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EC748 Notes in Measuring

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COOPERATIVE EXTENSION WORK
IN AGRICULTURE AND HOME ECONOMICS
U. of N. Agr. College & U. S. Dept. of Agr. Cooperating
W. H. Brokaw, Director, Lincoln

June 1935

Extension Circular 748

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NOTES ON MEASURING

By
Ivan D. Wood

I. STRAIGHT LINE

A. Chaining

In all types of measuring work having to do with land surveys, it is almost always necessary to measure in a straight line. Considerable error may be accumulated in using a surveyors chain or tape by measuring in a zig-zag course. It is, therefore, necessary that the chainmen have some sort of guide such as the edge of a field, a fence line or that certain objects be sighted upon in order that a straight line can be maintained.

In Figure 1, in measuring from "x" to "y", the zig-zag line is actually longer than the actual distance from "x" to "y".

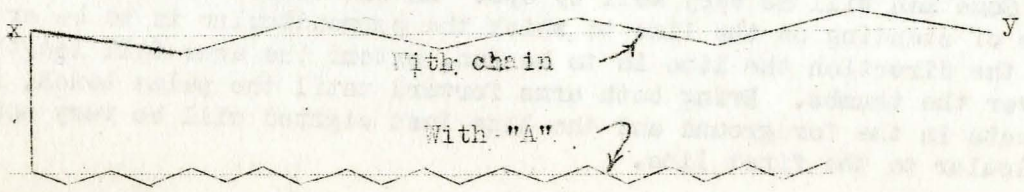

Figure 1.

B. With the Walking "A"

In using the Walking "A", it is absolutely necessary that a straight course be maintained. There is a chance for an error of an inch or more at each step if the "A" is allowed to wabble back and forth. In measuring a quarter of a mile, 264 laps with the "A" will be taken. If an error of one inch is made in each lap, there is a chance for a total error of 22' in measuring the line. It so happens that the slippage at the points of the "A" will partly compensate for this error.

C. Keeping on a Straight Line

It is practically impossible for a man to pick out one object in the distance and walk directly to it. Experience has shown that it is necessary to pick two objects in line. Then, by keeping these two objects in line, it is possible to walk a straight course. Thus, in attempting to measure a diagonal across a field with a Walking "A", it is necessary to have two objects sighted in the distance.

In measuring the altitude of a triangle as shown on Figure 2, the corner post at "y" and a tree at "z" might be sighted from a point "x". Inasmuch as "y" and "z" were in line with the operator, the line "x-y" will be straight. Many applications of this rule can be made in ordinary, rough surveying work.

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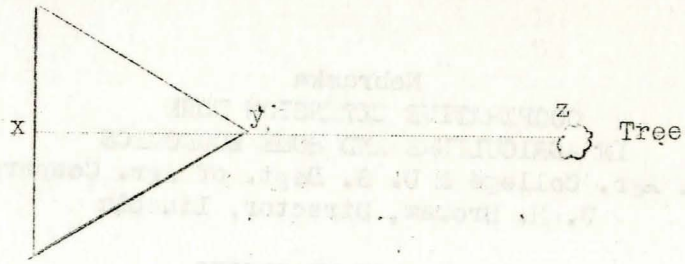


Figure 2.

In careful surveying, the two chainmen are kept on a line by a man with a transit who sights each pin as it is set. In the United States Coast and Geodetic Survey, the tape is pulled up with a spring balance in order to maintain perfect tension and corrections are made for expansion and contraction of the tape, due to changes in temperature.

II. TURNING OFF PERPENDICULARS

A. Using the Hands

It is easy enough with a transit instrument to turn off a perfect right angle. Some men will do very well by eye. An old scheme which works very well consists of standing on the line to which the perpendicular is to be erected, face in the direction the line is to be run, extend the arms full length and sight over the thumbs. Bring both arms forward until the palms touch, sight on two objects in the foreground and the line last sighted will be very nearly perpendicular to the first line.

In Figure 3, the operator stands at "x" on the line "a-b" with arms extended pointing in the direction of "a" and "b". Hands are brought forward until the palms touch. The operator then sights on the points "x" and "y" and proceeds to measure the line.

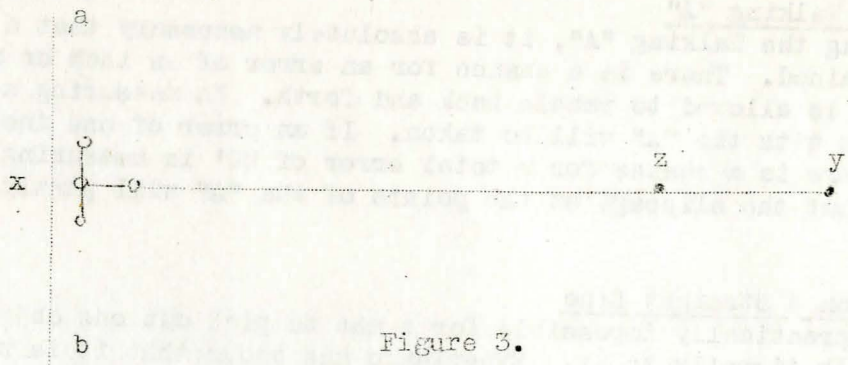


Figure 3.

