Proceedings of
SOUTHWEST TURF CONFERENCE

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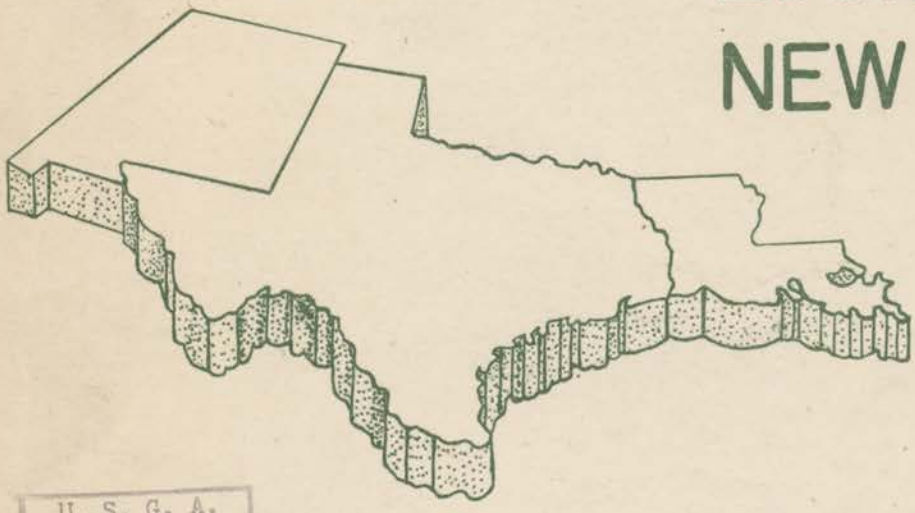

TEXAS A. & M. COLLEGE
COLLEGE STATION, TEXAS,
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FOREWORD

I would like to express my appreciation to all those who had any part on the program of The First Southwest Turf Conference.

Special recognition is given to the section chairmen, Dr. Ide P. Trotter, Dr. E. B. Reynolds, Dr. J. E. Adams, and Dean H.W. Barlow for the excellent way in which they kept the program moving, and Dean C. N. Shepardson for acting as toastmaster at the banquet.

Recognition is also given to those men in private business who aided in arranging, supporting, and developing The First Turf Conference.

I trust the Information contained in this report will be of value in developing better Turf for the Southwest.

R. C. Potts

R. C. Potts
Program Chairman

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NEED FOR A TURF PROGRAM IN THE SOUTHWEST

E. B. Houston, Director of Parks
Dallas Park Service
Dallas, Texas

The presence of so many here at the opening meeting today is conclusive evidence of the fact that the need for my talk is unnecessary. It is inspiring to all of us here to know that so many have been able to attend this first meeting, but since I did prepare a few remarks on my assigned subject, "The Need For a Turf Program in the Southwest", I will proceed to deliver them to you.

In this business with which we are connected I believe it would be of interest to briefly review its history. Within the memory of most of us, nearly all the golf courses in Texas have been built and put into operation. There are doubtless some exceptions but I believe most of the golf courses have been built in the life span of most of us. It was in the early twenties that most of the municipal and public links courses came into being. When those first courses were built most of them started with nine holes, sand greens. It wasn't until the middle twenties that we began to change those greens over from sand to grass. The players were so glad to play on grass instead of sand that demands on the quality of the playing surfaces were not exacting. The fact that they could play on grass on the public links was satisfying. Then we continued into the early thirties - the depression years, and players were willing to accept what the conditions then would allow.

The subsequent war years brought serious problems in golf course operation which made it extremely difficult to maintain a high standard of turf maintenance. But since the war play on most municipal and public golf courses is the greatest ever experienced. I suspect play on most public link courses almost doubled during the last season over the preceding season, and in many cases the green fees have been increased. So we can expect, as I see it, the player to insist upon a higher standard of maintenance on the municipal and public golf links. No doubt this will also apply to the private country club courses.

So in this business of operating golf courses, we must meet these new conditions. I don't know of any way whereby we may better prepare ourselves in the solution of turf problems than by meeting together as we are here.

