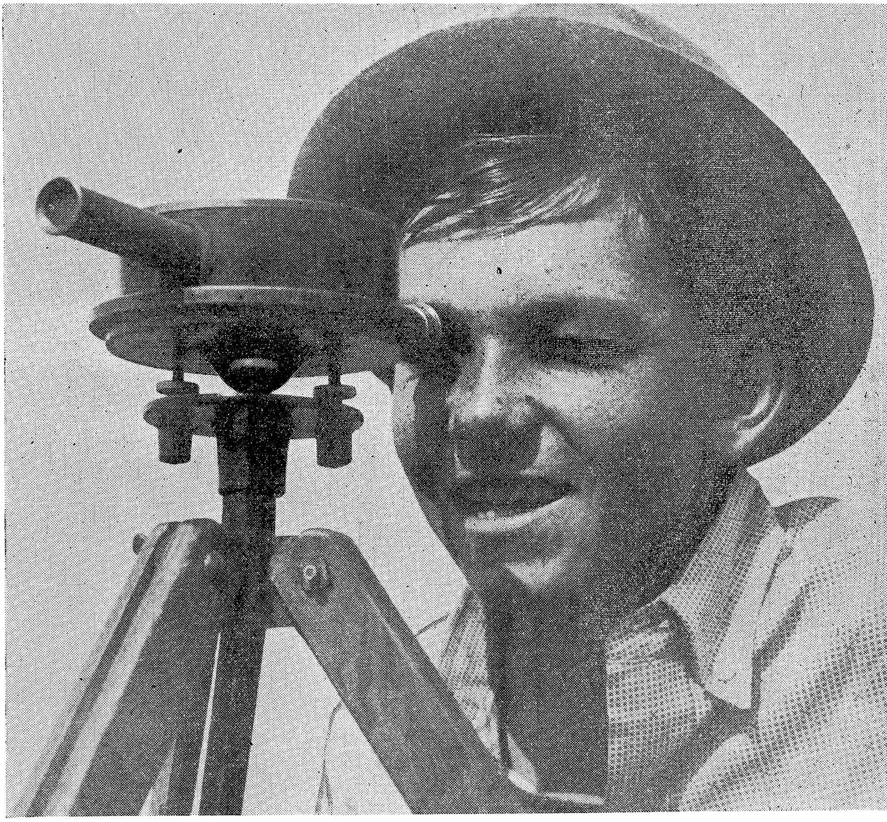
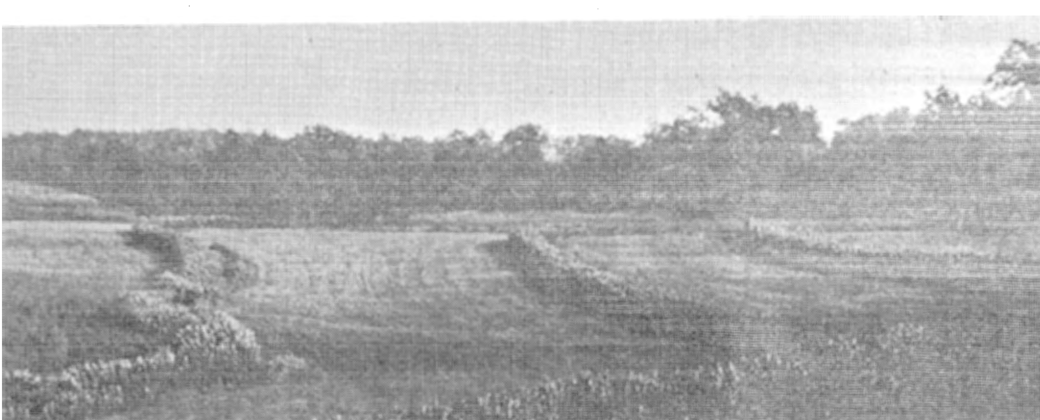


4-H Club Agricultural Engineering Manual

Circular No. 338 1937 Club Series 98

Oklahoma A. and M. College, Extension Division



4-H Club Agricultural Engineering Manual

TERRACING

PROFILE LEVELING

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Although terracing has been known and practiced for centuries, it is only in the last 50 years that it has been thrust upon the consciousness of the people of the United States as an urgent national problem. Terracing is only about 20 years of age in Oklahoma.

Row cropping of cotton and tobacco in the Piedmont section of the Old South speedily changed a new and fertile area into one badly eroded and depleted beyond economic crop production. When farmers saw the top soil going down the rivers, they were alarmed and commenced to seek methods for erosion control. This brought about the first Mangum terrace on the Mangum farm at Wake Forest, North Carolina, the original home of the broad base terrace.

Oklahoma is one of the most severely eroded states although it is one of the youngest states in the union. Oklahoma ranks fifth in the production of wheat and cotton. In order to overcome the devastating evils of erosion, we must hold and protect our soil by terracing and contour farming. Many of the steeper slopes shoud be protected and put back to grass. A program of this type, to be successful, must receive close cooperation by the adults and 4-H Club members of this state.

The main purpose of terracing is to keep water from collecting in sufficient quantities to wash gullies. Terracing is not a cure-all method of preventing erosion, and consequently must be supplemented by contour farming and other soil conserving practices. Terraces without contour farming will retain much water and soil on the field, but contour farming protected by terraces will do the job much better. Terraces prevent gullies, thereby enabling the farmer to cultivate his field with more ease.

The purpose of the 4-H agricultural engineering club is to train 4-H farm boys to conserve and use natural resources; to create a greater interest in the soil and farmstead improvement.

STATE 4-H AGRICULTURAL ENGINEERING CONTEST

Club members between 10 and 20 years of age, inclusive, are eligible to membership in the 4-H Agricultural Engineering Club.

