INTRODUCTION

Land Leveling Defined

Land leveling for irrigation is the process of modifying the surface relief by grading and smoothing to a planned grade and to certain specifications required to facilitate or improve the uniform application of water. It is the process of flattening or modifying existing slopes or undulations rather than necessarily creating a level surface as the name may imply. Normally land leveling requires earth moving over several hundred feet and should not be confused with land planing, land smoothing or floating. These operations are usually accomplished with special equipment to eliminate minor irregularities and do not change the general topography of the land surface.

Need for Land Levelling

Most of the irrigation in Western Canada is done on lands which are not properly prepared for surface irrigation and as a result labor costs have been high and crops disappointing. The average irrigating time in most areas is less than 5 acres per day per man using a 3 cfs. stream. If the irrigator’s wages are $15.00 per day, the labor costs of each irrigation are in excess of $3.00 per acre. On well-prepared land using the same stream it is possible for one man to irrigate more than 20 acres a day which will give a labor cost of less than $1.00 per acre. Depending on the original topography, levelling costs normally run from $10 to $100 per acre. Where money is available, the increased yields and reduced labor costs will soon repay the original investment in land levelling and in many cases this development is necessary to put irrigation on a paying basis.

Land Levelling Criteria

Land levelling is probably the most intensive practice that is applied to agricultural lands and has little value unless it is done right. Levelling jobs cannot be easily changed once they are completed and therefore the most efficient type suitable to a particular field should be selected and planned from the start. This is less costly in the long run than doing the work in successive stages and taking several years to finish the job. Usually the standard of farmers goes up from year to year and a job that is perfectly satisfactory today may be considered sub-standard tomorrow. Many fields levelled now will be relevelled several times in years to come, each time to a higher standard. Therefore, it is desirable to design as refined a job as the soil will permit and the farmer will accept and pay for.

Although the mechanics of land levelling is essentially an engineering operation, the finished product represents a practical application of both agronomic and engineering techniques and therefore requires a high degree of co-ordination between the two technical fields. It is a highly skilled operation, and experience and skill are of great value in doing a good job and doing it cheaply. In designing a land levelling job, the engineer must consider all factors, chief among which are: (1) depth and characteristics of the soil which may control the depth of cut, (2) land slopes, which influences grades, direction of irrigation, and method of irrigation, (3) surface irregularities, which influence the division of a field into smaller fields or benches, (4) water supply, which influences length of runs, grades, width of border strips and sometimes method of irrigation, (5) crops grown which may determine the method of irrigation, (6) economic considerations, (7) farmer preferences, (8) equipment available.

Land Levelling Design Methods

There are four basic methods of land levelling design and a great many variations of each in common use. These are: (1) the plane method, (2) the profile method, (3) the plan-inspection method, (4) the contour-adjustment method. Each has its advantages and disadvantages but when used intelligently, all will provide satisfactory results. The merits of an individual layout are often based on the experience of the engineer or designer.

The profile method is commonly used in Western Canada and is so called because the designer works with profiles on grid lines rather than with elevations on a map. It is especially well adapted to levelling design for relatively flat lands or land with undulating topography. There are many variations of the profile method but essentially it consists of a trial and error method of adjusting grades on plotted profiles until the irrigation criteria are met and an earth work balance is attained. Many workers find it relatively easy to select grades on a profile that will provide balanced cut and fill with a reasonably short haul and so this method is widely used.

A variation of the profile method commonly referred to as the Parkinson Method has been used quite extensively by the P.F.R.A. Drainage Division on the Bow River Project and by the Alberta Department of Agriculture Extension Service. This method was developed by Mr. E. J. Parkinson, a retired S.C.S. engineer at Great Falls, Montana. Some of the procedures are essentially the same as followed in laying out levelling work while others are unique to this method.

PROCEDURE

Briefly, the method involves the following steps:

(1) Staking the field and running levels.

A 100-foot grid survey is generally accepted as standard. Any existing physical features between grid lines such as ridges, swales, ditches, fence lines, etc., are tied in as “plus” shots. Elevations are taken to the nearest 0.1 foot.

(2) Plotting the grid map.

This map, appropriately called the “before levelling map”, shows the ground elevations before levelling. It is at this point that the engineer must study the map thoroughly and use his ingenuity and experience to best advantage. Areas that require different methods or direction of irrigation must be selected as sub-divisions and each sub-division must be considered separately. Soils, topography, water supply, field drainage, crops grown, method of irrigation to be used and the farmer’s preferences should influence any decisions made.

(3) Determining the best direction of irrigation.

This is simply the resultant direction of the average slopes in the two grid directions. Border dykes or border ditches should be laid out in this direction as this is the
of dirt per acre so it is almost always justified when land levelling is being considered.

(6) Preparing a contractors map. Cuts and fills are shown on this map in contrasting colors. When the map is colored, the contractor can start at one end of the field, cutting and filling as he goes, thus taking advantage of the shortest haul.

These maps also show the computed quantities of earthwork. Yardages are commonly calculated using the four-point method. This method is more accurate than the end area method when 100-foot shots without plus shots were used and gives results reasonably close to those obtained using the prismoidal formula.

After the design is completed, estimates can be made of the earthwork and its cost. At this stage, it is important to everyone concerned to know exactly the plan of work and how it is to be performed.

(7) Marking stakes and final inspection. The contractors map is used to mark stakes before the contractor moves onto the field. Generally on the original grid survey, stake lines are established only every 400 feet and intermediate stations are located quite accurately by eye. The remainder of the stakes are set now and marked according to the contractors map. Hargus markers are now generally used. The cost of these markers is nominal at 3 cents each if bought in quantity. They are convenient to use and in some cases, reduce yardage cost. Zero points are left unmarked or are marked by cross stakes.