A great deal, of course, has been published in periodicals and books on Turf and Turf Culture. In the North and Northeast where the cities are closer together the turf men can get together frequently without traveling excessive distances and this isn't an uncommon thing with them. This published material, I am sure most of you will agree, deals with conditions in other sections of the country and it does not apply to our conditions. So, as I see it, only through a course of this kind can we begin to assemble material on turf culture suitable for publication.

Then I suspect most of our attention has been given to the grass on the greens and tees of golf courses. Our own experience in Dallas has

given us very little time to devote to the work that we feel should have been done on the fairways. With increased play and with the higher green fees, I believe that the public is going to insist that we provide better fairways.

We have the question of weeds and weed control. A great deal of material is published and written about the use of chemical control. Probably all of us have tried them to some extent. From our own experience we don't feel that they are the answer yet. Is this because we are not using the right chemicals? Are we not applying them properly. We should like to learn more on this subject, and I feel that we can through a course of this kind.

It seems that in recent years one pest after another has bothered us. If it isn't clover, it's nutgrass, or it's crow foot grass, or it's dallis grass, or what not, each of which we would like to learn more about the control of. Then are we taking advantage of all the grasses that are available. Most of us in the Central part of the state have stuck pretty well with our Bermuda. Is that the only grass? Is there another grass that we could use, and do better with? I think through meetings of this kind we can ultimately get the answer to that question?

Then another phase of grass growing is on the public parks and playgrounds. The entire philosophy in the use of the public park has changed within the life span of most of us. Most of the grassy areas in our parks today are not just things to look at. They are places that we use and unless we have the right turf and proper maintenance to make these grassy areas as usable we are sacrificing the beauty and the utility of such areas. All over the country we are experiencing increased usage on municipal parks. I am thinking of a baseball diamond in my own city with sodded infield on which we are expecting to carry a schedule of up to twelve games a week. Bermuda grass or any other grass that we know of cannot stand up under a load like that. The same thing applies to football fields. We expected one particular field to carry a schedule of fifteen games in a fifteen day period. These requirements demand the application of scientific methods to assure satisfactory turfs.

Another consideration of our playgrounds and park areas under shady areas is the need of more suitable cover crops to use. Picnic areas under shade trees wear out very quickly. So far as our experience is concerned we don't yet have either the proper grass or the proper cultivation methods to assure a stand of grass under this usage. Possibly grass is not the answer. Maybe there is some other cover crop that will ultimately be the solution but through a meeting of this kind I think that ultimately we may find the answer.

There are other advantages in addition to the knowledge which we can gain from just attending the meetings. I would like to know you and the men from your organization better. It's a long distance from Dallas to Lubbock or Amarillo, or to Houston, or to San Antonio. It's not possible for us to run down and talk with you when we run into a problem on which we don't have the answer. It's difficult for you to do the same thing. This meeting should enable us to become better

acquainted personally and thereby facilitate the exchange of helpful information through correspondence on mutual problems.

Now then in a meeting of this kind I feel like we might have had experience with some particular kind of machinery or some new development which you may not have had. You likewise may have used some machinery or equipment that we haven't had. Exchange of such information can be profitable. I think if these meetings should become annual affairs no doubt the equipment people will have an interest in displaying their machinery to us. Demonstrations at a central point could be done. There are obviously limitations on the extent to which they can demonstrate to us individually.

I've talked entirely of golf courses and playgrounds, parks and athletic fields. I'm not sure whether there are any airport people here but in talking with our local airport men I learn that they have their turf problems too. Of course their chief problem is getting on their grass areas, working them quickly and getting out of the way. If a grass could be developed that would not require such frequent mowing, we can appreciate how much their problem would be minimized.

The cemetery turf problems are perhaps not too different to those encountered in the operation of parks and playgrounds and consequently those engaged in cemetery work should find much of mutual interest in discussions with those in park and golf course operation.

In closing I should like to express my appreciation to each of you gentlemen in responsible charge here at the College Center and to those other several individuals who worked so untiringly in bringing about this first meeting. We are sure it will be profitable to us and we hope this may become an annually recurring conference with unlimited possibilities to all of us.