A county agricultural engineering team consists of two members who are allowed to compete in two state contests per year, the annual 4-H Round-Up at Stillwater, and one of the three state fairs.

At the annual 4-H Club Round-Up farm levels are awarded as prizes to the winning teams. Club members who have won such prizes are not eligible to compete a second time.

Reports

A prescribed report is considered a very important factor in the agricultural engineering contest. The report should be filled out on the regular 4-H agricultural engineering report blank. If additional reports are to be had, they should be kept in neat form in a loose leaf notebook containing such information as newspaper clippings, announcements of terracing demonstrations, plats of the farms and fields that the club member has run lines on, or any other phase of agricultural engineering with which the club member has assisted.

These reports should be brought up to date and handed to the person in charge of the contest. The reports are graded and returned to the club member.

Rules Governing the 4-H Agricultural Engineering Contest

Club members participating in the terracing contest are graded on the following:

A. General knowledge of terracing 60%
   1. Setting up level, naming and identifying parts of the instrument 10%
   2. Ability to test and report the error of the instrument 10%
   3. Oral or written quiz 40%
      In this quiz, club members are held responsible for subject matter found in Extension circulars pertaining to agricultural engineering.

B. Farm Pond 10%

C. Profile Leveling 10%

D. Written reports submitted 20%

COUNTY AGRICULTURAL ENGINEERING CONTESTS

Before the State 4-H Club Round-Up at Stillwater, a county-wide engineering contest should be held under the supervision of the county agent and his co-workers. At this time the champion terracing teams and the highest scoring demonstration team should be selected and given the privilege of participating in the state contest.

THE FARM LEVEL

SETTING UP THE LEVEL

Remove the level from the case and screw it on the tripod head. Adjust the level screws to mid-position in the three bosses. This puts the spring under slight tension and allows the leveling screws to be either raised or lowered in leveling. Be sure that one screw is between the little lugs on the bottom of the horizontal limb.

When carrying the instrument, the tripod should be held over the left forearm, the level about one foot in front. This method prevents jamming the instrument in case of stumbling or falling while walking over the field.

The following exercises, in the exact order of steps indicated, should be carefully practiced, so that by the time of the county elimination contest, the club member will be able to set up this instrument within 30 seconds.

1. Set the instrument up and spread the legs of the tripod three or more feet and spike one firmly, then turn the telescope over two of the legs and spike the second firmly into the ground, so that the bubble in the vial is fully visible; then turn the telescope over the third leg of the tripod and force the spike into the ground, shifting it sufficiently to again keep the bubble fully visible in the vial. This method of keeping the bubble roughly centered in setting up the tripod makes the final adjustment with the leveling screws very brief and avoids distortion of the spring and pivot screw.

2. Tighten the wing nuts and focus the telescope by pulling the eye piece in or out until objects beyond 50 feet are clearly visible. (Do not twist.)

3. Set the telescope exactly over two of the leveling screws and center the bubble by turning the screws equal amounts in opposite directions.

4. Set the telescope exactly over the third screw and center the bubble using this screw only.

5. Repeat the centering in both positions.

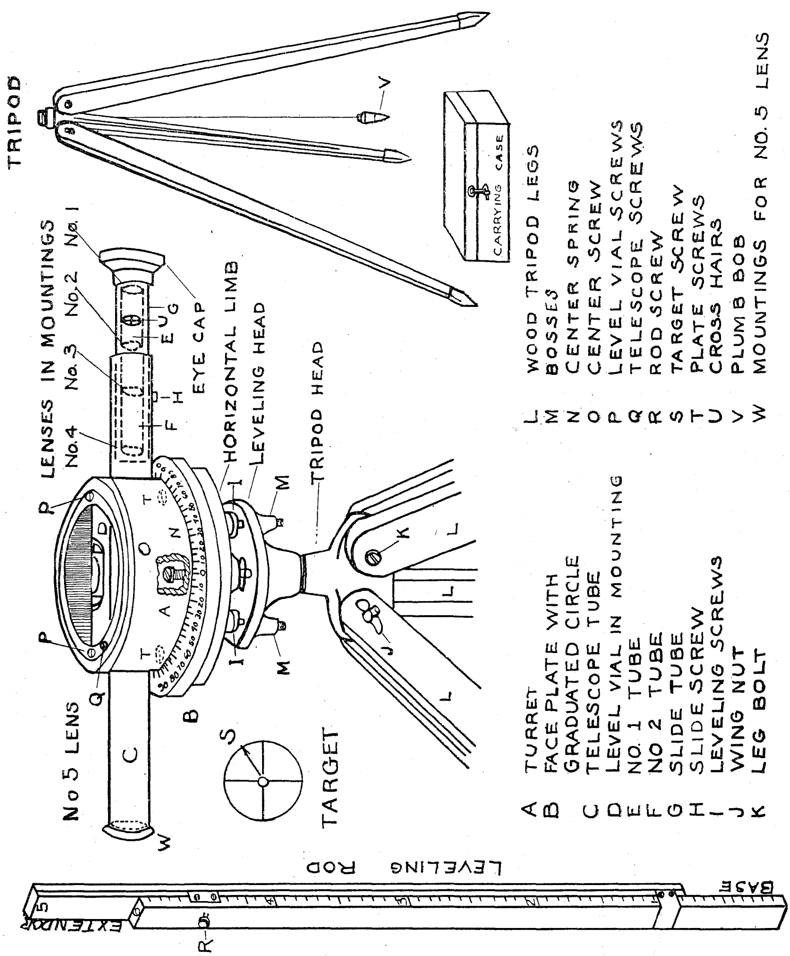


Fig. 1.—Showing Parts of a Farm Level.

