An Elementary Laboratory
Study in Crops,
Prepared by
Prof. Joseph A. Jeffery
of the M. A. C.

For the Schools of Michigan

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AN

ELEMENTARY LABORATORY STUDY

IN

CROPS

FOR THE

SCHOOLS OF MICHIGAN

BY

JOSEPH A. JEFFERY, Professor of Agronomy,
Michigan Agricultural College.

Published by the
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STATE OF MICHIGAN,

DEPARTMENT OF PUBLIC INSTRUCTION.

LANSING, November 15, 1907.

To Commissioners, Superintendents and Teachers:

The subject of nature study has been discussed for a number of years and has been taught in our public schools with such a degree of success that there is a general demand among those interested in agriculture that the subject of elementary agriculture shall also be taught. The president and faculty of the Agricultural College have given much time and thought to determine just what is meant by elementary agriculture and how much of agriculture can profitably be taught in the rural and village schools.

At the request of this Department, Joseph A. Jeffery, Professor of Agronomy in the Michigan Agricultural College, has prepared the material presented in the following pages as an elementary study in crops, and this bulletin is published for the purpose of putting into the hands of our teachers some simple and definite work in the subject of agriculture. We submit it to the schools and teachers of the State in the hope that it will be of material assistance in presenting this important subject to our students, and that ultimately we may be able to introduce into our courses of study a concise and profitable course in the subject of elementary agriculture.

Very respectfully,

L. L. Wright

Superintendent of Public Instruction.

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INTRODUCTION.

The farmer should understand the nature of a seed, its relation to the future plant, the importance of vitality in the seed, the conditions lessening its vitality, and the conditions requisite to preserve its vitality. He should understand also the conditions outside the seed upon which depends the production of vigorous plants. Upon such knowledge depends all rational practice in crop production.

The following course of laboratory exercises has been outlined with a view to giving the pupil the opportunity of demonstrating for himself by actual experiment the importance of such knowledge.

It is expected that some text-book will be studied in conjunction with this work.

LABORATORY EQUIPMENT.

The following apparatus will be needed:

Two doz. dinner plates or pie tins.

Two doz. discs of Canton flannel (or a like number of filter papers) of a diameter one inch less than that of the plates or pie tins.

One doz. 600 *c.c.* lipped beakers.

Two doz. one-quart bean pans (graniteware perferable).

One doz. shallow four-quart pans (graniteware preferable).

One doz. deep gallon jars.

One doz. one-pint graniteware or porcelain dishes.

Two doz. wooden boxes 18 inches long, 10 inches wide and 2 inches deep.

Two hundred pounds of fine quartz sand. (This sand can be procured of the Wausau Quartz Co., of Wausau, Wis.).

Two bushels of air-dry fine sand or fine sandy soil for germinating seed.

A collection of seeds and grains for illustrative purposes and for experimental work.

Tight boxes with covers should be provided to hold the sands and soil.

Glass receptacles should be provided to hold the seeds and grains. Pint, quart, and two-quart Mason fruit jars make inexpensive and convenient receptacles.

A SHORT COURSE IN SEEDS AND GRAINS.

Make a collection of seeds and grains commonly grown on the farm. This collection should include beans, peas, clover, timothy, beets, wheat, oats, barley, corn, buckwheat, etc. Different varieties of each should be brought in so far as possible.

Samples of each should be placed in 4 oz. screw-cap vials for later examination and reference, while larger quantities should be kept in bulk for study and experiment. Samples of many of these should be gathered in the pod, head, and ear, with portions or all of the plant. The extent to which this is done, beyond the study needs of the class, must depend upon the storage facilities of the laboratory or museum. The pupils should be required to help or indeed to do all the work of making the collection.

THE STUDY OF THE SEED.

The pupil should be made to understand that a seed or a kernel of grain consists of (1) a young plant, or embryo; (2) a supply of food prepared and stored for the use of the young plant until it can send out its roots and leaves; and (3) a coat inclosing both young plant and nourishment. That all this may be clear to the pupils, the following experiments should be performed, also observing the development of the plant from the seed:

EXPERIMENT I.

A Study in Seed Germination.

Apparatus and material needed:

Two ordinary dinner plates or two eight-inch pie tins.
Two pieces of blotting or filter paper, or Canton flannel of proper size to rest in the plate or pan used.
A beaker or cup of water.
Ten beans of any variety.

The experiment:

1. Place one of the pieces of paper or cloth in the bottom of a plate or tin. If the cloth is used, thoroughly wet and wring out before placing it in the bottom of the plate or tin. If the paper is used, wet thoroughly after it is set in place.
2. Distribute the ten beans over the paper or cloth.
3. Place the remaining paper or cloth over the beans, wetting the cloth before putting in place (or the paper afterwards).
4. Add water to the bottom of the plate or tin, but not enough to stand deeper than the paper or cloth lying on the bottom.
5. Cover the plate or tin by placing the remaining one, inverted, over it, and set in a warm room.
6. See, each day, that water enough is added to keep the moist condition of plate and paper, or cloth, about as it was the first day.
7. Examine the beans each day and (a) notice and record any changes that take place. (b) Open one bean each day for three days, and examine the embryo or young plant.
8. Set apart one particular bean and make a drawing of it each day for ten days, to show the changes that take place.

EXPERIMENT II.

A Study in Seed Germination.