QUESTIONS AND ANSWERS

Q. Whether in central Texas you have any solution to the successful growth of grass under shade trees?

A. We do not have the answer to it. We may have the partial answer. I have in mind several areas where we have shade trees very closely spaced - most of them are deciduous. Because of many years usage the ground is badly packed. In a number of cases we have removed the bad trees, trimmed up perhaps rather severely the limbs on the remaining trees (particularly the lower limbs), cultivated the soil, in some cases by the use of the tiller, some cases by the use of light charges of dynamite. Then during the fall the areas have been seeded with rye grass. In this way we get six to seven months of ground cover material when the leaves are off the trees and up until the time that the rye grass dies. With satisfactory rainfall this works very satisfactorily. While other vegetation is dead we do have a pretty green area under those trees. We haven't had success with Bermuda or St. Augustine in those areas where they are heavily used and badly worn during the summer months.

SOILS OF THE SOUTHWEST

Luther G. Jones, Professor of Agronomy
A. & M. College of Texas

I worked under the chairman, Dr. Trotter, at the time to which he refers; when he was long-haired. During that period he had a great system as some of you remember. When a paper arrived for the general good of the department he would read it first, sign his name to it, and pass it around. It was said that the members of the staff became so well-trained in signing their names to various papers that when they saw even a piece of scrap paper on the floor or in the waste basket they would automatically pick it up and sign it. Thus you can see what an efficient chairman you have this afternoon. I'll sign my name to whatever is said or written.

In reviewing "Timely Turf Topics", I noticed some of the procedures that were emphasized by the experimental workers of the association. They were texture, consistence, and structure, which profoundly affect internal drainage; so I decided to discuss this aspect of soils with the group on this occasion.

The subject of drainage is probably of far more importance than we have given it hitherto. There is an old saying that if a person gets sick they go to a doctor and get something in a bottle. There's also been an idea that if you had something wrong with your soil you could send it to a chemist and he would cure the trouble with a chemical. That's fine, in many cases. You will notice that I have listed some of your chemical characteristics of soils and some of the things that might be done to augment them. But in addition to that you have to attend to the physical needs and deficiencies of your soil. The first and foremost of these is soil texture. Instead of going into a lengthy discussion of the classification of the soils of the Southwest, we will discuss the textures of the Southwest.

I notice that here we have representatives of five states, the soils of which we will show by groups. We will content ourselves by looking only to the physical characteristics some of which you can determine by taking the soil sample between your thumb and your forefinger. Now observe the chart which Mr. Warner is holding. We generally call the green area the sandy soils area. It is listed as the red and yellow podzol region. Those soils are generally acid in reaction, sandy in texture of the surface soil, and clay in subsoil. Due to clay subsoil they are imperfectly drained unless you attend to them properly, and they are generally poor and unproductive. Their nutrients have been leached and taken away either by erosion or leaching.

Next comes the prairies. In this area you have soils of a clay nature that are generally even more impervious in their subsoil than the sandy soils of the red podzols. And as a rule they are formed under ecological prairie conditions of prairie grass or short grass, in other words, from your blue stems, and they are much richer than

their sandy neighbors. However they require a great deal more care in order to keep them open than do the sands.

Coming over into the Western side you have all the variations that you find in the East but moisture is such a limiting factor that you generally lose sight of both the chemical and physical characteristics in trying to add and hold moisture for the crop. As a result we frequently have troubles developing which we hadn't anticipated and which are due to the excessive application of water and the development of some salt in certain cases and leaching of those salts in others which results in a damaging physical condition. So in all three types of the soil areas we have to watch the physical side of the turf bed. And as the last issue of "Timely Turf Topics" stated, the physical characteristics involved in getting your soil more porous, and in getting the water to penetrate through it, becomes one of our dominant problems, and of such great importance that we can devote the balance of our fifteen minutes to its discussion.

We'll take texture as the first topic. Texture means the size of the average soil particles which you are considering. Structure, we have it on this chart, means the arrangement of those particles. Consistence, which is the third factor, is roughly the feel. It is the relative mutual attraction of the particles in the whole, soil mass, or their resistance to separation or deformation. In short, it is the feel when you try to mash them. You cannot always mash them, can you? I notice a great many of you are from Dallas. When you try to prepare a seed bed for turf on the Houston Clay or the Bell Clay soils in the vicinity of Dallas or on the White Rock area, in dry weather, it's somewhat difficult, especially those tight soils northeast of Dallas in your Hunt Clay and Wilson Clay area, where you have your whitest people and the blackest soils. There you find a soil that gets dry and impervious and becomes almost impossible to break except with a tractor.