B. Using the Walking "A"

The Walking "A's" used in the field are quite accurately made. The cross-bar at the bottom and the handle are set at a 90° angle. By placing the cross bar parallel to a fence line, for instance, and sighting down the handle as shown in Figure 4, a perpendicular may be erected to any line with fair accuracy.

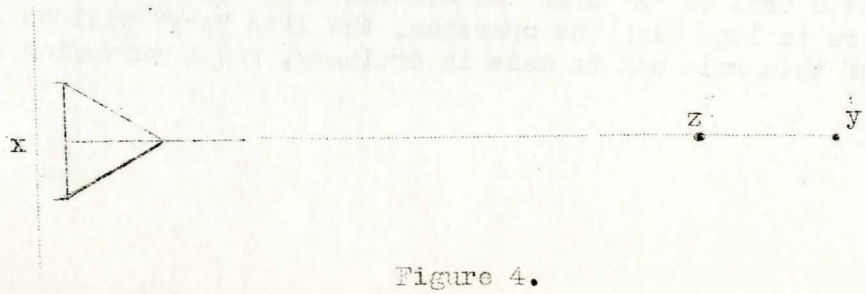


Figure 4.

III. MEASURING

A. Using the Tape

(a) Measuring is done with all sorts of devices such as 100' tapes, 66' chains and calibrated wires. Tapes are ordinarily calibrated in feet and the standard surveyor's tapes are 100', 200', and 500' in length.

The 66' chain has one advantage, and that is that the length of a field in chains may be multiplied by the width in chains and the answer is directly in acres after one place is marked off in the resulting figure. Thus, a field 20 chains long by 20 chains wide would contain 40 acres.

(b) Anyone using the 100' tape should learn how to do up a tape properly, how to throw it into a double circle and also how to let it out again for measuring purposes. A great deal of time is lost in straightening out snarled chains unless this process is learned. The process can scarcely be described in words and must be learned by demonstration.

(c) Chaining Pins. When using a 100' tape, the surveyor ordinarily uses eleven chaining pins made from 3/16" iron and from 14" to 18" long. The top is bent into a ring for convenience in carrying. Ordinarily, a red rag is tied through the ring to permit the back chainman to find the pin.

(d) For quick and effective measuring work, two operators are required when using a chain or tape. The rear chainman takes one pin and the front chainman ten. The chain is stretched up in the proper direction and pulled tight. The rear chainman calls "Stick" as soon as he has the end of the tape even with the back pin. The front chainman sticks the pin and calls "Stuck". The rear chainman should then drop the chain and allow it to drag, or at least carry the end without tension in the tape. The distance measured at any time will be the number of loose pins that the rear chainman has in his hand.

(e) The rear chainman should align the front chainman by sighting ahead to two objects, as previously explained.

Less mistakes will usually be made if the zero end of the tape is carried ahead. Supervisors in the field are making a lot of mistakes in mis-reading lengths, such as calling a 40' measurement 60' by not noting which end of the chain is ahead.

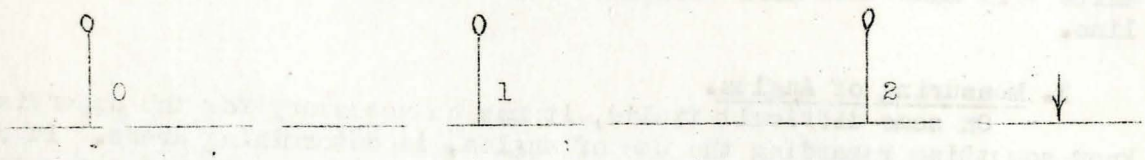


Figure 5.

(f) Care of Tape. The tape cannot ordinarily be broken by tension. A slight jerk will break it when kinked. Keep the tape dry when not in use. If the surface becomes rusty, it may be dragged behind a car through a stubble field or on a dirt road. Dragging through gravel will soon destroy the babbitt calibration marks.

B. Using the Walking "A"

(a) In order to do accurate measuring with the "A", the distance between points must be carefully calibrated. If this distance is to be 5', it must not be 5'-$\frac{1}{2}$". Two points can be marked on the bumper of a car exactly 5' apart and the "A" can be calibrated for each field measured. The bottom bar of the "A" may be marked off in tenths or in feet and inches, if desired.