Apparatus and material needed:

One dinner plate or eight-inch pie tin.

Two pieces of filter paper or two pieces Canton flannel of proper size to lie in bottom of plate or tin.

Ten kernels of good seed corn.

The experiment:

1. Place a piece of filter paper in a plate or tin and wet, or wet a piece of cloth and place in bottom of plate or tin.
2. Distribute the ten kernels of corn over the paper or cloth.
3. Place the remaining paper or cloth over the corn, properly wetting the paper after, or the cloth before, so placing.
4. Add water enough to just cover the bottom of the plate.
5. Cover the plate or tin by placing the remaining one, inverted, over it, and set in a warm room.
6. See, each day, that the moisture condition in the plate is kept about as it was the first day.
7. Examine the corn each day and note how the young plant makes its appearance and whether it is alike in all cases.
8. Set apart one particular kernel of corn and make a drawing of it each day for eight days to show the changes that take place.

EXPERIMENT III.

How the Young Plants Appear Above Ground.

Apparatus and material needed:

One one-quart pudding or bean pan.

One quart of air-dry sandy soil.

Ten beans.

The experiment:

1. Fill the pan three-fourths full of the sandy soil, shake down, and smooth over.
2. Add water until the soil is thoroughly wet and the water begins to glisten in the surface of the soil.
3. Place the ten beans upon the soil in the pan—two on their sides, two on one end, two on the other end, two with the scar down, and two with the scar up. *Make a chart of the planting.*
4. Cover these beans to the depth of one-half inch with the air-dry soil.
5. If on the next day the soil is not all moist, add just water enough to moisten.
6. Examine from day to day. Add water sufficient to keep surface from drying. Note (1) the manner and (2) the order in which the plants come up, and make a record of the same.
7. When the young plants have all appeared above the surface, carefully pull up one of them, examine, and make a drawing of it. Before pulling, it may be necessary to loosen the soil.
8. Did the positions in which the beans were planted affect the order in which the young plants appeared?

   Did it affect the manner in which they came up?

EXPERIMENT IV.

How the Young Plants Appear Above Ground.

Repeat Experiment III using corn instead of beans.

EXPERIMENT V.

How the Young Plants Appear Above Ground.

Repeat Experiment III using other seeds and grains, all together or separately, in order that the pupils may observe the manner in which the young plants appear above ground.

EXPERIMENT VI.

Quantity of Food Stored in Seed.

Apparatus and material needed:

One four-quart pan.

One gallon of well-washed, pure quartz sand, or the same amount of good clean building sand, which has stood for some time in strong hydrochloric acid and then has been thoroughly washed.

Four large and four very small kernels of the following: corn, wheat, oats, beans, and peas.

The experiment:

1. Fill the pan three-fourths full of the sand.
2. Moisten until thoroughly wet.
3. Distribute the several four seed lots over the surface of the sand with the different lots sufficiently separated that when they start to grow they will still be distinguishable as groups. Carefully make a chart on paper of the distribution of the lots to help later in locating the young plants.
4. Cover the grain and seed with a half-inch layer of the sand.
5. Set in a room having a temperature ranging from 70° to 85° F., and water just enough from time to time to keep the surface from becoming dry.
6. Observe each day until all plants cease to grow, and record observations.
7. Do you discover any difference—
   1st. In the time required for the plants from the small and the large seeds or kernels to appear above ground?
   2nd. In the size of plants from the small and the large seeds or kernels when they have ceased to grow?
   If there is an observable difference, account for it if possible.
8. Do the results in this experiment suggest a rule for practice on the farm? If so, formulate it.

NOTE. Pure quartz sand can be had of the Wausau Quartz Co., Wausau, Wisconsin.

EXPERIMENT VII.

The Depth to Which Seed Should be Planted.

Apparatus and material needed:

Four deep one-gallon jars.

Enough well-moistened, well-crumbled loam soil or sandy soil, to fill these jars.

Sixteen good kernels each of corn, oats, and wheat.

Twenty good seeds of red clover.

The experiment:

1. Fill the jars with the soil.
2. In one of the jars of soil plant four kernels of corn six inches deep, four kernels four inches deep, four kernels two inches deep, and four kernels one inch deep.

   Note: To plant the kernels of corn use a round stick with a square end. With the stick make a hole for each kernel. Introduce the kernels into the holes and fill the holes with the crumbled soil.
3. In the same way, plant the sixteen kernels of oats in another jar.
4. In the same way, plant the sixteen kernels of wheat in the third jar.
5. In the remaining jar plant the twenty seeds of June clover—four seeds six inches deep, four seeds four inches deep, four seeds two inches deep, four seeds one inch deep, and four seeds one-half inch deep.

   Note: Use a smaller stick to make the holes for the clover seed.
6. It would be well to make a chart of the plantings in each jar.
7. Place all the jars in a room with temperature ranging from 70° to 85° F.
8. Moisten enough to keep surface from drying, but do not moisten heavily.
9. Make a record of the rate and number of germinations.
10. If after three weeks any of the kernels or seeds have failed to send plants to the surface, carefully remove the soil, making reference to the proper chart, if necessary, and discover and record why the young plant has failed to reach the surface.

    Use a table like the following for each jar:

Germination of Seeds at Various Depths.