As shown on the exhibits before you we will emphasize five soil separates, divisions of soil sizes. In addition there are certain classes of soils for your examination at an off period. Beginning with the coarse gravel they run through fine gravel, coarse sand, medium sand, fine sand, the very fine sand, then silt, and clay. These are soil separates. And all natural soils are made up of two or more of those separates in varying amounts. We have in these pans actual soils taken from Vicksburg on the banks of the Mississippi, to New Mexico. They have been collected for demonstration to groups such as this one here. We will leave on the table seven samples and ask you, sometime before tomorrow night, to take some of these sheets and without assistance write out your idea of what each of these seven soils is, and leave it to be corrected. We trust you will be able to tell whether it is sand, silt loam, clay, clay loam, or just an ordinary loam.

Starting in now with one of these soils, suppose we take this brown soil here. It comes from the Brazos bottom. It is a pleasant soil to feel. When you rub it between your thumb and forefinger it gives a response something like talcum powder. It is a soil that has reached this area by coming 500 miles in the Brazos current. During the seiving out

process which the old Brazos has accomplished in carrying this soil all this distance it has separated the sand out and it has taken the clay all the way down to Freeport and dumped it into the salt water, where it drops due to the salt in the solution which percipitates clay. This soil is known as silt loam, and we will pass it out to you. We will ask you to rub it between your thumb and forefinger and see if you agree with me that it is an ideal soil from the standpoint of workability. Soil of this kind, you can plow when it is wet, or when it is dry, and it still stands up well. It doesn't blow away. It is one of the finest soils that one could choose if one had the right to choose a texture and have the whole state or the whole southwest from which to select. Another thing about that soil is that it is highly calcareous. If we drop a little acid on it you will realize its value. And if the light isn't imperfect you can see that it efferveses as if it were baking powder on some good rising bread.

Sandy soils are coarse and gritty to the feel. We are passing one of these soils around. This happens to be one taken within 100 feet of the golf course at Galveston, Texas. You would think this soil to be the poorest soil in the state as it has been carried across the state by rivers and dumped into the Gulf, where it was thrown up on the beach at Galveston, blown by the southerly winds over the country club course and we picked it up. Yet I believe Mr. Gordon Jones will agree with me that one never sees a thicker coating of Bermuda grass than occurs on this Galveston sand. With an excess of sodium cloride blowing in from the Gulf, and leaching occurring every month in the year, yet it produces a good stand of Bermuda grass. That seems to invalidate a great many theories that you had to have a rich soil to grow Bermuda grass. A sand is always gritty and it is always easy to plow. It is always well drained if you have somewhere for the water to go, and yet it is the poorest of the soils generally, as far as the holding of nutrients is concerned. Combine that with your clay and you really have a problem in your golf courses.

I noticed in the "Timely Turf Topics" that sewage sludge was listed as one of the things that is hard on putting greens. This may be due to the fineness of the organic matter. In order to make raw sewage sludge open up a soil and let the water penetrate through and down, a drainage system cannot be discounted. The use of sand would be more recommended, also providing you have some method of getting the excess water away. The old rule, "sand on clay is money thrown away, clay on sand is money in the hand", I believe may be rejected when you are working with putting greens. Sand helps a rapid growth if you have a fertile loam beneath.

The next sample is a Memphis Silt Loam, another one of the silt loams which was deposited on the bank of the Mississippi River by wind at Vicksburg. This soil is classed as being probably one of the finest soils in the world. It is similar to the Yahola silt loam of the Brazos and Colorado bottom. And going over to the other extreme to Florida we have some of their so called muck soil.

The next is a red sand from East Texas, Smith County, you will find when you feel it that it will make your hand a little red which indicates

the presence of some red clay. Still you would call it a sand because predominately it is sand. It goes by the name of Hannahatchie, named after a small creek in the vicinity of Tyler.

