.

Table 1 shows that a good yield does not always depend on late maturity. A difference in the table of one percent moisture at harvest means about two days difference in maturity.

Early maturing hybrids have these advantages:

1. Usually mature before a killing frost.
2. Lower moisture content at harvest permits safer storage.
3. Permits earlier harvest when weather is more favorable, field losses are less, there is less wear and tear on harvesting machinery and less danger of accidents.

Other considerations in hybrid selection are:

1. Choose the earliest hybrids for late planting, soils of low fertility, and for sandy and organic soils.

2. Choose more than one hybrid with small differences between them in maturity. This spreads the harvest load over a longer period and gives greater flexibility to the corn program. It becomes more important as the corn acreage per farm increases.

3. In selecting hybrids for silage choose a slightly later hybrid than for grain, but one that has high yielding ability for grain production. The later hybrids usually produce more fodder and, therefore, more total silage. Corn for silage should reach the early dent stage before frost.

4. Try some new hybrids which tests show to be promising for your area. These should be checked for yield in the same field and at the same plant population as the hybrids now being used. Do not judge on appearance—judge on the basis of production.

Selecting and preparing seed

There are many sizes and shapes (grades) of seed corn which are generally grouped as regular and medium flats, large and medium rounds, and smalls. The flats are more popular than rounds for regular planting. With high quality seed, the germination of any of these sizes and shapes is satisfactory. In general, the rounds run slightly lower in germination than flats. Under optimum conditions all sizes and shapes give acceptable stands. If weather conditions are backward the large and medium sizes are preferred because they contain more stored food than smaller sizes. The seedlings use food stored in the seed until they emerge from the soil and begin photosynthesis. Obtain seed which is uniformly sized since this contributes to accuracy in planting and in selecting the proper planter plates.

Most seed corn offered for sale in Michigan has been treated with a fungicide for the control of seedling diseases. Seed treatment has special importance when early planting is practiced. If the seed has not been treated with a fungicide, it should be treated before planting. Most of the acceptable fungicides include Thiram or Captan as the active ingredient. Follow the directions of the manufacturer of the fungicide as to rate and method of treatment.

For good success with early planting, seed should have a high "cold test" germination. Germination test results shown on the seed tag indicate what the seed will do under optimum conditions of moisture and temperature. With early planting, seed germinates under conditions somewhat less than optimum since temperatures may be lower and the soil may be wet. These conditions place the seed under stress and put a premium on seed quality.

If a "cold test" germination is not available from your seed dealer, you can run a test. Soak folded layers of newspaper in water and spread out on a flat surface. Cover with ¼-inch layer of soil from last year's corn field. Evenly space 100 kernels of seed corn on the soil and roll the newspaper lightly into a doll. Place in the cooling compartment of your refrigerator (about 45-50°F.) for 7 days. Remove and store at room temperature for another 7 days. Unroll the doll and count the seeds with healthy and vigorous top and root shoots. One should not expect to have as high a "cold test" reading as is shown on the seed tag; a good reading might be 10 to 20 percent less.

Continuous and rotation corn

No experimental data are available in Michigan comparing long time corn after corn yields with those produced in a rotation. Data from the Morrow plots in Illinois show that under their conditions the most profit from field crops could be made from corn grown continuously rather than from corn grown in a rotation. Observations of fields in Michigan on which corn has been grown continuously for 10 to 40 years suggest that this practice may be practical under certain conditions.

1. On level, well-drained, fertile soils with a good supply of organic matter it is entirely feasible to grow corn after corn for several years. Where this practice is followed, the soils are usually silt and clay loams. Sandy loam soils with a good supply of organic matter also may be suitable for continuous corn production.

2. Only limited success has been obtained with continuous corn on hilly fields, fields with long, gradual slopes, sandy soils, or soils classed as "poor corn soils" because they have poor drainage, are droughty, or are low in organic matter. Such soils are better suited to growing other crops with an occasional corn crop in the rotation.

3. To be successful with continuous corn:

- Leave all of the corn stalks on the fields after harvest for plowing under later. If this cannot be done, as in harvesting for silage, apply manure. A 100 bushel per acre corn crop will contribute about 3 tons of dry matter as leaves, stalks, and husks. This amount of material, plus about 2 tons of roots, should maintain the organic content of the soil but sufficient nitrogen should be made available for breakdown of the material by soil micro-organisms.