Depth of planting.	Number of germinations to the day indicated.																	
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 inch																		
2 inches																		
4 inches																		
6 inches																		

Combine what you learn from this experiment with what you learned in experiment No. XX in soils and what you may learn later in experiment No. XIV of this series, and make a rule for the depth of planting seed.

EXPERIMENT VIII.

Effect of Age Upon the Vitality of Seed.

Apparatus and material needed:

One wooden box, 10 inches x 18 inches x 2 inches deep.

Lots of seed corn 1, 2, 3, 4, and 5 years old respectively and a sample also of the last preceding crop.

Enough well-crumbled, air-dry, sandy soil to fill the box.

A straight-edge.

The experiment:

1. Fill the box rounding full with the soil, tap lightly, and strike off the surface.
2. Lay off six lines two inches apart and running the width of the box.
3. Count out ten kernels from each lot of corn.
4. Plant these six lots of corn in order of age—one lot on each line marked on the soil in the box. Plant to the depth of one inch.
5. Cover the kernels and place the box where the temperature will range from 70 to 90 degrees. See that the soil is kept moist but not too much so.
6. Observe and record the rate and vigor of germination.
   Use a table like this:

Vitality of Old Seed Corn.

Age of seed.	Total germination up to and including the day indicated.											Order of germination.	Order of vigor.	No. to plant in each hill.
	3	4	5	6	7	8	9	10	11	12	13			
New														
1 year														
2 years														
3 years														
4 years														
5 years														

7. How old should seed corn be to give best germination according to results obtained in this experiment?
8. Are you sure that the lots of seed used in this experiment were saved with equal care?

The above experiment should be repeated, using different grains and seeds common to field and garden. Assign one kind of seed or grain to one pupil and another to another.

Plant corn, beans, and peas one inch deep in the boxes; wheat oats, barley, flax, etc., one-half inch deep; and clover, timothy, and the like one-fourth inch deep. Have pupils compare results and conclusions.

It may not be possible to procure at once seeds and grains of different ages or those originally saved with uniform care and judgment. Each year a stock of the best fresh seed should be collected and saved for future study.

The Vitality of Bin Grains.

If pupils have access to grain bins on the farm, have them bring in gallon samples of grain that have molded or musted in the bin because of excessive dampness. Keep the lots so brought in separate.

If the pupils can procure, at the time of threshing, grains that have molded in the shock from being "shocked" too green, or that have molded or rotted in the shock or stack from wetting, have them bring in gallon samples.

These samples should be preserved in glass or metallic receptacles with close-fitting covers, and should be carefully and completely labeled.

There should be gathered, also, bin grains that have not suffered from mold, and these should be preserved and labeled.

EXPERIMENT IX.

Apparatus and material needed:

A number of 100-kernel lots of molded oats.
One 100-kernel lot of good seed oats.
One wooden box, 10 inches x 18 inches x 2 inches deep, for every three lots of grain.
Sufficient air-dry, fine, sandy soil to fill the boxes.

The experiment:

1. Fill the box or boxes with soil, rounding full, settle by tapping, and strike off with a straight-edge.
2. Divide the surface of the soil in each box into three areas—10 inches by 6 inches each.
3. Plant in each of these areas one 100-kernel lot of oats, carefully labeling each area. Plant to depth of one-half inch.
4. Thoroughly wet down the soils in the boxes.
5. Set the box of boxes where the temperature will range from 70° to 85° F. and see to it that the soil is kept moist, but not too much so —never so moist as after the first wetting.
6. Observe and record the rate and number of germinations, using table like the one below:

Germination of Poor and of Good Seed Oats.

Description.	Total germinations on day indicated.												Order of total germinations.	Vigor of young plants.
	3	4	5	6	7	8	9	10	11	12	13	14		
Good seed														
Moldy seed from, etc														
Moldy seed from, etc														
Moldy seed from, etc														
Moldy seed from, etc														

7. Observe and record the vigor of the young plants.
8. Do the results suggest any new ideas concerning the saving of seed oats? Do they confirm any old ideas? Do they suggest any warnings against methods now in use?

It would be well to repeat this experiment by using other grains and seeds. Or each pupil might be assigned a certain kind of seed or grain to experiment with. Then have pupil bring together the results obtained and compare and discuss results and conclusions. This experiment has a most important bearing upon crop yields.

EXPERIMENT X.

Vitality of Sprouted Grain.

Apparatus and material needed:

One-fourth pint of wheat, home grown preferable.
One pint dish.
One wooden box, 10 x 18 x 2 inches deep.
Enough air-dry, well-crumbled sandy soil to fill the box.

The experiment:

1. Place one-eighth pint of wheat in the bottom of the pint dish; cover with water and keep covered for a few days. Keep in a room with temperature ranging from 70° to 85° F. The wheat will soon begin to sprout.
2. As rapidly as the kernels acquire sprouts one-sixteenth inch long, remove the kernels and place on a piece of blotting paper and dry in warm room. In this way pick out and dry at least 200 kernels and allow to dry for one week.
3. Fill the box with the soil as described in experiment seven and divide the surface into three divisions—10 inches by 6 inches each.
4. Count out two 100-kernel lots of the dry sprouted kernels, and also one 100-kernel lot of the unsprouted wheat—that which was not covered with water.
5. Plant the two sprouted lots of wheat in the end areas of the box and plant the lot of unsprouted wheat in the middle area. Plant one-half inch deep.
6. Wet down the soil in the box and set the box in a room having a temperature ranging from 70° to 85° F. Water from time to time, but not excessively.
7. Observe and record the number and rate of germinations. Use a table something like the one below:

Germination of Sprouted and Unsprouted Seeds.