6. Do not touch any part of the instrument while sighting.

7. Sight over the telescope, bring it in line with the target or object to be observed by a slight pressure sideways with the tips of the forefingers on each hand. Use the tangent screw, where available, for exact setting of vertical hair.

8. Always check the bubble, before and after each sight to be sure it is still in adjustment.

TESTING THE FARM LEVEL

The discussion in this bulletin is limited to the type of level with a turret and three leveling screws. This method will apply to levels with or without stadia hairs; other methods of testing levels are found in Circular No. 218.

TESTING THE BUBBLE VIAL

Set up the instrument on firm ground and level it. Turn the telescope over two of the leveling screws and adjust until the bubble is exactly in center of the vial; then turn the telescope over the third leg and level. Check back from the first two legs and make any adjustment necessary. When the bubble remains centered for these two positions, turn the telescope until it points in the opposite direction to one of these positions. If the bubble still remains in the center, the vial is in good adjustment. If, however, the bubble shifts, then adjustment is necessary.

TO ADJUST THE BUBBLE VIAL

First level the instrument and take out the screws that hold the turret in place, first noticing to which end of the vial the bubble has approached. Loosen one of the small screws in the turret that holds the bubble vial in place and tighten the screw on the lower side of the turret. The bubble vial will be moved toward the screw that is being tightened. Replace the turret on the horizontal limb and relevel the instrument. Check the bubble again. Repeat the operation until the bubble remains in center position at different directions of the telescope.

TESTING THE TELESCOPE BY THE METHOD OF INVERTING THE TURRET

Set up the instrument on firm footing and level; release the turret so it can be easily removed. Measure 100 feet from the instrument and drive a stake. With the rod on this stake, read the center horizontal hair with the turret in correct position; then invert the turret and again read the center hair Care must be taken not to disturb the tripod. The difference in the rod readings is twice the error of the instrument. To correct this error, remove the turret from the tripod, and adjust the small screw at the front port (where the telescope goes through the turret) to half the error. Take new readings on the rod to check. Repeat the process, if necessary, until the rod readings are the same when taken from the turret in the correct position and when turned over.

There are other methods of testing and adjusting an instrument. The two-peg method is perhaps the most practical one, aside from the inverted turret method. See Circular No. 218, "Terracing in Oklahoma" for two-peg method.

CARE AND REPAIR OF AN INSTRUMENT

The level or instrument is delicate and certain precautions should be taken in handling. Many instrument men have the habit of oiling the base of the turret of the farm level. This is bad practice because the dust and small particles of sand collect and form a grinding effect. Within a few years' time, the smooth finished surface of the turret is destroyed and too much play is present, thus preventing accuracy. When an instrument gets dirty or rusty clean it by using a soft cloth and gasoline, then wipe with a cloth with a little oil, but do not leave free oil on the surface. A small amount of graphite is much better than oil. There is enough graphite in the lead of a pencil to furnish sufficient lubrication.

The pivot spring, if kept under extreme tension, will become weakened and the horizontal limb cannot be held firmly after the instrument has been leveled. The leveling screw should not be oiled. No oil should be allowed to get around the adjusting screws. When the level is placed in the carrying case, some form of packing should be used to prevent jarring the instrument. To prevent rusting, the instrument should be dried thoroughly with a soft cloth after being used. The lens should be wiped dry with a soft cloth. The wing nuts of the tripod legs should be loosened when the instrument is not being used. If good judgment is used in caring for the instrument, it will last a long time.

TERRACING

SIZING UP THE AREA

One of the most difficult things that the club member will have to master is the ability to size up the area that is to be terraced or contoured. Since a terrace system is of a permanent nature, it should be planned with much care and discretion with due respect to the whole farm and should conform, as nearly as possible, to the adjoining watersheds. The following steps should be kept in mind when planning the terrace system for the average farm:

1. Water should not be diverted into the borrow pit of the highway unless it is the last resort.

2. Keep in mind the length of the terrace. The greater the length, the larger is the amount of water that the terrace has to carry.

3. As the natural drain or water-draw is where the water usually goes, it is good practice to turn the run-off water into the natural draw.

4. It is not advisable to divert more water into a natural drain than naturally flows there.

5. Plan the terrace system so that the least possible amount of outlet ditch need be constructed, with the least amount of fall along the ditch line and with the least possible cost.

6. If terraces are not excessive in length, pasture and timber are usually good places to discharge the terrace water.

7. Well sodded or vegetative areas can be used for disposing of the water, if the volume of water is not too large or the slope of the vegetative area too great.

8. Do not dump the terrace water on another man's property.

MEASURING THE SLOPE

The rodman takes the rod to the average high point where a rod reading is taken. As an illustration, we will say that the top rod reading is one foot. The rodman selects what he considers to be the average slope of the field, takes 33 steps, which is approximately 100 feet, directly down the slope, places the rod on average ground and secures another rod reading. The rod may read five feet. To find the amount of fall per 100 feet of slope, subtract the top reading, which was one foot in this illustration, from the bottom rod reading, which was five feet; the difference is four feet. This means that the ground is falling four feet vertically every 100 feet. This is a four percent slope.

The club member should consult the following table on terrace spacing in order to find how much vertical spacing should be given between the first terrace and the high point of the field. In this case, it would be three feet, according to the table.

A GUIDE TO THE PROPER SPACING OF BROAD BASE TERRACES

When the slope of the land in 100 feet is	Give a vertical fall between terraces of
* 1 ft.	2 ft. 0 in.
2 ft.	2 ft. 3 in.
3 ft.	2 ft. 9 in.
4 ft.	3 ft. 0 in.
5 ft.	3 ft. 3 in.
6 ft.	3 ft. 9 in.
7 ft.	4 ft. 0 in.
8 ft.	4 ft. 3 in.
* 9 ft.	4 ft. 6 in.
*10 ft.	4 ft. 9 in.