(b) It is necessary to walk in a straight line as before described.

(c) An operator will ordinarily do better work by counting out loud. A small tab may be thumb-tacked to the leg of the "A" and each 100 laps marked on the tab with a pencil.

C. Effect of Slopes.

(a) Land Surveys. Careful land surveys are not made over the slopes. In Figure 6, a hill occurs between points "a" and "b". If the measurement is taken over the hill, the distance from "a" to "b" will, of course, be longer than if the measurement was made over level land. In careful land survey, the tape is leveled up on each measurement so that the resulting distance is the same as though the land were level between "a" and "b".

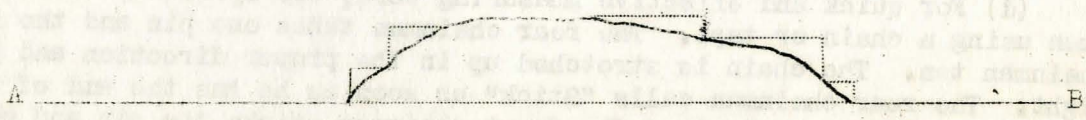


Figure 6.

Many errors result in attempting to take slope into consideration and, therefore, it is being largely neglected this year except in extreme cases.

(b) Slope Tables. On Page 2 of L-15, will be found a description of the effect of slope and a slope table.

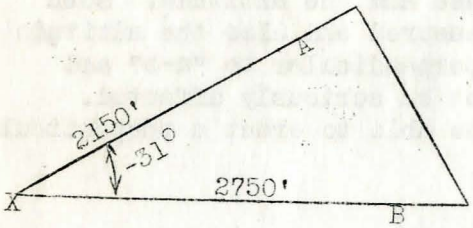
D. Use of Range Poles.

In many measuring problems it is necessary to establish a straight line which can be found again. For instance, in the case of an irregular field where offsets are necessary it is desirable to have a base line which can be found at will. This line may well be marked with range poles made from 1" x 2" material and from 6' to 8' long. Painting with alternate bands of red and white will make them more visible. Four range poles will usually mark any line.

E. Measuring of Angles.

On some difficult fields, it may be necessary for the supervisor to know something regarding the use of angles, in determining areas. In Figure 7, is shown a triangle. To determine the area, it is only necessary to measure the sides "a" and "b" and the included angle at "x". The area is then given by the following formula:

A x B x natural $\frac{1}{2}$ sign of the angle X = Area



2150 x 2750 x .258 = 5,912,500

5,912,500 x .258 = 1,525,425.0 =35.01 A

(See Page 11, L-15)

Figure 7.

A complete description of this method will be found in L-15, Page 4, and a table of natural one-half sign values is found on Page 10. In L-15, there will also be found the complete description of angular measurements on many sided fields and methods are given for plotting up these fields and determining areas.

IV. FIELD MEASUREMENTS.

A. Rectangles.

By far the greater proportion of all fields in Nebraska are rectangles. This is due to the system of rectangular land surveys instituted in middle-western states. Undoubtedly, the greatest proportion of all fields are long and narrow rectangles.

Due to inaccuracy of original surveys, many field corners are not exactly right angles. Figure 8, shows a-b-c and d as a perfect square. a-d-f and e shows a deformed figure which represents a common shape of field. The angle at "a" may vary $8\frac{1}{2}^{\circ}$ from a right angle and still affect the area of the rectangle only 1%. It is imperative that all four sides be measured on square fields and those which approach squares.

Figure 9, shows a long, narrow rectangular field with a width of 220 feet and a length of 1,300 feet, a common shaped field. If a supervisor measures only one side and one end he may introduce a serious error into the work. The end measurements should both be taken. A difference of 20 feet in the length of the long sides causes an error of only 2,500 square feet but a difference of 20 feet in the length of the ends makes an error of 13,000 square feet. The error in side measurement is represented by the small triangle at "a" while the error in end measurement is represented by the big triangle at "b".

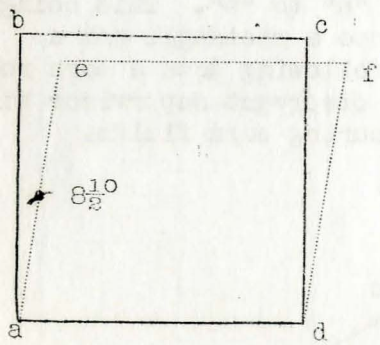


Figure 8.