Description.	Total germinations on day indicated.												Vigor of young plants.	Per cent of germination.
	3	4	5	6	7	8	9	10	11	12	13	14		
Good seed														
Sprouted seed														
Sprouted seed														
Average of sprouted														
Difference between sp'ted and unsprouted														

8. How do the results agree with your previous notion concerning the vitality of sprouted grains?
9. Would you advise the practice of using sprouted grains for seed?

This experiment may well be repeated, using other grains and seeds.

Vitality of Kernels from Different Parts of the Ear of Corn.

The question is often asked whether the kernels from different parts of the ear of corn are equally good for seed, or whether some should be discarded, and if so, why?

Experiment XI.

Apparatus and materials needed:

Three wooden boxes 10 x 18 x 2 inches.
Enough air-dry light, sandy soil to fill the boxes.
Three well-filled, carefully saved ears of seed corn.

The experiment:

1. Fill the boxes with the soil as in previous experiments.
2. From one of the ears shell off carefully 50 kernels from the extreme tip of the ear, 50 kernels from around the middle of the ear, and 50 kernels from the extreme butt of the ear.
3. Divide the surface of one of the boxes of soil into three areas—10 inches x 6 inches each.
4. In the middle area plant the 50 middle kernels, in one of the end areas plant the 50 tip kernels, and in the remaining one, the 50 butt kernels.
5. In like manner shell off from another ear 50 each of tip, middle, and butt kernels and plant in one of the other boxes.
6. In like manner plant 50 each of tip, middle and butt kernels from the third ear in the remaining box.
7. Carefully label the boxes and the areas in which tip, middle and butt kernels are planted.

8. Thoroughly moisten the soil in the boxes and keep just moist enough to prevent the surface from getting dry.
9. Place the boxes in a room with temperature ranging from 70° to 85° F.
10. Observe and record the number, rate, and vigor of germinations, using a table like the following:

Germination of Tip, Middle and Butt Kernels of Corn.

Description of kernels.	No. of box.	Total number of germinations on day indicated.												Average height on 14th day.	Quality of stalk.
		3	4	5	6	7	8	9	10	11	12	13	14		
Tips	1														
	2														
	3														
Middles	1														
	2														
	3														
Butts	1														
	2														
	3														

11. On the fourteenth day or when germination is complete, determine the average height of each lot of corn plants and record.
12. Shall the farmer shell off tip and butt kernels from ears when preparing his seed corn? Give reasons for your answer.
13. Compare and discuss results.
14. Ask your farmer friends whether they discard tip and butt kernels, and if they do, why?

If there are more than three pupils in the class, furnish one ear of corn and germinating box for each.

The Importance of Early Saving and Drying of Seed Corn.

For this work the teacher or some very trustworthy person should prepare the corn to be used or direct the pupils in the preparation.

1. He should select a number of good ears before the first severe frost. These ears should be carefully dried at a temperature ranging from 70° to 80° F., stored, and later shelled for class use.

2. He should as late in the season as possible select an equal number of ears as good as the first lot of ears selected. These ears should be hung where the opportunity for drying is not good and where later they will freeze. An open corn crib or shed would be a good place to hang the corn. Later, dry, shell, and store for class use.

3. Select an equal number of ears from the corn crib when winter weather has thoroughly set in. Place in pail or other vessel of water and let stand until they are well soaked. Then place them where they will freeze solid. After a week, dry, and later shell and store for class use.

EXPERIMENT XII.

Effect of Freezing Upon the Vitality of Seed Corn.

Apparatus and material needed:

One wooden box 10 x 18 x 2 inches deep.
Enough air-dry fine sandy soil to fill the box.
Fifty kernels each of the three lots of corn described above.

The experiment:

1. Fill the box with the soil as in previous experiments.
2. Divide the surface of soil in box into three areas, 10 inches x 6 inches each.
3. Plant in these three areas respectively the three lots of corn.
4. Carefully label the areas.
5. Thoroughly moisten the soil and thereafter moisten just enough to keep surface from drying out.
6. Place box in a room with temperature ranging from 70° to 85° F.
7. Observe and record the number, rate, and vigor of germinations, using a table like the following:

Germination of Frozen Corn.

Description of corn.	Total number of germinations on day indicated.												Relative vigor of plants.
	3	4	5	6	7	8	9	10	11	12	13	14	
(1) Carefully saved and dried..	....	....	....	....	....	....	....	....	....	....	....	....	
(2) Carefully saved but not dried	..			..			...	.	.	.	..	...	.
(3) Crib corn wet and frozen....	....	.	...	...	...	.		.	...	...	..	. .	.
Difference between lots 1 and 2..	..	..	...	.	...	...	.	..	...	..	...	...	..
Difference between lots 1 and 3..	....	..	...	..	...	...	..	...	...	...	...	...	....

8. Do you discover any differences in the number, rate, and vigor of germinations? Account for any such differences.
9. Does the experiment suggest an important practice in saving seed corn?

EXPERIMENT XIII.

Necessity for Air in the Germination of Seeds.