NOTE: This table is slightly revised from the similar table found in older editions of Extension Circular 218, "Terracing in Oklahoma," and is preferred to the older data.

***In this circular, it is necessary to give the vertical interval for all slopes of land that are at all tillable. Where land is very flat and shows no signs of gully erosion, the field may be contoured with strip cropping instead of terracing, if so desired. The terraces on this flat land at these intervals serve nicely for markers for either strips or contours and cost very little.**

Slopes of seven and eight percent are really a little too steep for row cropping. It is recommended that slopes above eight percent be put back into pasture or meadow where possible. However, we realize that there are farms where the farmer does not have sufficient land that is flatter, and necessarily must farm these slopes, but he should remember that his terraces should be built a little higher and a little extra precaution taken in keeping them up.

TO LOCATE THE FIRST TERRACE LINE

After measuring, we found we had a four percent slope. When the club member consults his tables relative to slopes and vertical spacings, he will find that on a four percent slope we give a three foot vertical drop. The rodman then adds the vertical spacing of three feet to his top rod reading, making the rod read four feet. Then he moves up or down slope until the cross hairs correspond with the cross on the target. At that point the first terrace should be located.

RUNNING THE TERRACE LINE

After locating the first terrace, the terrace line is run as follows: The rodman holds the rod some place on the terrace line which generally is the point located when locating the terrace. The target is raised up or down as signaled by the instrument man. When the cross hairs are on the target the rodman changes the target before leaving the station the amount to give the terrace the proper grade and steps 17 steps in the direction he thinks the terrace line is going to run. The instrument man signals either up or down; this means that the target is not to be changed but the rodman is to hunt either higher or lower ground as signaled. When the point is found where the target is on the cross hairs, this is marked as another point on the terrace line. In like manner, other points are found. If the terrace is to be level, the rodman does not change the target.

If the terrace is to have a fall and the rodman is going in the direction in which the water is to run, he must raise the target the proper amount and if he is walking in the opposite direction in which the water is to run along the terrace, he is to lower the target the proper amount for the grade.

There are two common types of grades, one is the constant grade, meaning that the amount of fall for 100 feet along the terrace or ditch line is constant throughout its length. This type of grade is not recommended for average terracing in Oklahoma. The other is the variable grade; that is, the grade varies along the terrace. We shall take as an illustration a terrace 900 feet long, and in our mind locate about where this terrace will run. Run the first one-third of this terrace, which would be approximately 300 feet, on the level; then, give the second one-third, or a second 300 feet distance, a grade of perhaps one-half inch per 100 feet. Give the last 300 feet or the final one-third of this terrace, a grade of one inch fall per 100 feet. This method is recommended for terraces where a grade is applied to a terrace system.

The rodman should remember that the target is to be raised the proper amount for the given grade when he is walking in the direction he expects the water to flow, but lowered when he is walking in the opposite direction from which he expects the water to flow. For reference see Circular No. 218, "Terracing in Oklahoma."

DUTIES OF RODMAN

When surveying terraces or contour lines, the rodman holds a very important position and much is dependent upon his accuracy. A good rodman should be alert, hold his rod as nearly vertical as is possible, watch the instrument man for signals, and locate the rod on average ground, trying at all times to keep his stations and grades well in mind.

(Continued on page 14)

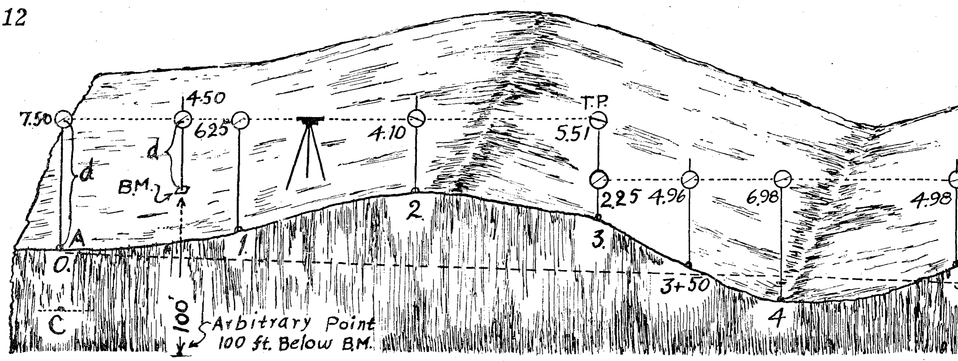


Fig. 2.—Method of Ru

FIELD NOTES FOR PROFILE

Station	+B. S.	H. I.	—F. S.	Ground Elev.	Grade Elev.	Cut	Fill
B. M.	4.50	104.50		100.00			
0+00			7.50	97.00	97.00	0	
1+00			6.25	98.25	96.67	1.58	
2+00			4.10	100.40	96.34	4.06	
3+00			5.51	98.99	96.01	2.98	
T. P.	2.25	101.24					
3+50			4.96	96.28	95.84	.44	
4+00			6.98	94.26	95.78		1.52
5+00			4.98	96.26	95.45	.81	
6+00			1.97	99.27	95.11	4.16	
7+00			4.75	96.49	94.78	1.71	
T. P.	3.52	100.01					
8+00			2.51	97.50	94.45	3.05	
9+00			4.52	95.49	94.11	1.38	
9+60			6.25	93.76	93.76	.00	

The readings in columns "Sta.," "B. S." and "F. S." are taken from the figure above. The columns "H. I.," "Ground Elev.," "Grade Elev.," "Cut" and "Fill" are calculated as follows:

How to calculate H. I. and Ground Elevation

Rod readings are the distances between the line of sight and the ground where the rod is setting as shown at "d" in figure above. H. I. is the distance the line of sight is above the arbitrary point. Therefore H. I.=B. S.+Ground Elev.