In the West Cross Timbers there occurs a soil known as the Windthorst fine sandy loam. In that area the moisture is such a tremendous factor that you have to take special pains to save it all in order to get your land to produce the right kind of turf. This is a sample of the soil that came from the neighborhood of Stephenville.

We now come to a soil profile which A. & M. students took from the side of a road bank, first digging a verticle wall on the side of the bank then cutting back into the wall and fitting this rectangular container over the block, and then cutting it off. This is a so-called undisturbed soil from the red soil area between here and Hearne. You notice the subsoil is red and the surface soil is a fine sand. It is typical of a great many soils of the humid section of Texas and the Southwest.

There is a feeling among some workers that if you can break a clod between your thumb and forefinger it isn't so bad but that you can get along with it, and work it. But if you can't break it between your thumb and forefinger you certainly better take some special precautions before you choose that soil for your green.

A business has sprung up recently in Texas of supplying material called Texas muck. Here is a sample from a pit near a coal mine near Welder, Texas. It may help some soils but it is too fine to have a noticeable loosening action on a tight soil.

The next is a soil that was named after one of our experiment stations. It is a Nacogdoches fine sandy loam.

In order to complete discussion of profile we will pass around a sample of soil taken 6 feet deep. Some of the troubles occurring with your underlying material. This came from Dallas County and when you consider that erosion is always taking its toll then you will understand why this stuff underneath may become your working material later. This may cause you to be careful to preserve what soil you have. The white rocky pellets are known as concretions and are due to leaching carrying out the best part of the soil. It is calcareous. I'll pass this around with the bottle of acid and you can drop some of the agent on the concretion and see that there is no question about its constitution.

You have been given so far a sand, a silt loam, a sandy loam, and a clay, as four different textures of surface soils with which you probably will have to work. We will add one more, the sandy clay. That will make six different divisions that I would like to have you consider. Which is a mixture of just sand and clay. There has been a great deal said for this type of thing, but more said against it. I have heard green operators say that they had rather work with any type of mixture than this 50-50 mixture of sand and clay. If not ametorated

with silt and humus it becomes tight, impervious, impractible, hard when dry; and it is sticky, plastic, and impossible to do anything with when it is wet. But even this can be used if you will give it the proper amount of organic matter to help it between the extremes of drought and moisture.

The next sample is a Windthorst Sandy Clay and it occurs about 18 inches below the surface. We have a great many other materials like this in East Texas, in South Texas, and many counties in Northwest Texas. Attention to this soil is important as to humus content.

This completes the divisions for you to remember, sand, silt loam, sandy loam, clay, and the sandy clay. There will be seven of these pans numbered alphabetically for you to name under those five divisions. I would like to ask you to name them properly.

QUESTIONS AND ANSWERS

Q. What should you do with sand to make a good soil to grow turf on?

A. Beneath almost every sandy soil is a subsoil of clay or sandy clay. Add 100 pounds of loam per 100 square feet with a coarse organic matter such as peat, manure, or compost. I would rather work with sand where I had the fertilizer than with clay as it is easy to maintain a good turf with a little fertilizer. Five pounds of mixed fertilizer per 100 square feet after sodding will be sufficient on 95 % of the sands in the Southwest, provided you add moisture.

For a water-logged sand use a fork or sheep's foot or some other instrument to get your penetration water. In many cases it involves the installation of tile drains. But a tile drain isn't worth installing if you don't have a soil through which water can penetrate to get to the tile.

Your pasture man here recommends to disk and harrow that organic material in but I don't know how you are going to do that to putting greens. So that does make a problem.

SOILS IN TURF MANAGEMENT

O. J. Noer, Agronomist
Milwaukee, Wisconsin

Considerable thought was devoted to the subject assigned without deciding on what to stress because this is a mixed group with many different interests in turf. Before starting I would like to know how many are interested primarily in golf courses. Hands up. Now how many have bermuda greens for summer play and rye grass for winter. How many are interested in bent greens or have bent greens--let's have the hands. That's quite a sprinkling of bent for Texas. How many are not interested in golf turf but rather in cemeteries and parks or estates. Let's have the hands. The number is so small that the time will be devoted to the soil problems which the golf courses are confronted with and principally to the soil factors controlling greens management.