In checking completion of levelling in a field, a tolerance of 0.1 foot is allowed. This tolerance can be eliminated by the use of the land plane later on.

Final checking is very important. Much loss of time and misunderstanding can be avoided by a close relationship between the operator and engineer. Any errors involving cuts and fills may require considerable time and money to correct if not detected at once. The frequency of checking depends on the job being done, the experience of the equipment operator and the engineer in charge. A final check should always be made before the contractor leaves the field. The cost of engineering work should be a limiting factor. The best job should be done and it will be found that the technical excellence of the job will be remembered long after the cost has been forgotten.

OPERATIONS

Equipment

Most levelling is accomplished with tractor-drawn loading-type scraper equipment. Tractors used are both crawler or rubber-tired wheel type and vary in size from small farm tractors to large heavy construction units. If properly matched, they are efficient outfits because they can cut to grade, spread dirt evenly and haul economically up to 500 feet and even to 800 feet if soil conditions are unfavorable. Rubber-tired tractors can be used to advantage where hauls are extra-long. Small wheeled scrapers drawn with farm tractors move dirt just as cheaply as large equipment but take more time to finish the job. Elevating scrapers of the 5, 8 and 11 yard size pulled by large farm tractors are becoming increasingly popular in Western Canada. A desirable feature is the ability to get a heaping load each time under varying depths and soil textures. Also, cutting and spreading can be done evenly. Costs of earth moving is often less than for the carrier-type scrapers.

Finishing

Normally it is impractical to accomplish a high finish with scraper equipment, and where possible the use of large land planes or floats are recommended to remove minor irregularities. Although a field may be levelled perfectly, sometimes after tillage and irrigation the fill areas will settle and the cut areas "fluff up". It may be advisable to delay planing until after the initial settlement has taken place and corrections made, especially if perennial crops are to be grown.

Cost

Most of the work in Western Canada is done on an hourly basis at commercial rates but some experienced dirt movers are contracting land levelling on a yardage basis. An average cost of 20c per yard is usually assumed in estimating cost of earthwork. The following tabulation is a summary of some costs available from P.F.R.A., Bow River Project and the Alberta Department of Agriculture Extension Service.
Saving Topsoil

Reference has often been made to some of the harmful effects of disturbing the top soil. For this reason, heavy land levelling has often met with much opposition and criticism. Several methods of saving top soil have been devised. One method is stock-piling the topsoil but since this involves moving earth twice, the cost is prohibitive on a large scale.

The common method of saving topsoil is known as the "trench" or "strip" method. It consists of cutting trenches or strips below the desired grade throughout a cut area and later borrowing topsoil from adjacent untouched strips to bring the area to grade. There is some mixing of topsoil and subsoil but it does avoid complete removal of all top soil from any portion of the field. The extra cost involved varies according to the soil profile and the amount of levelling. One cost study showed that 9% of the total area required topsoil saving. This represented a cost of $8.15 per acre or 12.6% of the total cost of levelling. The problem of bringing these cut areas back into production has been a major concern, especially where shallow soils are encountered. On deeper and lighter soils, there has been no depression of yields. The problem is primarily one of introducing sufficient amounts of organic matter into the soil and a stimulation of biological activities. The best way to do this is by planting green manure crops or by making large applications of manure to the unproductive areas. This should be followed by applications of commercial fertilizer. Many farmers who have followed one or more fertility improvement practices have reported 80 to 100% production within 3 to 4 years.

Another problem experienced by farmers after a levelling job is poor water penetration on cut areas. Chiselling or subsoiling immediately after levelling will correct the situation allowing air to enter the soil and also mix the disturbed soil in fills. Frost action and water will aid in improving infiltration.

BENEFITS

The benefits from a well-planned, well-constructed and well-operated land levelling job are many. In Western Canada, we are often guilty of accepting these apparent benefits without having definite information or figures to prove it. There is need for research and economic surveys to evaluate the resultant benefit of land levelling and good land preparation.

The immediate benefit of land levelling is the saving of irrigating time and labour. Almost all farmers report that they can irrigate 2 to 3 times as much land as previously using the same head of water. This varies from 5 to 20 acres a day depending on the water applied, moisture conditions at the time of irrigation, the crop, soil type and the slope of the land. Also an irrigator can apply water much easier and it is often possible to handle extra heads of water on other fields.

Improved water management has resulted in some yield responses after levelling. In a survey on the Bow River Project, half the farmers reported average yields and some farmers who had done heavy levelling reported 25 to 40% increases in yields after levelling. This can possibly be attributed to the fact that the high spots suffered from drouth and low spots drowned out. After levelling, a uniform application was possible. There are so many factors such as fertility of the soil before levelling, physical soil conditions such as tilth and moisture as well as the farmer's management that it is impossible to determine the after effects of levelling on production.

There are other inherent benefits of land levelling besides saving time and labour and increased production such as better field drainage, improved surface conditions, better shaped fields, better control of water and longer runs. These are only a few.

From a farmer's point of view, the operation of land levelling is highly profitable. Because of the improved condition the land has an increased sales value that quite often excels the cost of the work. Aside from the more tangible benefits, the general appearance of the farm is enhanced if a good levelling job is followed up with other improvements in the irrigation layout.

The importance of land leveling and good land preparation can be summed up by saying that is the first essential to good irrigation farming. Without it, money spent on fertilizer, good seed and farm machinery is partly wasted. It is difficult to believe that the majority of farmers are not aware of this. The fact remains that hundreds of irrigated farms lack proper land preparation.

REFERENCES