Apparatus and material needed:

Six one-quart pudding or bean pans.
Two quarts finely crumbled air-dry clay soil.
Two quarts finely-crumbled air-dry loamy soil.
Two quarts finely crumbled air-dry fine sandy soil.
Six 25 kernel lots of *good* seed corn, all from the same lot of bulk seed.

The experiment:

1. Fill one pan half-full of the clay soil, weigh the pan and contents and introduce into another pan enough of the clay soil to bring its weight to that of the first pan.
2. Smooth down the soil in each pan to bring to uniform depth, and tap the sides of the pans to settle the soil.
3. Over the surface of the soil in each pan distribute a 25-kernel lot of corn, and then add to one of the pans one-half inch of the clay soil. Weigh the pan and contents, and add enough soil to the other pan to make the weights of the pans equal again. Number these pans *1* and *2*.
4. Fill two other pans with the loam soil. Place 25-kernel lots of corn in each, and cover with half-inch layers of the loamy soils, following the directions given in paragraphs 1, 2 and 3 above. Number these pans *3* and *4*.
5. In like manner, fill two pans with fine sandy soil. Introduce 25-kernel lots of corn and add a half-inch layer of fine sandy soil. Number these pans *5* and *6*.
6. To pans *1*, *3*, and *5* add water enough to thoroughly moisten, and thereafter just enough to keep the surface from getting dry, but not enough to prevent the clay from cracking. (In applying water, lay a piece of paper upon the surface of the soil and pour the water lightly upon the paper. The water thus spreads from the paper over the soil without tearing up the soil).
7. To pans *2*, *4* and *6* add water till it stands one-fourth inch deep over the surface after the soil has been thoroughly saturated, and thereafter enough to keep the surface covered at all times. (Use a piece of paper in applying water as described above).
8. Set the pans in a room where the temperature ranges from 70° to 85° F.
9. Observe and record the number, rate and vigor of germinations, using a table like the following:

Germination of Corn in Different Soils.

Moisture condition.	Kind of soil.	Total number of germinations on the day indicated.												Order of vigor.	Germinations after removal of excess of water.			
		3	4	5	6	7	8	9	10	11	12	13	14		11	12	13	14
Good	Clay																	
	Loam																	
	Sandy																	
Poor	Clay																	
	Loam																	
	Sandy																	

10. Account for any differences in the rate and number of germinations.
11. Have you ever noticed a similar difference in germinations, and for apparently similar reasons in fields of corn?
12. Does this experiment suggest to you a lesson in field management? If so, what is it?

This experiment may be varied as follows:

13. At the close of the tenth day carefully remove with a pipette or glass tube as much of the excess of water as you can conveniently. Allow the remaining excess to evaporate until the soil begins to crack, after which add just water enough to keep the soil moist.
14. Observe and record any further germinations.
15. If more germinations do occur, account for them.
16. Observe also whether these new germinations are as vigorous as the earlier. Account for differences.

This experiment might be repeated, using other grains and seeds.

EXPERIMENT XIV.

Effect of Temperature on the Germination of Seed.

Apparatus and materials needed:

Three one-quart pans.
Three quarts of air-dry fine sandy soil.
Three 25-kernel lots of good seed corn, all obtained from the same bulk lot.

The experiment:

1. Fill the three pans one-half full of the sandy soil, even off to uniform thickness, and tap pans to settle soil.
2. In each pan distribute evenly over the surface of the soil one of the 25-kernel lots of corn and cover with a half-inch layer of the sandy soil.
3. Add water to each pan to thoroughly moisten the soil, and add water thereafter just sufficient to keep surface from becoming dry.
4. Place one of these pans where it will take on a temperature of 50° F. or less, but not less, if possible, than 38° F.
5. Place another of the pans where it will take on a temperature of from 65° to 75° F.—ordinary room temperature.
6. Place the third pan where it will be subjected to a temperature ranging from 85° to 95° F.
7. Observe and record the rate, number, and vigor of germinations, using a table like the following:

Germinations of Corn at Different Temperatures.

Number.	Temperature.	Total number of germinations on day indicated.								Vigor of plants on 10th day.	Total number of germinations on day indicated.						Vigor of plants on 16th day.
		3	4	5	6	7	8	9	10		11	12	13	14	15	16	
1	85° to 95°																
2	65° to 75°																
3	48° to 50°																
Differences between 1 and 2																	
Differences between 1 and 3																	

8. After ten days place plants together in a room, temperature ranging from 65° to 75° F. and keep properly moistened.
9. Observe and record germinations as before.
10. On the sixteenth day observe and record the average height and vigor of plants.
11. What do the results in this experiment teach?
12. Can the farmer control the temperature of his soil?
13. Can he modify the temperature of his soil?
14. Give reasons for both answers.

Experiment XV.

Practical Seed Corn Testing.

Apparatus and materials needed:

One wooden box 10 x 18 x 2 inches.
Twenty-five feet of store wrapping twine.
Enough air-dry light sandy soil to fill box.
Fourty-two to 140 ears of seed corn.
Fifty tacks or three-quarter inch brads.
A straight edge.

The experiment:

1. On the sides and ends of the box, one-fourth inch below the edge, drive tacks or brads one and one-fourth inches apart, allowing the heads to stand out one-eighth to one-fourth inch.
2. Fill the box with the soil, tap lightly, and strike off.
3. Tie or loop one end of the string to one of the corner tacks or brads and stretch back and forth over the surface and under the tack or brad heads after the manner illustrated in Figs. 1, 2 and 3. This divides the surface of the box of soil into eight rows of squares, with fourteen squares in each row, and each square one and one-fourth inches on a side.