It is not easy to modify or change the physical condition of the soil on a large area such as 60 acres of fairway. The same applies to parks and cemeteries. It is necessary to make the best of the soil at hand. The kind of soil which is best from the standpoint of texture is well known. Turf grasses grow best on loam and silt loam soils, and will manage nicely on clay loam. When it comes to a putting green, or a small playing area, it is possible to make the soil to suit the requirements for the growth of the grass that we intend to use. High cost is the deterrent on large acreage.

It was gratifying to have the half-hour before devoted to some of the fundamentals and the basic information about soils was presented in a very understanding manner.

A putting green is more than a place to grow grass. It is a spot which must have dense turf and a good putting surface irrespective of weather, that is, during rainy, hot, wet periods. The green must hold a pitched ball without the necessity of overwatering. Because many greens have heavy soil, golfers say they are not watered enough. All they know is that a wet green holds their shot. Watering is not the proper solution to the problem. The physical condition of the soil should be such that it is not necessary to over-water a green for it to hold the ball. Those of you who experiment with bent grass will not succeed if you over-water continuously.

Soil is not just dirt, but in mass is a mixture of a solid, a liquid and a gas. Each constituent is important from the standpoint of grass or any other plant. The solid portion is the medium through which the plant anchors itself to the ground, the liquid is water and the gas is air. Both are vital to the well-being of the living plant. A good soil should be about one-half solids and about 50 percent of pore space or voids between the particles. About half of the pore space or voids between the particles. About half of the pore space (25% by volume) should consist of water, and when there is much more than that amount the soil becomes water logged easily. Then plant

roots are deprived of the air which they must have. They breathe and require air just as you and I must have oxygen. The root system is going to be near the surface unless the soil is permeated with air.

When talking about the proportions of soil, sand and organic matter for greens it is best to speak in terms of volume rather than weight because that is the way you mix soil for greens. You may take two shovels of soil, two shovels of sand, and one of humus material or some other similar ratio. It is best to refer to organic matter content by volume also. The surface soil in a golf green should have more organic matter than an ordinary soil contains. In the neighborhood of 20 to 30 percent by volume is about the correct amount. The type of organic matter is also important. A fibrous material is better than a plastic colloidal one because it will tend to keep the soil more open and will produce the resilience that is necessary to hold a pitched ball.

In Texas and Oklahoma a great deal of manure, commonly called dairy loam, is used in making soil for greens. Personally, I think a change to a reed or sedge peat of fibrous character would be a preferable source of organic matter. Dairy loam and manure is highly decomposable. It rots rapidly in the soil due to the activity of soil micro-organisms. After they finish using it as a source of energy food the residue left in the soil is negligible. That is still true even though you start with considerable quantities of manure. There is another objection to dairy loams or manures. Their actual percentage content of plant food is low, about one-half a percent of nitrogen, one-quarter percent phosphoric acid and one-half percent potash. So we usually talk of its being a 1/2-1/4-1/2 in analysis. Yet the amount of plant food applied is considerable because of the large volume used. The dairy loam may be all right for Bermuda grass but it is bad for bent greens. They should be fertilized when plant food is needed and top dressing should be applied for the sole purpose of providing soil of the right physical condition. Dairy loam top dressing will build up a high content of nitrogen which makes the grass too soft and causes trouble during hot humid weather. After all that is the time in Texas when troubles are apt to occur especially during June, July, August, and September. Hot weather may start in May and last into October, but troubles may occur during the hot period of the year, particularly when there are heavy down-pouring rains.

When it comes to the sand used in the mixture, it should be sharp and granular. Timely Turf Topics (Oct-Nov.'46) gives the specifications for a good sand. The specification is one any dealer in sand will understand because it was gotten up by the Testing Laboratories of the Sand and Gravel Association as specifications for a concrete sand. The sand used should not be uniformly fine, actually a very fine sand isn't much different from silt. It will pack and will cause trouble, and when used in a mixture with silt or clay the final product may resemble concrete instead of a good soil for the growth of grass. The top soil on the green should contain plenty of sand, and most of the particles should be rather large. Some of these profiles illustrate

