MAINTENANCE MACHINERY AND SURFACE DRAINAGE

TOM MASCARO

Although not introducing anything new I hope to organise your thinking as managers of turfgrass areas how you can alter conditions to grow better grass by the use of maintenance machinery and cultural practices. The five major factors that affect surface drainage are:—Degree of Grade, the Sub-Surface Drainage, Soil Structure, Soil Texture and Thatch.

Degree of Grade & Sub-Surface Drainage

First it should be clear that the degree of grade, or slope, will have a profound effect upon surface drainage. The greater the degree of grade, the more rapid the run-off of excess water. Therefore it is vital for turfgrass areas that both surface drainage and internal drainage be adequate to remove excess water rapidly. The reason, of course, is that grass roots breathe, just as you and I, and all living things on this planet. Excess water, devoid of oxygen, prevents the grass plant from functioning. Severe damage and death of the plant especially at high temperatures will occur.

Degree of Grade is something you cannot alter very much once it is established and by and large you have to live with what has been done from the very beginning. The same applies to the drainage underneath. The tile drains which were installed, the type of sub-surface which exists under the grass you are growing, once it has been established, generally cannot be altered very much unless you go to a tremendous amount of expense. So as Greenkeepers and Golf Course Superintendents you have a very small area to work in, and this is that upper layer we are all familiar with. Much can be done here and we will discuss this area under three headings, Soil Structure, Soil Texture and Degree of Thatch.

1. **Soil Structure**

By structure we mean how the soil is put together, how the particles are arranged. The sand, silt and clay of any soil is arranged in such a way so that it has 50% solid, 25% for air space and 25% for water. Modern irrigation systems supply the water. What we like to see under turf is a soil in good tilth, one which is made up of aggregates. We have spaces for air, water, fertiliser to move down and also to exhaust gases that are produced by the roots. We say that roots don't grow in the soil, they grow in the spaces within the soil and this is what we like to see under turf areas; this is what the farmer likes to have when he plants his crops.

Unfortunately, water is a lubricant and this can compact the soil quite easily. If you take a feather and stroke a wet soil you can seal it off very nicely. When we were children and made mud pies, we didn't make them by pounding the soil, we made them by patting the soil. So water

and the pudding effect has a profound effect on the soil structure.

It is not so much weight that causes compaction because we do not use massive equipment on turfgrass areas, we use rather light equipment. There is however, some degree of compaction from the equipment, and it certainly should not be discounted. Most of the damage comes from the roll of the wheel, the roll of a person's foot and even raindrops. The golf car in America has certainly created quite a bit of damage to the turf. These mechanical forces, although light in nature, repeated often enough, will seal the soil quite effectively, and even sandy soils can become sealed at the surface without too much trouble.

Soils are very hard to compact when they are saturated. Grasses mostly grow at what we call the field capacity; when the soil becomes saturated growth drops off quite rapidly. You cannot compact a saturated soil, because you cannot compress water, but you can puddle it and this is where most of your problems come from in these areas.

So this matter of drainage becomes very important. There is one saying that I think we all have when we begin construction on a golf course, there are only three things to remember, and they are:—"Drainage, Drainage and Drainage". Those are the three things because if we cannot get that water off, we are going to have trouble. Any traffic that passes over it will seal the soil off and this is where your problems begin. Roots become shallow and most of this compaction surprisingly enough is up near the surface, it is not down very deep. Granted over a number of years you can transfer this compaction down below, but most of it is up near the surface, and after you have compacted the first inch of soil, it is almost as if you have put a piece of 3/4" plywood on it. You cannot transfer it down very easily, so in most cases you take a sample. A good sampling tool is 6" deep and 3" wide and will take an undisturbed profile. You can then see where the compaction is, and after thousands of these samples, it is interesting to see what pattern is formed. Fortunately we have good architects, who write good specifications and are very careful, but there are many times when construction is done by the inexperienced, and they can build more problems into it than you can imagine. If machines pass over a soil not in the right condition, a hard pan can be formed below quite easily.