4. On the ends number the rows, and on the sides number the squares in the rows.

Fig. 1.—Galvinized iron germinator. Small notches are cut in the rim at intervals of 1¼ inches to carry the string or wire which divides the germinating surface into 1¼ inch squares. This figure shows four rows of kernels in place.

Fig. 2.—Same as Fig. 1, after four days.

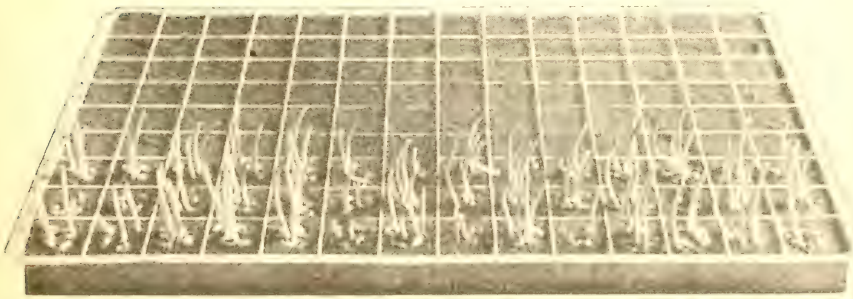

Fig. 3.—Same as Fig. 1 after seven days. At the end of seven days the young plants have made a sufficient growth to give some idea of their vigor.

5. Place the seed corn in rows on tables, shelves or floor, 14 ears per row, and number the rows to correspond with the rows of squares in box of soil.

6. Remove four kernels of corn from each ear of row one and plant each four kernels so removed in the corresponding square of row one of the squares. Remove the four kernels from as many separate points on the ear. Plant the kernels tips down and deep enough to have the back of the kernels about one-eighth of an inch below the surface.
7. In like manner plant four kernels from each of the ears of the other rows. Keep all rows in order.
8. Moisten the soil and keep properly moistened.
9. Place box and contents in room where temperature ranges from 75° to 85° F.
10. On the seventh day examine carefully and if in any square there fails to occur four vigorous germinations, discard the ear from which the four kernels were taken.
11. Read in connection with this experiment, Corn Improvement, p. 293, Report of Michigan Board of Agriculture for 1906.
12. What per cent of ears are you required to discard?

CORN JUDGING.

Much attention is given in corn growing sections of the country to the study of the ear of corn. This study brings us ultimately to *corn judging*. Many texts in agriculture now take up a discussion of this important subject.

An exercise in corn judging is here offered, including a description of a perfect ear of corn and directions for scoring in accordance with the rules of the Michigan Corn Improvement Association. The description and directions are copied from special bulletin No. 34, Michigan Experiment Station. See p. 293, Report of Michigan Board of Agriculture for 1906.

THE IDEAL OR PERFECT EAR.

It is not often found. It must possess certain physical qualities or characteristics:

1. Shape. In shape it should be cylindrical, or only slightly tapering. The very tapering ear is being bred away from. The rows should be straight, extending completely from butt to tip.
2. Color. The cobs should be red for yellow corn, white for white corn, and red or white for the white caps as now bred, but all red or all white.

There should be no kernels present indicating by color or shape that cross polinating from another breed has taken place.

3. Tips. The tips should be well covered with kernels of uniform size, the rows remaining unbroken to the end. The question as to whether the cob may not protrude slightly is an open one.
4. Butts. The butts should be well rounded as shown in the Fig. 4. The shank or ear stalk should equal about one-third the total diameter of the ear.

5. Kernels. The kernels should be wedge-shaped, so that they shall fill completely all space between the circumference of the ear and the circumference of the cob. See Figs. 6 and 7. To examine kernels, remove two kernels side by side from the cob, one-third or one-half the distance from butt to tip, and lay them on some flat surface, germs up in the same relative position they occupied on the cob.

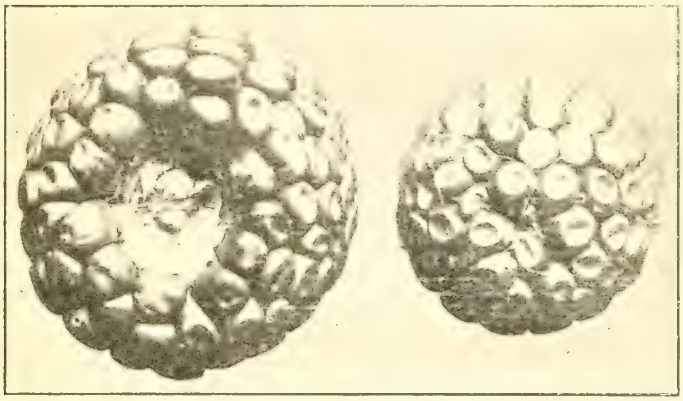

FIG. 4.—A very good butt and tip.