Since the H. I. or the line of sight is above ground level, it is necessary to subtract the rod reading (F. S.) from the line of sight to find the ground elevation.

H. I.=B. S.+Ground Elev.
=4.50+100=104.50

Ground Elev.=H. I.—F. S.
=104.50—7.50= 97.00
=104.50—6.25= 98.25
=104.50—4.10=100.40
=104.50—5.51= 98.99

H. I.=B. S.+Ground Elev.
=2.25+98.99=101.24

Ground Elev.=H. I.—F. S.
=101.24—4.96=96.28
=101.24—6.98=94.26
=101.24—4.98=96.26
=101.24—1.97=99.27
=101.24—4.75=96.49

H. I.=B. S.+Ground Elev.
=3.52+96.49=100.01

Ground Elev.=H. I.—F. S.
=100.01—2.51=97.50
=100.01—4.52=95.49
=100.01—6.25=93.76

Available fall=Difference between the zero station and last station=97.00—93.76=3.24 feet.

How to calculate Grad

Grade= Total fall / Total distance =

feet per foot=.0033×10
100 feet.

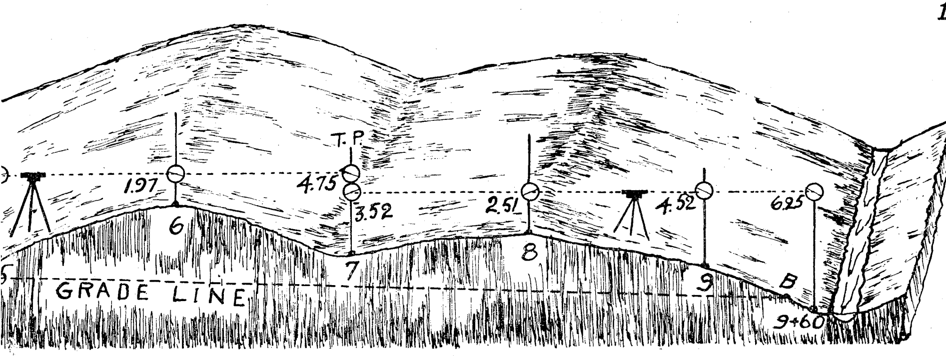
97.00—.33=96.67
96.67—.33=96.34
etc.

How to calculate Cut.

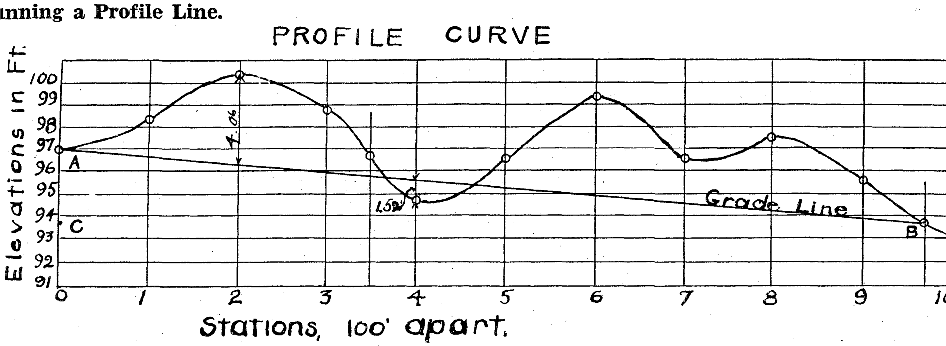
Ground Elev.—Grade El
97.00—97.00=0
98.25—96.67=1.58
etc.

How to calculate the F

Grade Elev.—Ground E
95.78—94.26=1.52
etc.



nning a Profile Line.



The Above Profile Curve Plotted From The Data on The Adjacent Page.

e Elev.
3.24
—— =.0033
960
0=.33 ft. per
ev.=Cut
ill.
lev.=Fill

EXPLANATION OF THE PROFILE CURVE

1. **Curve.** The curve shows the profile of the surface of the ground. The curve is plotted by marking the stations along the horizontal base line. The distance between stations in this case is 100 feet. That is, the distance from station 1 to station 2 is 100 feet, from station 5 to station 6 is 100 feet and so on. Many times there may be an abrupt rise or a gully that happens to be between stations. Under these conditions, an extra rod reading should be taken at these unusual points and the readings recorded as fractional stations. On the curve it will be noted there is 1/2 station between stations 3 and 4 and there is a fractional station beyond station 9. These are necessary, otherwise these unusual high or low places are not indicated on the curve. The elevations or vertical distances are plotted from the column under the heading "Ground Elevations" from the table on the adjacent page. These elevations on the curve are the distances above the arbitrary line 100 feet below the bench mark; therefore, this curve really represents the cross section of the surface of the ground.

2. **Grade Line.** The grade line represents the bottom of the ditch. If there happens to be considerable fall along the surface of the ground where the ditch is to be made the proper grade may be chosen. In the curve it is chosen as four inches per 100 feet. This is generally about as much fall as is desired. A ditch with a fall of six inches per 100 feet may wash badly. Starting with the point A, draw a line to point B. To find point B, it will be necessary to know the distance from point A to B. In this case, it happens to be the distance between station zero and station 9+60 which is 960 feet. If we allow a fall of four inches per 100 feet, the total fall will be

9.60×4=38.4 inches or 3.24 feet. From point A drop down a distance representing 3.24 feet to point C. Draw a horizontal line from C to where it cuts the curve as indicated by B. Then a line drawn from A to B, as stated above, is the grade line. If there had not been sufficient fall to choose the grade, then it would have been necessary to use all the fall available and B would be in the low place where the water is to be discharged. A line drawn from A to the outlet of the ditch B will be the grade line. Then, the amount of the grade is figured by dividing the total fall by the total distance (as shown at bottom of center page). Since the curve represents the surface of the ground and the grade line represents the bottom of the ditch, it is easy to see that the distance between the curve and the grade line represents the depth of the ditch at the various places along the line. Where the curve drops below the grade line, it indicates that the surface of the ground is lower than the bottom of the proposed ditch, and it may be necessary to build a dam in this natural gully below the proposed ditch in order to confine the water in the desired channel. This distance between the grade line and the curve below shows the distance it will be necessary to fill the gully in order to be level with the bottom of the proposed ditch, but to confine the water in this proposed ditch, it will be necessary to build a levy at least three feet higher than the grade line on the lower side of the proposed ditch.