Now the farmer knows that he never ploughs the fields when the soil is too wet, because if he develops slip layer, roots will not penetrate. But roots don't grow in the soil, they grow in the spaces and if these layers are built in down below and are covered with loose soil and seeded, you can be sure this will be a problem area.

People do the same thing. Over a period of one week, the boys in the band of North Western University practised marching on an athletic field and the lines where they had marched remained for a long time until we used some aerating tools. At an international tournament at Merion Golf Club in the Philadelphia area, a mass of people in 3 days did a fine job of really compacting the soil. Golf cars also create compaction. An experiment was conducted in the State of Georgia on Bermuda Grass, which is one of the toughest grasses we have. The question was what size tyre should be used. There was the 650, the 850 and the 950, and we found they were all just about as bad as each other. The other thing was that the 650 sank down and the grass couldn't be mown.

Over a period of time, these things do happen and after compaction is formed, it is sometimes very difficult to regain good soil structure. On the edges of the green we often find

severe compaction. Poa Annua is the first plant that will come in and replace the grasses, because it is shallow rooted and can live in compacted soil provided you give it enough moisture. The only problem with Poa Annua is that in some parts of the world it dies at the wrong time of year.

Another area where we find severe compaction is at the ends of the fairways where we turn with the tractor. This is not only due to the puddling effect of the wheels but also to the side thrust as the wheel turns, actually grinding against the soil. If you were to see a high speed movie of a wheel going over the turf on a wet soil, you would find that the soil immediately in front of the wheels is actually rolling, very much like a rolling pin rolls dough. It is moving the soil in a circular pattern and destroying the soil structure. These are some of the things you have to worry about and should form part of your management programme.

Erosion is another problem to look out for. Water can carry away a puddled soil into other areas. There was an example on one golf course fairway where water had moved over it for a period of about 6 months. Eroded soil had been brought in by surface drainage. A 3″ deposit of clay was left over the good soil. Sometimes tile lines come up to the surface, not because of freezing and thawing but because of erosion. In a period of 25 years pipes buried 18″ deep, came to the surface. They had lost 18″ of topsoil.

The misuse of water is evident in many areas where there is no drainage. Then people do all sorts of interesting things. The Stadium at Berkeley in California was so wet through lack of drainage they decided to hire a helicopter to come in and fan it and see if they couldn't evaporate the water.

However, you run into these things. So what do we do about it? Up on the surface where the sealing off is taking place, the obvious answer is to plough it up and start again. If those of us who are charged with maintenance of turfgrass area had our own way, this is what we would do; simply bury all our problems and begin afresh. Unfortunately we cannot do this, so we look for other ways. We know that ploughing is a practice that has gone on through the centuries. In the mists of antiquity man discovered that seeds which fell to the earth took root and grew better if he stirred the earth with a stick. Through the years we have developed better and better sticks with which to stir the earth.

No man would attempt agriculture without the plough; it is the basic tool. With the plough he renews soil structure; the plough simply picks the soil up, turns it over and moves it somewhere else. If you dig a hole, get the soil out and then try and put it back in, you'll never get it all back, because you have renewed the soil structure. The renewed air spaces within the soil allow for the free movement of air, excess water, nutrients and roots. The plough mechanically renews soil structure.

On turfgrass areas we cannot do this. We use aerifying tools which are essentially modified ploughs. Instead of turning over the entire soil in the turfgrass area at one time, these tools turn over a small percentage of the soil. Over a period of time, following a judicious programme of aerification, all of the soil will eventually be turned over and relocated.

When you are cultivating the turf itself, do not attempt to fill the holes, because what you are trying to do is to remove soil, so that the surrounding soil can expand into it. When the job of cultivation has been done well, in two or three weeks' time there is no evidence of the hole. The soil structure has been renewed and more

spaces created for roots to grow and for air, water and nutrients to move down through the soil.