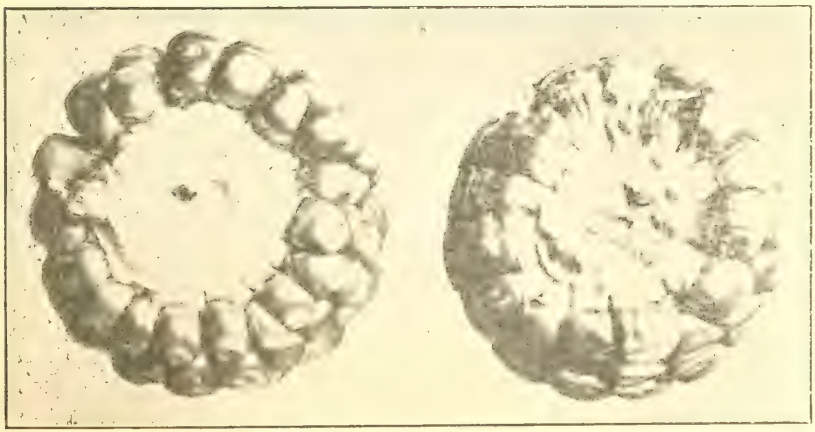

FIG. 5.—Two poor butts. The left one would be cut at least a half point, while the right one would be cut at least three tenths of a point, under our rules for scoring.

6. Length and circumference. At the present time the standards of the Michigan Corn Improvement Association are 9 inches for length and 7 inches for circumference. The circumference is measured one-third the distance from butt to tip.

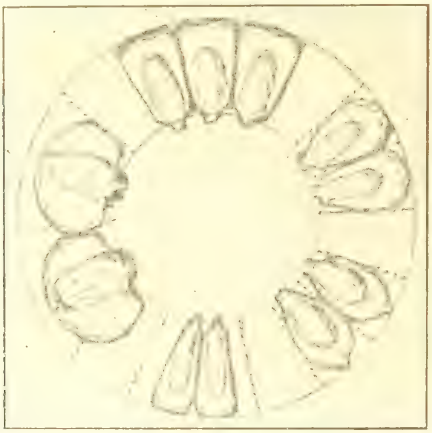

FIG. 6.—A study of kernels.
The upper three kernels are well proportioned and occupy completely the space between the circumference of the ear and the circumference of the cob.
The upper right hand two kernels are poorly shaped, and leave a lot of unoccupied space.
The lower right hand two kernels show how the white rice popcorn kernels occupy the space.
The lower two kernels are of the shoe-peg type.
The left two kernels show the relative shape and position of flint kernels as compared with the upper three dent kernels.

It is thought by many that it would be better not to have definite arbitrary standards for length and circumference, but that it would be better to require a definite relation between length and circumference, with a stated definite minimum length of each.

7. Spaces. (a) The outer spaces between rows should be small. With very rare exceptions ears have even numbers of rows, and the rows are in pairs. This distinctness of pairing of rows is considered one of the evidences of good breeding. The space between the rows in the pairs is smaller than the spaces between the pairs. (b). There should be no spaces between kernels as they stand in the rows. In Fig. 8 *a* these spaces are seen clearly between the lower one-fourth of the kernels. The spaces do not appear in Fig. 8 *b*.

8. Per cent of grain to ear. The M. C. I. A. requires that 100 pounds of ears shall shell out 88 pounds of grain, and individual ears shall shell in that proportion.

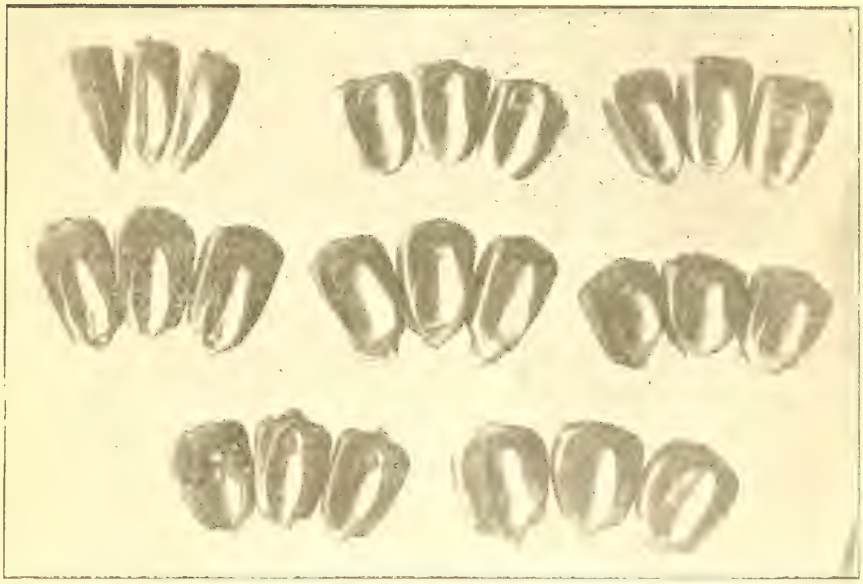

FIG. 7.—A study of kernels. The shoe-peg type is seen in the upper left hand corner. The three kernels in the upper right hand corner approach most nearly to the ideal shape. Note the unoccupied space because of the rounding edges in most of the cases.