- More nitrogen fertilizer should be used than in a rotation where a legume crop is plowed down or manure applied.

4. Growing corn continuously on the same field especially where low yields are produced may result in:

- More competition from weeds.
- More difficulties with some insects.
- Less desirable physical condition of the soil.
- Potential build-up of corn diseases—has not been clearly demonstrated yet.
- High soil erosion losses on hilly fields and fields with long, gradual slopes.

To avoid some of the problems associated with continuous corn, change to a different crop every 3 to 5 years.

The data shown in Table 2 suggests that crop rotation may influence corn yields as much as 30 bushels per acre. The same amount of fertilizer was used and minimum tillage principles were followed in each rotation.

The effect of the rotation upon corn yields was primarily differences in the soil structure that developed as a result of the rotation. The soil of the lowest yielding rotation does not have as stable a structure as that of the high yielding rotations. The crop rotation with the greatest amount of organic matter plowed down produced the highest yields.

Preparing land for planting

Soil serves the corn crop as an anchoring medium and as a source of plant nutrients, water, and oxygen.

Table 2 — Corn yields as affected by five systems of farming on a Sims sandy clay loam soil.

Crop Sequence	Bushels per acre (5 year average)
Beans, wheat, sweet clover (1), sugar beets, corn (2)	121.4
Soybeans, wheat (3), beans, sugar beets, corn (2)	118.2
Sugar beets, beans, wheat, alfalfa, corn	104.9
Sugar beets, barley, beans, wheat, corn	92.4
Beans, wheat (3), soybeans, sugar beets, corn (2)	110.8

(1) oat cover crop seeded in August plowed land
(2) green manure mixture seeded in corn
(3) green manure mixture seeded in wheat

The purpose of soil preparation is to provide a loose, and well-aerated soil which allows excellent penetration of air, water, and roots. Therefore, the goal in land preparation for corn should be to create a soil condition to meet these requirements.

A good job of plowing seems essential to soil preparation for corn. This is frequently the first step in preparation, although it is sometimes necessary to use a stalk shredder or disk first to insure a good job of plowing. The plow (1) covers vegetation, manure, and crop residues; (2) it loosens and crumbles the soil; (3) it increases soil pore space, and (4) it kills weeds. Plowing at optimum soil moisture is important to do all of the above things and it reduces the need for additional tillage before planting. A properly adjusted plow is one of the main considerations in doing a good job of plowing.

Plowing depth is regulated by (1) the quantity of organic material to be plowed under and (2) the physical condition of the soil. Shallow tillage seems desirable where the soil is on the wet side and deep tillage where dry. Tillage should destroy any zones of compacted soil that occur within the root zone. Tillage in the fall or early winter may be necessary or desirable only on those level fields that are high in silt or clay.

After plowing, the least amount of tillage required to obtain a firm seedbed and a loose root bed is all that is necessary or desirable. Additional tillage serves only to return the soil to its original compacted state except for trash coverage. Because of weather conditions a secondary tillage operation may be necessary to get the right soil condition for good seed germination.

Planting must be done with care in a minimum-tilled field. Many of the newer planters are equipped to plant in loose soil. With the older planters, it is good insurance to plant in the tractor wheel marks or to devise a way to firm the soil in the area where the seed is planted. This is easily done with extra wheels on the tractor or with press wheels which travel in front of each planter unit.

Tests have been conducted with minimum and conventional soil preparation methods for many years in Michigan and other states. They have shown that minimum methods will:

- reduce production expenses.
- reduce soil erosion.
- reduce soil compaction.
- reduce weed competition between rows.