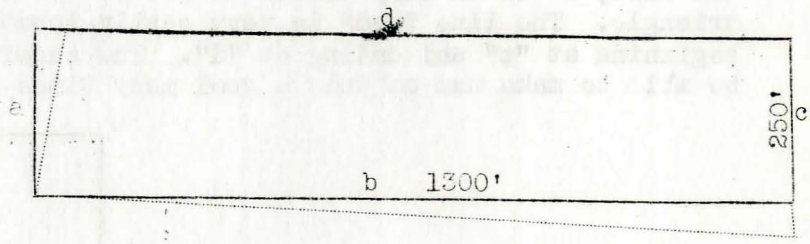


Figure 9.

B. Triangular Fields

Luckily, most triangular fields are right angle triangles or nearly so. The areas can be determined by measuring two sides with fair accuracy. In other triangular fields, it is necessary to measure the base and the altitude. Such a field is shown in Figure 10. The base "a-b" is measured and also the altitude "c-d". The line "c-d" may not be laid off exactly perpendicular to "a-b" and still the accuracy of the area determination will not be seriously affected. The average supervisor with a little practice will be able to erect a perpendicular line with sufficient accuracy.

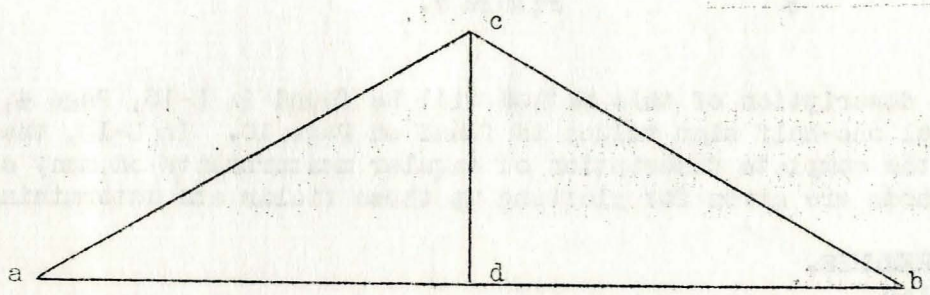


Figure 10.

In many corn fields, it may not be possible to measure diagonals, due to the high corn. In this case, the three sides of the triangle may be measured and solved by the formula given in Extension Circular 747, Figure 7. This method requires considerable computing in the office and should not be used except in extreme cases.

Other Shaped Fields. Most other field shapes are covered in Extension Circular 747, as are the methods of making computations for area. This circular should be carefully read by each field supervisor.

V. MEASURING IN ROW CROPS.

Under Production Control contracts, all measurements in row crops are made at a distance of one-half the width of a row from the sides and ends of the field. In other words, if rows are 42" apart, then all measurements are made 21" outside the actual area covered by the crop.

In some cases, it is possible to make use of a corn row in determining field areas but it is ordinarily not good practice to compute fields by counting rows as there is a liability of too much variation in row widths.

A simple case where rows may be put to good advantage is shown in Figure 11. The rows are planted in the direction of "a" to "b". This being the case, it is an easy matter to divide the field into a rectangle and a triangle. The line "c-d" is very easily located by following down a corn row beginning at "c" and ending at "d". The careful and observant supervisor will be able to make use of this a good many times in measuring corn fields.

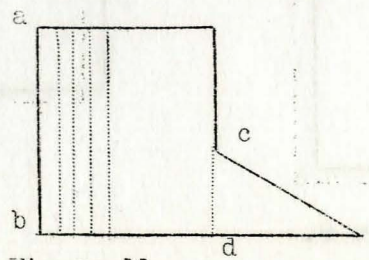


Figure 11.

VI. COMPUTATION

District Supervisors who are contacting counties should become familiar with computing machines and methods of computation. Bulletin L-15, will be found of some value and the following notes are given for reference purposes.

A. When Walking "A"'s are Used

Walking "A's" are made in widths of 5' and 6.6'. The 6.6' "A" is one-tenth of a chain. Some counties have made the mistake of making this "A" 6'-6", which is incorrect. The actual width between the points is 6'-7 3/16". When the 5' "A" is used, the following formula can be used in computing areas:

$$\frac{\text{Width in laps x length in laps}}{1742.4} = \text{Area in Acres}$$

Another method is to work out the total area in square feet and divide by 43,560 - the square feet in an acre.

When the 6.6' "A" is used, the area is determined by multiplying the width in laps by the length in laps and marking off three places in the answer.

When converting laps of the "A" to feet, the lap table attached should be used. All counties should be provided with these lap tables if they do not have them. It is sometimes necessary for a supervisor in the field to compute acreages without a machine. The Second Supplement to L-15, also attached, gives a method for doing this rapidly and accurately by shifting decimal points. Counties which are not supplied with the table may secure the same by writing to the Office of the Extension Engineer.

In many offices the computing work is done by inexperienced girls who are more or less unfamiliar with the field measurements. It should be the duty of the District Supervisor to look over the computing set-up carefully and find out if the work in the field and the computing in the office is being carefully correlated.

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