2. Soil Texture

Texture, the second major factor, means the amount of sand, silt and clay in any given soil. A soils map of the British Isles looks like a checker board; I am sure that I could come onto any golf course or any sports ground, and from one end to the other find all sorts of variation in between. Nature does not give you a uniform soil throughout an area.

One simple way you can determine the texture of a soil is to get a soil sample and shake it up in a jar; let it settle for about 5 minutes and that is your sand portion. This does not mean the sand you would find in a river bed, but pieces of rock and all those particles which are in the larger range. Shake up the jar again and let it settle down for 24 hours, pour it off and you have your silt and clay separated. It is a very easy thing to do and it gives you a general idea of what you are working with and how to attack it.

Texture and its relationship to water has a bearing on growth. If you had a soil and you were to send it to The Sports Turf Research Institute at Bingley, they would report back that it was a good soil, had all the nutrients, the pH was right and everything else, but it wouldn't necessarily grow grass; it may have no stability and many soils are in this condition. I can illustrate the point in this way. Dr. Aldifer at Pennsylvania State University a number of years ago ran an experiment. He laid out plots of ground and on some he grew grass and some he kept bare. In one year's time he took samples from each plot. He took beakers and filled them with water, placed a copper screen about half way down, and then dropped these two samples in simultaneously. Within five minutes, the sample that had had no grass growing on it showed some flaking off and then began to disintegrate, whereas the sample that had grass growing on it remained intact. We can see that grass is the plant that gives stability in the soil. This is the plant that helps drainage. Here we are then, growing the very crop that can build soils. All it asks of us is a little bit of help; that help is good management.

Soils are in themselves inert; we've seen pictures of the moon and there is no life there; there is no life on earth if we look at the soil itself. The soils become dynamic in the presence of organic matter. Soils are composed of mineral matter, but when we add organic matter and especially organic matter derived from the grass plant, we make it dynamic. The soil then has stability and will also expand and contract.

If you take a soil that is rich in organic matter derived from grass-roots and wet it, it will expand; if you allow it to dry, it shrinks and contracts. Now no one is going to build a machine to replace this simple property. So the manipulation of water, alternate wetting and drying, will do more good than any machine you could ever buy, expanding and contracting the soil deeper than you would be able to go with a surface tool or sub-surface tool.

In addition to the many textural differences that occur naturally in soils, man sometimes adds to these problems. In his effort to modify a soil with, for example, sand, he does a poor job of incorporating it into the entire soil profile. The result is a layer of pure material which effectively inhibits the movement of roots. If sand is in a vertical pattern water will move down through it, but if it is horizontal there will be a false water table. It has been demonstrated that roots do not grow through sand layers. At the Bellair Country Club

in Los Angeles, there is a sand layer about 1½" down, with absolutely no roots going down through it. One cultivation over that sand layer and lumps appear where the roots have gone right through.

Layering also occurs when top dressing is used without removing thatch accumulation. This partially decayed material forms a strata of unlike matter in the soil profile, and has a profound effect upon the movement of surface water.

When soils are modified to improve texture with materials like sand, humus, peat moss, thorough mixing must be done to incorporate these materials through the entire soil profile. If top dressing is done, care must be taken to remove surface thatch accumulation. Ensure that dressing material makes contact with the soil below. Verticutting is a vital practice in any long range programme of turfgrass management. Prevention of layering will help movement of water to the root zone.

Outside ploughing, or repeated aerification is the best and most practical means of changing soil texture in the upper three to four inches of the soil profile, and still keeps the area in play. Soil cores are lifted out and redistributed over the turf surface.