Methods of minimum tillage

Plow-plant is the ultimate in corn production on many soils because all preparation and planting operations are combined into one. Several farmers, in-

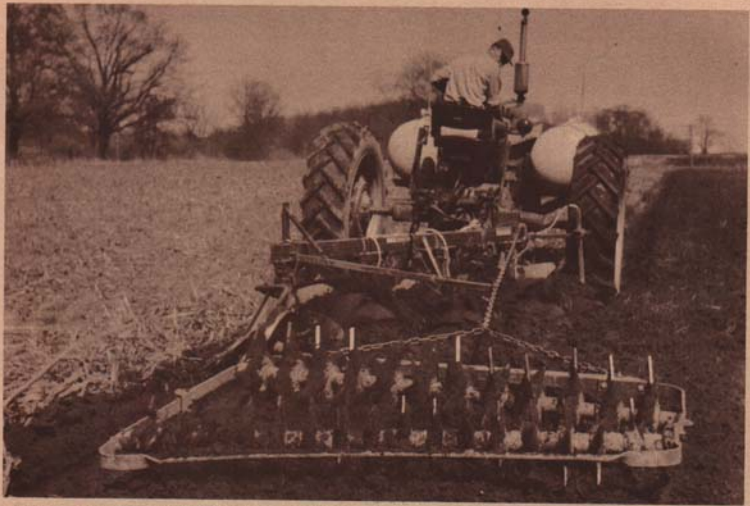


Figure 1 — One type of minimum tillage. Applying anhydrous ammonia and plowing with a trailing tiller is all the preparation necessary before planting corn.

cluding both large and small operations, have successfully devised combinations of tools for this purpose. The data in Table 3 are typical of the yields obtained with plow-plant methods. The data in Tables 4 and 5 illustrate the economics of minimum soil preparation.

"Plow, then plant" is the minimum tillage method most commonly used in Michigan. Where the plow alone does not sufficiently crumble the soil, the use of a trailing tool behind the plow is desirable. Such implements firm the soil as well as smooth it. This expedites cultivation and improves the effectiveness of pre-emergence herbicides. See Figure 1.

Table 3 — Corn yield in bushels per acre produced with plow-plant (PP) and conventional tillage (CT) methods on different soils with different organic matter content.

Texture of surface soil	Low		Medium		High	
	PP	CT	PP	CT	PP	CT
Clay loam	69.2	69.2	96.5	95.2	125.0	136.0
Loam	87.0	81.1	122.0	124.0	105	88.5
Sandy loam	70.7	46.3	128.0	108.0	—	—

Unpublished data from C. M. Hansen and L. S. Robertson, Departments of Agricultural Engineering and Soil Science respectively, Michigan State University.

For more information on minimum tillage refer to Michigan State University Extension Bulletin 352, Minimum Tillage.

Planting date

Date of planting tests have been conducted on mineral soils at East Lansing, Michigan, for over 10 years. A summary is given in Table 6.

Corn planted May 1-9 averaged 9 percent higher in yield than May 12-20, 16 percent higher than May 22-31, and 27 percent higher than June 1-11 plantings. Yield differences have consistently favored early May plantings. Mid to late April plantings averaged 5 percent less than early May planting because of slightly lower plant stands. With high quality, treated seed, equally satisfactory stands were obtained every year with early May planting compared to later plantings.

Early planted corn usually yields more because it has passed the critical stage of growth by late July and early August when a dry period of some duration usually occurs in Michigan. The critical stage of growth occurs during tasseling, silking, and early ear development. Water and nutrient requirements are higher at that time.

Table 4 — Power and man-hour requirements for soil preparation for one acre of corn grown with three production systems.

	Conventional tillage		Minimum tillage		Plow-plant	
Operations	Gals. of fuel	Horse-power hours	Gals. of fuel	Horse-power hours	Gals. of fuel	Horse-power hours
Plow	2.67	24.72	—	—	—	—
Plow with tiller	—	—	2.83	26.53	—	—
Disk 1	0.99	9.56	—	—	—	—
Disk 2	0.74	7.45	—	—	—	—
Spring-tooth harrow	0.34	3.23	—	—	—	—
Planter	0.50	3.73	0.50	3.73	—	—
Total	5.24	48.69	3.33	30.26	3.00	27.45
Man hrs./acre	2.34		1.52		1.20	

Data adapted from C. M. Hansen and L. R. Robertson, Departments of Agricultural Engineering and Soil Science, respectively, Michigan State University.