Examples: At station 2, it will be noticed that the depth of the cut is 4.06 feet. It will also be noticed that on station 4 the curve goes 1.52 feet below the grade line. Therefore, the fill will need to be 4.52 feet high which gives three feet above the bottom of the ditch. This profile curve should be plotted on regular cross section paper so that it will be possible to read fairly accurately to one tenth of a foot. However, it is not absolutely necessary to have cross section paper because the stations can be ruled off at equal spacings and equally spaced horizontal lines can be drawn representing elevations of one foot. Then, to get accurate results, a scale can be used to find the fractions of a foot.

OUTLET CONTROL WORK

Much research has been done on outlets for terraces and ditches. The native stone baffle has proved its worth where native rock is plentiful. The concrete brick check and spreader is a very good method of checking the flow of water. The loose rock baffle can be used where the flow of the water is not excessive, and especially when vegetation is used as a binder for the rock. Circular No. 328, "Baffles for Terrace Outlet Control" will be the text for 4-H Club agricultural engineering members to study on outlet control work. The club member should familiarize himself with the contents of this bulletin.

THE FARM POND

The 4-H Club member in agricultural engineering is expected to have a knowledge of how to lay out and construct a farm pond.

The farm pond or small lake has two phases which should be considered. These phases are structural and biological and following is a brief discussion of them:

1. Construct the dam with clay core to prevent seepage.
2. Install shell wall to prevent burrowing of animals, such as mink, muskrats and crayfish.
3. Install silting basin or vegetative cover to prevent the pond from filling up with silt.
4. Use surface dirt on downstream side of the dam to encourage growth of grass.
5. Rip-rap the upstream side of the dam to prevent wave and wind action from affecting the dam.
6. Provide steep shores and stock with fish to prevent mosquitoes.
7. Install a non-erosive spillway to prevent break in dam in time of flood.
8. Plant mosses in the water to act as purifiers.
9. Exclude deleterious salts to prevent damage to plant growth.
10. Fence the pond to exclude livestock and avoid liver fluke infestation in sheep.
11. The weir notch of the spillway should be screened or wire guarded to prevent the loss of water life.
12. A drain for complete drying may be installed in order to remove objectionable accumulations.
13. Stock the pond with snails to clean out slime.
14. Stock with tadpoles to destroy decayed vegetable matter.
15. Stock with clams to strain the water for microscopic life.
16. Stock with scale fish to destroy mosquito larvae and provide food for the table.
17. Stock with catfish to consume organic matter.

PROFILE LEVELING

INTRODUCTION

While terracing work can be done without it, a knowledge of profile leveling is an advantage because so many fields are located below a pasture or neighbor's farm and it becomes necessary to construct a hillside ditch to cut excess water off the field before terracing. Profile leveling makes it possible to avoid extra work because preliminary lines can be run and the one chosen that requires the removal of a minimum amount of dirt for the ditch and the minimum fills to be made.

Then again, profile leveling is extremely important in drainage work. Many times it is impossible to determine with the eye whether or not a flat wet place in a field can be drained. A profile line determines quickly whether or not this place can be drained and how deep to make the ditch at various places. If gullies are crossed, it is very easy to know what fill to make in order to divert the water into the ditch rather than to let it break across the field in a natural gully where it is not wanted.

The principles of profile leveling are not difficult. It is possible for the average 4-H Club boy to get a working knowledge of profile leveling from this circular. By attending a one-day 4-H Club school in addition to studying this circular, many boys and farmers ought to be able to use the level in running profile lines to determine where to put hillside ditches, how to drain low wet places in their fields, and through additional study they can undertake the installation for tile drainage systems.

Since the greater portion of terracing and drainage work in the state of Oklahoma is yet to be done, it is going to fall on the young men who are now 4-H Club members to do this work and it is highly important that they study profile leveling along with terracing and other methods of soil conservation in order that they may be able to do the work efficiently and at the least possible cost.

DEFINITIONS USED IN PROFILE LEVELING

Before one can understand the principles of profile leveling clearly, it will be necessary to know the meaning of the following terms:

1. *Bench Mark* (B. M.). A station of assumed elevation from which the elevations of the other stations are calculated. It is necessary that we have a reference station from which all other points are compared. We will call this station the

bench mark (B. M.). This bench mark should be located in a place where it will not be disturbed and can be easily found. A heavy stake driven flush with the ground will serve as a bench mark. The location of the bench mark should be described from some given object so it may be easily found. It does not need to be on the profile line that is being run. It is the station on which the first reading of the rod will be taken and all elevations, figured along the profile line, will be relative to this station. The elevation of the B. M. will be considered as 100 feet above the imaginary or arbitrary point below. See drawing at top of pages 12 and 13.