what is meant. These two sections were taken from a putting green on a golf course in St. Louis, with bent greens. The soil profile shows something about the kind of greenkeeper a man is. Al Linkogel inherited the golf course soon after it was built. Construction was on a contract price basis. The grass was planted on yellow clay at the bottom of the profile. On a farm it is possible to dig up the soil and work other material into it. Once a green is covered with grass it is impossible to put sand, humus, or anything else into it without producing layers. The soil column should be uniform throughout the depth in which the root system exists. In the time that Linkogel has been on the course he has built a four inch layer of good soil over the yellow clay base. It represents a period of 10 to 12 years. One of the greens was so bad that grass was lost every summer. The green was rebuilt and during reconstruction 90 tons of coarse sand was applied on 5000 square feet and mixed with the soil. The two profiles will be passed around to illustrate our idea about sand, and a good soil mixture for bent grass.

Nobody can tell you just what proportions should be used in making a soil. We like to express it this way, the mixture should have enough sand and enough organic matter so when the mixture is puddled with an excess of water and allowed to dry it will crumble quite easily with slight pressure between the fingers. With a mixture of that kind you are not going to have trouble caused by faulty soil texture. Root systems will be deep because such a soil contains the optimum amount of air, which is so important. From the soil standpoint a sand is any soil containing 85 per cent of sand particles. The other extreme, or clay soil, is any soil containing 30 percent, or more of clay particles. In other words by changing the clay content only 15 percent a soil is thrown from one extreme to the other. From a practical standpoint what does that mean. Only that it takes an awful lot of sand to change the texture of a clay soil, but very little clay is needed to modify a sandy soil. This fact should be realized whenever top dressing is being made.

The top soil on the green should be uniform to a depth of 6 or 8 inches, or more if possible. There should be no pronounced layer of sand, peat or clay near the surface. This profile came from a green in Indianapolis. The present greenkeeper has no end of trouble every wet summer. The grass becomes thin and the surface covered with green scum. The former greenkeeper on that golf course believed in pure peat and prized its high water holding capacity and its ability to make the surface resilient. Both are desirable features but become objectionable when the top dressing is all peat. When the present greenkeeper lost the grass some of his superiors and many club members thought that he didn't know how to grow and keep grass on greens. The reason for trouble was the fact that the peat with its enormously high water holding capacity trapped the water and prevented it from going down. After the surface soil became water-logged the trouble started. Serious loss of grass has been overcome by using hollow tine forks. You will see how the roots have started to travel down in the holes.

This profile was taken from a putting green in Detroit. I am not going to tell you the name of the club. The greenkeeper has had no end of trouble during the last three or four years, and for good reason. A Britishor was in charge of maintenance at one time. Because he came from Scotland he said pure sand is the only thing to use on putting greens. So the greens were sanded. You can see the layers of sand which developed as a result of top dressing with it. Troubles don't start from sand layers until they become imbedded in the soil to a depth of one-half to several inches deep. During the hot weather root systems refuse to go below the sand layer and then grass wilts on hot windy days because the roots are too near the surface. High winds take the water out of the plant and soil faster than it can be absorbed by the meager root system. Somebody said grass should never be cut close, so the greens at this course were cut at 3/8 of an inch. When the profile is passed note the thick heavy mass of stems and leaves at the top. A dense thick surface mat is not good from the standpoint of play, and is bad from the standpoint of maintenance. In the old country, Scotland for instance, they can't afford to buy shingles so grass is used on the roof of homes to keep water out. When a mat of that kind is allowed to develop on the surface of a green it amounts to shingling the green. The turf on a good green is tight to the surface, and the soil is uniform throughout.

This is a profile from a putting green at the Milwaukee Country Club. This club has greens which are as fine as any in this country. Dr. Grau will support that statement because he has seen and played on them. The profile tells something about the last three greenkeepers on that golf course. The soil at the bottom was put there by Charles Gardner. He was a great advocate of sand and his top dressing mixture tended to be rather high in sand, although there was enough fine material (silt and clay) so he never had any real trouble in maintaining the turf. After he left Fred Haselow took over. He thought a soil of black color must be good and so he used rather large amounts of peat in the mixture. I would say peat content exceeded the 30 percent maximum mentioned before. The middle section of the profile represents his regime as greenkeeper. The present greenkeeper, Ted Booterbaugh, has been there a few years. Soon after taking charge he noticed that the greens were too springy as a result of the large proportion of organic matter in the top dressing. This was substantiated by a few complaints from the players about sponginess. He cut down on the amount of organic matter, and is now using a good soil on the greens.