Moisture content of the grain at harvest has averaged about 2 percent higher for each week of delay in planting. With early planting, earlier harvest is possible. Weather is usually more favorable, and harvest losses lower.

Spring frosts after planting and emergence may kill the above-ground seedling leaves. Since the growing point of the corn plant remains below the ground until the plants are about 10 inches tall, the plants are seldom killed if the soil temperature does not go to freezing or below. Soil temperatures lag behind air temperature. When air temperature goes to freezing or below in May, the soil temperature of mineral soil seldom goes to freezing. Plants having frosted leaves will usually produce new leaves in a few days and the crop will be ahead of later plantings or replants. An exception might be on organic soil which is dry and loose and soil temperature is more likely to fluctuate closely with air temperature.

With early planted corn, seed mortality may be higher because the soil is more likely to be cold and damp than at later dates. Planting rates should be increased by 15 to 20 percent and the use of high quality, treated seed is very important. Seed which has a high "cold test" germination should be used for early planting. See discussion on "Seed" for running a cold test. Weeds may be more of a problem with early planting but this can be overcome by using pre-emergence herbicides. See discussion on weed control.

Planting depth

Optimum planting depth varies from 1 inch on the fine-textured clays to about 3 inches on a sandy soil, with an average of 2 inches. When the soil is dry, adjusting planting depth to place the seed in moist soil

Table 5 — The effect of the number of tillage operations on the cost of land preparation for corn. (3-year study with 103 farmers)

Tillage Operation	Approximate cost per acre of seedbed preparation
Plow with trailing tillage tool	$5.50
Plow and work 1 time	6.25
Plow and work 2 times	7.75
Plow and work 3 times	9.00

Data from A. T. Hall and R. S. Lincoln, County Extension Directors, Michigan State University.

may be beneficial. Depth should not exceed three inches on heavy soil and not over four inches on a sandy soil. Depth should be checked at the start of planting in each field.

With shallow planting, the surface soil may dry out, resulting in poor seed germination because of a moisture deficit. With deep planting the seedling is at a disadvantage because it must depend on food stored in the seed until it emerges from the soil and is able to make its own food supply through photosynthesis. If the soil becomes compacted after kernels are deep planted, the seedlings are at a more serious disadvantage.

Information from the New Jersey Experiment Station has shown that seed planted 1 and 2 inches deep gave 93 percent emergence; 3 inches deep, 85 percent; 4 inches deep, 82 percent, and 5 inches deep, 58 percent emergence.

Additional studies have shown that some soils have a temperature about 4 degrees higher at the 2-inch than at the 4-inch depth. This would result in slower germination at the greater depth.

Regardless of the depth you plant, the main root system of corn will develop just below the soil surface.

Table 6 — Corn yields in bushels per acre as affected by date of planting at East Lansing for a ten-year period.

	Dates of Planting				
Year	April 16-29	May 1-9	May 12-20	May 22-31	June 1-11
1963	108	112	103	91	83
1962	94	87	58	51	48
1961	141	138	128	124	111
1960	90	97	86	78	79
1959	129	143	135	127	125
1958	108	112	116	102	87
1957	109	106	93	81	65
1956	—	96	91	77	55
1955	102	112	105	100	82
1954	86	92	81	80	70
Aver.	104	109	99	92	80

Planting speed

Recent tests conducted with speed of planting corn at Michigan State University show that this factor has a definite effect on the final plant stand. With most planters now in use and equipped with 16-cell seed plates, a 3 to 4 mile per hour speed is best when attempting to get 16,000 plants per acre. For each mile per hour above 4 miles per hour, the plant population drops about 800 plants per acre. As the desired plant population increases, difficulty with faster planting speed also increases.

An increase in the number of cells per seed plate will allow a faster planting speed. Late model planters equipped with 24-cell seed plates, precision cut-off plates and knockers, and short drop tubes, will give accurate planting at speeds of 5 to 7 miles per hour. As is usual with any planting operation, a check should be made to insure satisfactory seed spacing in the row. If unsatisfactory, make necessary adjustments. Besides planting speed, the seed may be poorly graded, the selection of planter plates may be faulty, soil conditions may be unsatisfactory to do a good job, or incorrect drive sprocket combinations may be used.