2. *Stations* (Sta.). Stations are points along the line being run where the rod readings are taken. Stations may be placed at intervals of 100 feet along the line to be run. Mark the stations as bench mark, zero, 1, 2, 3, etc. See table on pages 12 and 13 of this manual. Occasionally an extra station may need to be put in some low place or some particularly high place that falls between regular stations. These stations should be indicated as fractions of stations; for example, the figure at the top of the center page shows a station between 3 and 4 and a 1/2 station between 9 and 10. The elevations of these unusual places should be taken in order that they may be shown on the profile curve.

3. *Backsight* (B. S.). Backsight is the rod reading taken on a station of known or assumed elevation. The term backsight does not mean sighting backwards. It is the first reading on the rod after each set-up of the level. The readings are recorded under the column "B. S." in the table on the center page. The reading on the bench mark is always a backsight. It is necessary that we have the backsight reading after setting up the level each time in order to compute the elevation of the other stations. The B. S. reading is thought of as a plus reading because it is added to the known elevation in order to find the height of the instrument.

4. *Height of Instrument* (H. I.). The term, height of instrument, means the distance the line of sight of the level is above the arbitrary point below the bench mark and is expressed in feet. It is necessay to have the height of this line of sight in order to determine the elevations of the various stations along the profile line. For example: H. I.=B. S.+ Elevation.

5. *Foresight* (F. S.). Foresight is the rod reading taken on a station of unknown elevation. Foresight reading does not mean sighting in a forward direction. Foresight readings are the readings taken on the various stations. For example, the first reading after the instrument is set up is a backsight and all the rest of the readings taken before the level is changed are foresight readings. After the level is moved and set up again, a backsight must be taken on the same station that the last foresight was taken. Foresight readings are thought of as negative readings because they are subtracted from the height of the instrument in order to find the elevations.

6. *Elevation.* The true meaning of elevation is the distance in feet above the sea level, but since there are comparatively few marked elevations above sea level, the average person is interested only in comparative elevations. So, in this discussion, elevations are distances above a chosen imaginary point or line below the bench mark. For rolling countries, this chosen point is 100 feet below the bench mark. Therefore, the elevations are distances above a horizontal line drawn through the imaginary point, rather than exact elevation above sea level. If work is being done in a mountainous country it would be necessary to use 1,000 or more feet above the arbitrary point instead of 100 feet. Elevation=H. I.—F. S.

7. *Turning Point* (T. P.). The turning point is used as a reference point when moving the level. It is generally not possible to take all readings along a line without moving the level. Some of the reasons for moving the level are: A tree or building may obstruct the view; the distance from the level to the rod may be too great for accuracy; the slope of the ground may be such that the line of sight may hit the ground below the rod or the rod may not be long enough to reach up to the line of sight. There are always two readings taken on the turning point, a foresight (F. S.) and a backsight (B. S.). Before the level is moved a foresight (F. S.) reading is taken on the last station. This station is called the turning point (T. P.) and after the level is moved and set up in a new position a B. S. reading is taken on the same station. They should be recorded as shown in the table on the center page in this manual.

8. *Grade.* The term grade is used to denote the number of inches or the fraction of a foot fall per 100 feet along the bottom of a ditch or along a terrace. For example, we speak of a grade as a fall of two inches per 100 feet or four inches

per 100 feet, etc. Grade is also expressed as a percent. For example, a two percent grade means a fall of two feet in 100 feet distance. Grade is found by dividing the total fall by the total distance. That is, $\frac{\text{Total fall}}{\text{Total distance}} = \text{Grade}$. Suppose a ditch 800 feet long has a fall of eight feet, then $\text{Grade} = \frac{8}{800} = \frac{1}{100} = .01 = 1\%$. That is, the fall along the ditch is one foot for each 100 feet length.

A constant grade means that the fall along the ditch is uniform. That is, each 100 feet length of the ditch has the same fall. Variable grade means that the fall is not uniform along the ditch. For example, the upper 100 feet may have a zero percent grade, the next 200 feet may have a one percent grade, and the remainder of the ditch may have a two percent grade. The grade may be increased near the lower end of the ditch but should generally not be decreased because a decrease in grade will cause the rate of flow of water to be less, thus causing sediment to settle out, thereby filling the ditch with silt.

9. *Profile Curve or Graph.* Profile curve or graph is an outline of a cross section. For convenience in determining the depth to cut the ditch in various places along the line, it is advisable to plot a curve using the vertical distances as elevations and the horizontal distance as the distances between stations. If these elevations are plotted for each station and a line drawn through the points, the profile curve represents the surface of the ground.

10. *Grade Elevation.* The grade elevation is the distance the grade line is above a horizontal line drawn through the arbitrary point below the surface.

11. *Depth of Cut.* The depth of the cut is the difference between the ground elevation and the grade elevation. These distances may be figured or they may be taken from the curve.

12. *Height of Fill.* The height of the fill is the distance between the grade elevation and the ground elevation, plus the desired safety distance above the grade line. Fills are made where the grade line is above the surface of the ground shown at station 4, center page.

HOW TO TRANSPOSE FEET AND INCHES INTO FEET, TENTHS AND HUNDREDTHS

When doing profile leveling, it is necessary to have the rod readings recorded in feet, tenths and hundredths rather than in feet and inches. Unfortunately, many rods that come with farm levels are graduated in feet and inches. Therefore, when using the rod for profile leveling, it will be necessary to know how to transpose the readings from feet and inches to feet, tenths and hundredths. Since there are ninety-six "1/8" inch divisions in a foot and one hundred "1/100" divisions in a foot, there will be a very small error if we call 1/8 of an inch 1/100 of a foot. Three inches equals 1/4 foot or .25 foot. However, by allowing 1/8 inch to equal 1/100 foot, the three inches would equal only .24 foot instead of the true value of .25 foot. In like manner, 4 inches equals .33 foot instead of 4x8 or .32 foot; six inches equals .50 foot instead of 6x8 or .48 foot and nine inches equals .75 foot instead of 9x8 or .72 foot.