3. Thatch

The third factor drastically affecting the movement of surface water is thatch. It's quite possible to grow too much grass. All mowers, whether they use a reel, a sickle bar or a rotary, cut on a horizontal plane. Not all the grass blades stand up to be cut, so every time you mow you only cut about 20% of what's growing, or perhaps a little more. These uncut leaves are called "grain". Grass is the only plant that grows from its base. If we take a leaf on a tree, take some scissors and cut it in half, it will stay like that until it falls off in the Autumn, but with grass we can cut it and it will keep coming up because it is growing from the base. These uncut leaves will remain in their prostrate form until they die in about 30 days, generally speaking, and they become part of the thatch, part of the build up of the excess crop. As the thatch builds up, because mowers will keep riding over it, it becomes quite dense and is very hard to decompose. We have to do things to it culturally to get it out of the way because it is really a thatch roof. We now have a grass plant that has no desire to go down into the soil. All the water, all the nutrients, will stay at the top; if you get excess water the plant will drown. So we have a basic problem, getting down through the thatch and opening up the soil, and, of course, removing some of this material.

The build up acts like a filter and materials won't pass through it. Nitrogen is easily dissolved and will move through the prostrate layers but lime, potash and other materials that we use, tend to be caught in this filter material and just remain there. The plant now is just on the surface of the ground, so one of your best indications of the grass plant just growing on the surface of the soil is to look out and see how many divots there are. If there are many divots you will know that the grass plant is not anchored in the soil.

An example was in Portland, Oregon, and we had rain for 2 days. It was during the depression, and brown spots appeared. The Superintendent thought he had disease. We went out and looked at it, dug a hole and found pure dust underneath. We came in and he said "My God, during the depression even the water isn't wet!". When thatch gets wet it's hard to dry out; it becomes unplayable, hard to mow, the players don't like it, and footprints show badly. We condemn the manufacturers of mowing equipment when it's no more than a

mattress we are trying to mow.

Thatch prevents the penetration of surface water to the soil profile. Like thatch on a roof, it can effectively shed water to prevent it from entering the root bed. It has been demonstrated many times that thatch, under the proper conditions, can cause almost 100% run off of natural or applied water.

Thatch, during certain stages of decomposition, develops sponge-like characteristics. Water is held at the turf surface, rendering the area unusable. Conditions are suitable for moss, algae and fungi. When heavily thatched turf surfaces are used while saturated with water, severe surface soil compaction is likely to occur. Excess water, held at the soil surfaces, sets up ideal conditions for puddling. Traffic, (equipment, golf cars or people), can create a great deal of damage in a very short time.

Thatch that holds too much water can effectively form a barrier that impedes the free movement of air. Under cool conditions, this may not be serious. However, when temperatures rise, a number of deleterious effects occur. Water, which can absorb more heat than dry thatch, becomes very hot. This can cause scalding of the plant tissue.

Water, held at the soil surface by thatch can hold accumulated salts and other toxic substances. These chemical compounds, derived from exudated fluids, applied fertilisers, soil salts or leached from the thatch itself, can, in sufficient concentration cause severe root, stem, leaf burn, or a combination of these.

Judicious control of accumulating thatch, therefore, is extremely important when related to surface drainage.

Aerification will help as you are getting some of the soil out and mixing it with the organic matter on the surface. New roots will develop. You need surface working tools all the time, bearing in mind we want the golfer to be as undisturbed as possible. Even mowers have come into play. There are certain times when you can be pretty rough on grass without hurting it. An experiment was run in Florida with the Ransomes machine and we set it right down to ground level to cut the grass and shaved it off. There was a vote taken in the Club to fire the Superintendent, but we went ahead and did 18 fairways and shaved all of them and in about 4 or 5 weeks they elected to reinstate him.

In summary, when dealing with surface drainage, one must keep in mind the inter-relationships of Degree of Grade, Sub-surface Drainage, Soil Structure, Soil Texture, and Thatch. It becomes evident that good planning, followed by a sound Turfgrass Management Programme, is important to the production of good turf. Machinery is available to help us achieve these goals. Turfgrass Machinery, along with good cultural practices can help us produce and maintain the kind of playing surfaces that will please everyone.