Row spacing

Considerable interest has been aroused during the past few years in reduced row spacing as compared to the conventional 36 to 40 inch spacing. Research data is not conclusive in favor of reduced spacing, and presently there is a harvest problem for multiple row pickers. Narrower rows might be expected to give higher yields because the plants are spaced more evenly over the land area. At the same population there is increased light penetration with the more even spacing of plants. Data obtained from row spacing tests at Michigan State University are given in Table 7.

More data are needed to establish the value of 28-30 inch rows compared to conventional row spacing. The small differences may not be worthwhile, considering the extra cost and time involved in planting, cultivating and harvesting. Plant population had a greater effect on yield than row spacing.

Table 7 — Average corn yields in bushels per acre from 28-inch and 36-40 inch row spacings in eight over-state comparisons, 1962-64.

Plants per acre	28-inch rows	36-40 inch rows	Average % increase for narrow rows
9,300	70	65	8
13,700	82	78	5
18,300	89	84	6
23,000	84	80	5
Averages	81	77	6

Table 8 — The effect of plant population on corn yield in bushels per acre from 1948-1963.

Average plant population	Number of trials	Times significantly higher than next lowest population	Average yield 139 trials	Average yield 113 trials	Average yield 41 trials
8,600	139	0	65	66	68
12,400	139	3	81	80	85
16,100	139	106	92	94	97
*20,200	113	23	—	97	99
*23,900	41	0	—	—	91

**The 20,200 and 23,900 populations were included in the trials for a fewer number of years than the lower populations.*

Additional information shows that an 18-20 inch row width gives significantly higher yields than 36-40 inch rows at populations of 16,000 and 20,000 plants per acre. However, there is no multi-row equipment to handle the harvest, and the larger size tractor tires will not pass between 18-inch rows.

Planting rate (plant population)

Plant population should be decided on the basis of the yield goal. Moisture and nutrient supply, including organic matter, are the main things which affect plant population and final yield. In general, the following populations are needed for yields as indicated:

Desired Yield Per Acre	*Plant Population Required*
70- 80 bushels	12-14,000
100-110 bushels	16,000
over 110 bushels	18,000

Most hybrids respond favorably to plant population increases to a point, but some respond more than others. Hybrids must be tested to determine those best suited for higher than normal population. Plant population can be too high for these reasons:

- Moisture is frequently a limiting factor.
- Barrenness increases at high populations.
- Lodging increases at high populations because the stalks are smaller in diameter.
- Grain yield in proportion to fodder may be lower at high populations.

Tests have been conducted at Michigan State University and out-state locations for many years on the effect of plant population. Data are given in Table 8.

A total of 139 trials were involved in this long-term experiment. In 106 trials a population of about 16,100 yielded significantly more (14%) than a 12,400 population. A plant population of 20,200 had a higher yield in 23 of 113 comparisons. The average difference was only three percent above the 16,100 population. Only three of 41 trials showed a yield increase for the 23,900 population over 20,200 and none of these were experimentally significant at odds of 19 to 1. The average yield for 23,900 plants was 8 percent lower than 20,200 plants per acre for the 41 trials.

Considering all factors and test results the following plant populations per acre are suggested for the conditions listed:

- For second class corn soils 12- to 14,000 plants
- For first class corn soils 16- to 18,000 plants
- For productive organic soils 18,000 plants

In getting the desired plant population, start with a seed population 10 percent higher when planting after May 15 and 15 to 20 percent higher when planting early. Imperfect germination, insects, diseases, and cultivator damage account for about 10 percent average seed mortality. Information given in Table 9 should be helpful in getting a desired plant population.

The first step in getting the desired seed population is to obtain proper planter plates for the size of seed you expect to plant. A tag with planter plate suggestions is usually available with the seed and is a good starting point. Next, find out if the seeds will properly fit the cells of the plate. A kernel should fit loosely into the cell, but allow no extra room for a second kernel. A snug fit in length or thickness will probably result in unsatisfactory performance, especially at faster planting speeds and high populations.

After making the hand check, try the seed in a planter box or a special seed testing hopper, using the plate selected. Many implement companies have special testing hoppers to aid in plate selection.