For example, suppose the rod reads 3 feet 3 5/8 inches. Three inches=.25 foot and 5/8 inches=.05 foot. Then the reading in feet and hundredths will be 3 feet plus .25 foot plus .05 foot=3.30 feet. For a second example, suppose the rod reads 2 feet 8 6/8 inches. This is nearer 2 feet 9 inches than it is to 2 feet 8 inches. If the rod had read 2 feet 9 inches, the value would be 2.75 feet, but 8 6/8 inches is 2/8 inches less than 9 inches, so the actual reading is 2.75 feet—.02=2.73 feet.

RUNNING OF THE PROFILE LINE

After determining about where the line is to be, either for a hillside ditch or for a drainage ditch, set up the level near either the outlet end or the upper end of the proposed ditch. The level does not need to be set exactly along the line; it may be on either side of it. Drive a stake for the bench mark in a place where it is protected. Then, take a rod reading with the rod setting on the bench mark. This reading should be recorded under column "B. S." and opposite station "B. M." in a table ruled off similar to that shown on pages 12 and 13. After the B. S. reading on the bench mark is recorded, set the rod on station zero, which may be a low place to where the water is to be drained or it may be the upper end of the ditch. In the data shown on pages 12 and 13, it is the upper end of the ditch. Record this reading under column "F. S." opposite "Sta. zero."

Then, take a reading on station 1 and record it under column "F. S." and opposite station 1. In like manner, get station 2, 3, and so on until the instrument has to be moved, then the rodman holds the rod on the last station where the last foresight reading was taken and the man with the level picks it up, and walks in the direction of the line being run, some distance beyond the rodman, and sets it up again. After the level is set up and leveled, take a second reading on this last station and record it under column "B. S." and opposite the same station on which the foresight reading was recorded. (See sketch and table on pages 12 and 13.) Then proceed to take foresight readings on all stations until it is necessary to change the level again, recording all these readings under the column "F. S." and opposite the station numbers. If this set of readings does not complete the line, move the level again and proceed.

If this line is run as a preliminary, stakes may not need to be driven because it may be better to run several lines and figure out the elevations roughly in order to determine which is the better line to consider for making a ditch. Then, after the best line is chosen, repeat the process and drive stakes at intervals of 100 feet, putting in fractional stations at unusual low or high places when they fall between regular stations. (See figure top pages 12 and 13.) Then take the readings at each one of these stations as discussed above, and figure the elevations of all these stations. This data will then be used to plot a curve. The method of figuring the elevations and plotting the curve is found on pages 12 and 13.

TEAM DEMONSTRATIONS

The team demonstration phase of 4-H agricultural engineering started in 1930. Its popularity has increased until it has become one of the most attractive phases of 4-H agricultural engineering. The demonstration phase is as important as the terracing project.

The team demonstrations are an important part of 4-H agricultural engineering because they present a splendid opportunity for the club member to introduce good, sound practices into the community. They also teach the club member how to think and act before an audience, and how to clearly and definitely show the exact steps used to get the right results.

The members of the demonstration team should, with the assistance of the county agent, select a subject pertaining to agricultural engineering practices. They should familiarize themselves with all available information on the selected subject, such as may be found in Extension, U. S. Department of

Agriculture and state bulletins in order that they may answer any questions that may be asked at the close of the demonstration.

The club member should use originality in developing the demonstration. In order to make the demonstration clear, models, comparative data, pictures, samples of soils, etc. may be used. The team members should use their initiative in such procedure, but must adhere very closely to facts.

It is advisable for the team to give the demonstration at local 4-H Club meetings, community and civic club meetings, county and district meetings, and at the 4-H Club Round-Up. Giving these demonstrations at public meetings is the way in which boys get the training they need.

Score Card for 4-H Demonstration Teams

The team demonstrations will be judged on the following points:

Subject matter	30
Team work and organization	20
Skill	20
Results	15
Practicability	15
Possible score	100

A demonstration team should show how to do a thing and not merely tell how to do it. The time used in presenting a team demonstration in a state contest should not exceed 15 minutes. The score of the team exceeding the time limit will be penalized 1/2 point for each minute overtime.

SUGGESTED LIST OF SUBJECTS FOR 4-H AGRICULTURAL ENGINEERING TEAM DEMONSTRATIONS

1. Location, construction, and care of the farm pond. Extension Circular No. 175.
2. Building with native materials, rock, logs, concrete, brick. Extension Circular No. 317; U. S. D. A. Bulletin No. 1660.
3. Terrace outlet control, either by vegetation, by baffles, or both. Extension Circular No. 328.
4. Farmstead arrangement.
5. Gully control and prevention. (This means the control of gullies in fields not in cultivation.) U. S. D. A. Bulletin No. 1234.
6. Construction of the trench silo and methods of filling. Extension Circular No. 320.
7. Construction of the septic tank. Extension Circular No. 339.
8. Homemade method of making concrete brick and making them into a wall. Extension Circular No. 328.

9. The farm shop.
10. Yard improvement (cleaning up and improving).
11. Remodeling farm buildings. U. S. D. A. Bulletin No. 1751.
12. Use of the carpenter's square.
13. Irrigation (surface and subsurface). U. S. D. A. Bulletins No. 864 and 1630.
14. Contour farming with terraces. Panhandle Bulletin No. 58.
15. Farm fencing.
16. Gates.
17. Planning the terrace system. Extension Circular No. 218.
18. A simple water system with or without pressure tank. Extension Circular No. 245 and U. S. D. A. Bulletin No. 1448.
19. Rope work, making knots and splices.
20. Location, construction, and maintenance of terraces. Extension Circular No. 218; U. S. D. A. Bulletins No. 1669 and 1386.

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