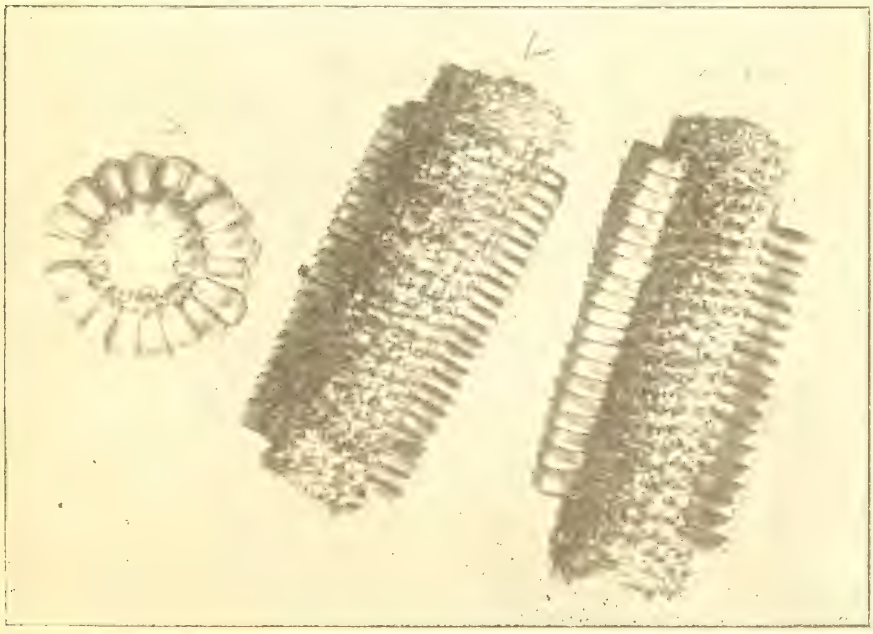

FIG. 8.—An examination of (a) reveals large spaces between the kernels in the row for ¼ the length of kernel from the cob out. No such spaces are found between the kernels of (b). (c) is a cross section of a very good ear of Michigan corn.

In corn judging the following additional points are considered:

9. Trueness to type. It is not sufficient that the ears shall be properly shaped, etc.; they must have also the special characteristics of the breed to which they belong—the roughness or smoothness of kernel, the style of dimple, general outline of kernel, etc.

10. Uniformity. Ears may show that they belong to a particular breed, and yet lack in uniformity of appearance, just as a group of cows may leave no doubt as to what breed they belong, and yet may not be uniform in appearance in the group.

11. Market condition. This takes into account whether the corn is ripe, sound, free from disease and injury, bright in color, and of apparently good vitality.

12. Uniformity of kernels. Two kernels are removed from each ear as described above and the pairs placed in rows for comparison. Every pair should look like every other pair in shape and size.

Apparatus and materials needed.

Several ten-ear lots of the best dent corn that can be had.
One thirty-six inch tape.

CORN JUDGING OR SCORING.

In judging corn, 10 ears are studied, their defects determined and charged against them. The score card is a convenient form for use in this work.

CORN.

SCORE CARD.

	Scale of Points.	Standard.	Student's score.	Corrected score.
1	Uniformity.			
	(a) Trueness to type	5		
	(b) Uniformity of exhibit	5		
2	Shape of ear	5		
3	Color	10		
4	Market condition	10		
5	Tips	5		
6	Butts	5		
7	Kernels. (a) Uniformity	5		
	(b) Shape	5		
8	Length of ear	10		
9	Circumference of ear	5		
10	Space. (a) Between rows	5		
	(b) Between kernels at cob	5		
11	Proportion of grain to ear	20		
	Total			

Date

Variety

Weight of five ears

Weight of grain from these five ears

Proportion of grain to ear

The following outline of things considered and rules for cuts is found convenient for beginners in corn judging:

OUTLINE FOR SCORING DENT CORN.

Department of practical Agriculture, M. A. C.

		Things to Consider.	Rule for Cuts.
1	(a)	Nearness of approach to type as to general form of kernel, indentation, etc.	½ point off for each variation from type.
	(b)	Likeness between ears exhibited.	½ point off for each odd ear.
2		Shape of ear. Arrangement and character of rows.	½ point off for each poorly shaped ear.
3		Freedom from cross-breeding.	10 points off for { red cob in white ear or white cob in yellow ear.
		Trueness to variety color of kernel and cob.	1-10 point off for each mixed kernel. ‡
4		*Ripeness, soundness, freedom from injury, brightness of color and vitality.	1 point off for every diseased, injured, chaffy, or immature ear.
5		Uniformity of kernels, regularity of rows, completeness of covering.†	¼ point off for every badly covered tip. ½ point off for every inch of exposed tip. ⅛ point off for every ⅛ inch exposed tip.
6		Manner of rounding out and quality of kernels.	½ point off for every uncovered butt. 3-10 point off when butt is covered but kernels are flat.
7	(a)	Likeness in shape and conformity to type.	½ point for each set of kernels lacking in general uniformity.
	(b)	Approach to ideal wedge shape.	½ point off for each set of poorly shaped kernels.
8		Variation from standard length.	1 point off for every inch of excess or deficiency in length of ear.
9		Variation from standard circumference.	1 point off for every 2 inches of excess or deficiency in circumference of ear.
10	(a)	Outer space.	No cut for less than 1-32 inch between rows. ¼ point off for 1-32 to 1-16 inch between rows. ½ point off for 1-16 inch between rows.
	(b)	Inner space.	¼ to ½ point off for each marked case of space between near points of rows.
11		Per cent of grain to ear.	1 point off for each per cent short in weight of corn.

*Indicated by firmness of kernel on cob. †Does not have reference to length of cob.
‡Kernels missing count as mixed kernels.
For Dent Corn ears should have length of 9 inches, circumference of 7 inches, and shell 88% grain.