

Doubtless much of the readily soluble fertilizing material used today is lost in this manner if applied in excessive amounts, or if the soil is too open in texture, such as very sandy soil. If, however, the soil structure is right, the plant roots quickly absorb much of these soluble fertilizing elements, and a great deal of the soluble plant food remains also in the capillary water. The general tendency of capillarity is to bring water to the surface from varying depths, the flow being always from soil where the water films are relatively thick towards soil in which the films are thinner. This action is comparable to that when a piece of blotting paper is dipped in ink. Hence as the top soil becomes dry, the soluble salts are brought into contact with the plant roots by being drawn to the surface in the capillary water. In this way the plant roots are able to select such soluble materials as they require as long as the materials are present; but the roots may reject to a certain extent injurious salts. In well-drained soils both injurious and needful salts are finally washed or drained away beyond the power of the capillary attraction to bring them to the roots. Everything considered, soils should therefore not be allowed to remain saturated with water too long, and if the soil can not get rid of surplus water by natural drainage, ditches or lines of tile should be provided to carry it off.

EQUIPMENT

Often in golf course construction it is not realized until too late how much more economical it would be to purchase or hire adequate equipment for the work. As an example, it may not be realized until the job is half over that a team and wagon might have been bought



Snatch team loading a wheel scraper.

and paid for had they, rather than a wheelbarrow, been used from the start. In other cases it would be far greater economy to employ tractors than horses, and in still other cases the greatest economy would be in the use of still heavier machinery, such as steam shovels.

It is important to decide at the outset just what machinery can be used to advantage. Man power, horse power, or machine power are all used more or less on golf course work. Man power on golf work is the most expensive, even as it is in most construction, farming, or manufacturing operations. A good many details of golf course

construction must, due to the type of construction, be performed by hand. Picking stone, grubbing roots, burning, hand grading, and raking, are all phases of the work which are done more or less with hand tools, such as shovels, axes, spades, and rakes. But modern construction methods lessen the need of hand work greatly, and even the hand tools used are more efficient; for example, small piles of field stones are more easily loaded with stone forks than by hand. When it comes to larger stones it is easier to load stone boats than wagons. Grub hoes and mattocks are useful in rooting fairways, but with the proper clearing methods much of this costly work may be avoided. The disk plow and the palmetto plow are both useful in rooting ground. The disk plow, which requires only a small tractor for operation, cuts roots as large as one's arm in two and partially pries them loose. The palmetto plow, which is composed of three or more knives which cut into the soil at intervals, has revolutionized the clearing of palmetto land, since it tears the roots enough to allow men to quickly grub the roots loose. The palmetto plow, however, requires at least a 5-ton tractor to pull it.

As stated, a good type of plow, especially for work in rooty fairways, is the disk plow. These disks come in various sizes, and should be kept sharp; they bolt to an attachment secured to the body of the tractor and can be raised or lowered by the operator. If the tractor is not required for more steady work, a disk plow is a handy thing to have on a scraper job. It stands by idle, not burning gas, until a few furrows of earth are required to be loosened up for the scrapers. It will plow a much bigger and deeper furrow than a team of horses can.

Similarly, in burning there are pulley devices and methods for piling stumps which save hand work. Hand grading should be greatly reduced in golf course work by the use of horse-drawn and tractor-drawn equipment. Fine, natural contours can be made on scraper fills, and disk and drag harrowing bring out long undulating natural contours. By properly working horse-drawn and tractor-drawn grading equipment very little hand work need be done, and this phase is important since hand grading is costly. Thorough cultivation with the smoothing harrow and cultipacker saves much hand raking.

Various equipment can be used in construction, and it is rather important from an economical standpoint to decide upon the manner in which the job as a whole is to be done, before it is commenced.

In moving earth, except for small lots, it is comparatively costly to load by hand. In building greens or in making other fills or excavations, it is far less expensive to move earth for distances up to 100 feet with slip scrapers and teams, or with ordinary small farm tractors and scrapers which are operated by drivers. For distances over 100 feet tractor scrapers can still be used economically on comparatively smooth land, but where the route of hauling is rough or muddy, wheel scrapers are better. For hauls up to several hundred yards, wheel scrapers are very efficient, especially if the soil in the cut is naturally loose or is kept so by being plowed ahead of the scrapers. However, as most courses will be maintained by tractor units for mowing, it is an exceptional job on which a tractor or two will not be economical. In using the ordinary wheel traction tractor (not caterpillar), large cleats or lugs will be required for work with scrapers, also for rough plowing with a gang plow.

Where tractors, instead of teams, can be employed for grading, the work is usually done much more economically. In construction, where tractors are used from the beginning of a job, and employed for clearing, plowing, and other fairway work, it is usually easy to make them pay for themselves and show a profit. If the architecture of the putting greens calls for large fills and extensive elevations, the job should be done with a steam shovel or gas excavator. In that case the shovel would probably be rented, although some golf course jobs have required enough shovel work to pay for one and then show thousands of dollars profit. If a steam shovel or gas excavator is used, either teams or tractors are required to pull the dump wagons. The tractors necessary on fill work are at the same time the best for plowing and other preliminary work, but are of little use on future maintenance work. The tractors most useful for golf course construction work with shovels are of the 2-ton caterpillar type. They pull dump wagons or carts and can work in soft ground, climb steep grades, and turn in small spaces.

A shovel and tractor job needs some planning, and the shrewdest planner will save the most money on construction.

CLEARING THE LAND

In commencing the construction of a golf course the first consideration will be that of the clearing, a subject discussed in detail in the article "Clearing Land for Golf Purposes," on page 56 of THE BULLETIN for March, 1928. This refers not only to heavy timber, woods, or scrub, but also to rock ledges, boulders, fences, buildings, and any other obstructions which will interfere with grading or with cultivation of the soil. Clearing and working of cleared land may well be carried on at the same time.

USING UNBROKEN SOD LAND

Sometimes pasture land on the golf course property is found to have an even surface and to possess a good tough sod which is entirely satisfactory for golf purposes without any treatment other than mowing or perhaps the removal of a few large stones. In other cases a little top-dressing to fill low areas will be sufficient to make old sod suitable for fairways. Wherever possible, such old turf should be preserved, for it takes much longer to grow tough turf than is ordinarily realized. In some portions that are slightly ridged or uneven it is possible to improve the old turf by cutting in various directions with a sharp disk harrow. The harrow should be set almost straight so that it will cut into the turf but will not turn it over. The turf should then be fertilized and rolled. On old Bermuda turf this treatment given in either the spring or fall growing season shows very noticeable results. In treating old turf on stiff clay soils an application of coarse sand in addition to this cutting will benefit the turf by opening or loosening the soil around its roots. Another condition frequently met with on light, sandy soil where it would not be advisable to plow, is that of very thin topsoils with poor subsoil. If such land were plowed the small amount of humus con-