Remember, that every time you change the size and/or shape (grade) of seed or change to a different hybrid, it is necessary to check the new seed against a planter plate. The old plate may or may not be the one to use.

With proper plates on hand, getting the desired seed population is a matter of planter adjustment and planting speed. The instruction book covering the corn planter is invaluable as a starting point on adjustment. However, actual checking in the field is necessary for accuracy. In making this check the planter should be driven at least 50 feet *at the speed you expect to use in the field;* the seeds could be counted in a shorter distance, say 25 feet. If so, the calculation is:

$$\frac{\text{25 (feet) x 12 (inches per foot)}}{\text{Seeds in 25 ft. of row}} = \text{distance between}$$

seeds in inches. A 25-foot distance or longer is preferred for accuracy. If the results of the check show that there are nine inches between seeds in a 40-inch row spacing you can refer to Table 9 and find that this would be a seed population of about 17,600 or a potential plant population of 16,000 plants per acre.

Cover crops in corn

Greater pressure on the land because of increased corn acreage, shorter rotations on many farms, and continuous corn production increases the need for cover crops in corn. A good cover crop should be easy to establish, low in cost, and should compete as little as possible with the corn for water and plant nutrients.

When incorporated into the soil a cover crop adds to the organic matter supply and improves soil tilth. It helps to prevent soil erosion, may reduce nutrient leaching and fall growth may help to support corn harvesting equipment. In some cases it may furnish some late fall or early spring pasture.

Provision for the nutrient needs of the cover crop should be made when the corn fertilization program is planned. The recommended cover crops and seeding rates are:

Domestic ryegrass—15 pounds per acre
Rye—84 pounds per acre
Grass-legume mixtures—Domestic ryegrass at 10 pounds and either sweet or red clover at 5 pounds per acre.

Sow ryegrass or grass-legume mixtures, at the time of the last cultivation of corn. Rye may be planted at this time but it often competes with the corn for nutrients and water. Rye is frequently sown by airplane in August or September or drilled after silage harvest.

Table 9 — Seed spacing in the row to get a desired plant population under average conditions.

Desired plant population per acre	Kernels needed per acre to get the desired plants per acre	Approximate kernel spacing in the row (inches) to obtain the desired plant population at various row widths in inches							
		28	30	32	34	36	38	40	42
12,000	13,200	17.0	15.8	14.8	14.0	13.2	12.5	11.9	11.3
14,000	15,400	14.5	13.6	12.7	12.0	11.3	10.7	10.2	9.7
16,000	17,600	12.7	11.9	11.1	10.5	9.9	9.4	8.9	8.5
18,000	19,800	11.3	10.6	9.9	9.4	8.8	8.3	7.9	7.5
20,000	22,000	10.2	9.5	8.9	8.4	7.9	7.5	7.1	6.8
22,000	24,000	9.3	8.6	8.1	7.7	7.2	6.8	6.5	6.2

If atrazine was used for weed control a cover crop cannot be established that year unless rye is used after harvest of the corn for silage. If the atrazine was applied in a band over the corn row, it will be possible to establish any of the cover crops between the rows. If 2,4-D was used pre-emergence on the corn, the grass cover crop may be sown at the time of the last cultivation but not the clovers.

Other publications dealing with Corn Production in Michigan are: Bulletin 437, Fertilizing; Bul. 439, Insects; Bul. 438, Weed Control; Bul. 440, Diseases; and Bul. 441, Harvesting and Storing.

Publications such as this one are one of the educational services provided by the Cooperative Extension Service of Michigan State University. These services to the people of Michigan are financed jointly by your county, state, and federal governments. Agents at the County Cooperative Extension Service offices can provide information and help in many farm, home, and community problems. They work in agriculture, home economics-family living, 4-H, marketing, and community and resource development. Their services are available to all residents of Michigan. Publications on more than 500 subjects and a list of available publications are available at your County Extension Office or from the MSU Bulletin Office, P.O. Box 231, East Lansing, Michigan.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U. S. Department of Agriculture. N. P. Ralston, Director, Cooperative Extension Service, Michigan State University, East Lansing, Mich. 48823.

2P—2:66—15M—ST