There are other profiles but only one from Texas. That was taken in August 1946 at Amarillo. Last summer we did not know how to ship profiles. Since then we have learned how to pack them so they can be shipped to Milwaukee. The next time I visit Texas a more extensive series of profiles will be collected from the greens throughout the state.

Soil texture is less important with the bermuda and rye grass greens than with bent greens. As Dr. Jones said, Bermuda grass will grow anywhere. That statement is true but misleading. No other grass responds to good treatment faster or better than Bermuda. You can

accomplish more with Bermuda in six weeks than can be done on fairways in the North in two or three years with Kentucky Blue Grass. Although soil texture is not as important from the standpoint of growing Bermuda, it is just as important from the standpoint of the player. Generally speaking the golfer wants a firm but resilient surface. Unless the soil contains enough organic matter, and is of the right texture, Bermuda greens will not hold a pitched ball any better than a bent green. This fact should be borne in mind and emphasized even though the turf is Bermuda grass.

Drainage is extremely important and is often the difference between success and failure with greens. The quickest way to get surplus water away from any place is by surface runoff. It means that greens should have perfect surface drainage. They should not slope in one direction only. Too many of them slope from back to front. That is done so any ball poked at the green will stop. After a heavy down-pouring rain the front of the green stays wet long after the back part is dry. It stays wet due to surface run-off from the back. Most players approach from the front and step on that part first. That part should dry out first rather than the back. In shaping a green the slope should be in two or three directions, partly to the front, and part to one side or the other. This is perfectly feasible and will not interfere with the play of the course. There should be no high mounds or depressions on any green. The old chocolate drops of the past are a nuisance in hot weather. It is impossible to keep moisture in them. Turf dries out on the knobs and the adjoining depressions get too much run-off water while getting water into the high spots. Long sweeping and gentle curves are preferable to abrupt slopes and banks. Steep slopes must be mowed; they must be treated with fungicide, watered and fertilized. Yet there is no cupping space on them so they are waste land on a putting green.

I visited a course in Atlantic City right after the new greenkeeper came up from Florida. I knew him when he was in Florida and thought he had some of the best Bermuda putting greens in the South because he fertilized heavily with nitrogen and I thought he might do the same thing in Atlantic City, where the going is tough with bent in the summer. When we walked out to the first hole on the old course I saw a monstrosity and told Mr. Anderson, who was Mr. Geist's representative that the green should be rebuilt. It was sloped like a bath tub with two high chocolate drops in the center. The design made it impossible to keep bent grass. The turf was mostly poa annua. It came because the bent died. As a result turf was good in spring and fall when the weather was cool, and lousy in summer when the poa annua disappeared. Mr. Anderson was deaf to my pleading because the green was a pet and prized possession of Mr. Geist, his employer.

Tile drainage is required when the subsoil is heavy textured. The herring bone system should be used. Lines should be close together, not over 10 to 20 feet apart and trenches should be backfilled with pea gravel to within 6 to 8 inches of the top.

Dr. Jones said nothing about soil reaction. It is important. The acid soils of Texas are mostly in the South and Eastern parts, rather than in the Western portion of the state. Is that not true, Dr. Jones? Although Bermuda grows over a wide reaction range it responds to lime. Sour soil to the average layman is indicated by the presence of moss, or by a damp location. Moss is just as much an indication of an impoverished soil as it is an indicator of acidity. A wet spot means drainage is needed. The soil may or may not be acid. The so-called pH scale, or potential of hydrogen is used to express reaction. The scale runs from zero to fourteen and the midway point, or figure 7, is neutrality. Figures below 7 are increasing acidity. The scale differs by multiples of ten, so pH 6 is 10 times, pH 5 is 100 times and pH 4 is 1000 times more acid than neutral. When a soil gets down to pH 4 or 5 it is strongly acid and lime is badly needed. The first time I ever saw benefits from lime on Bermuda was at Houston on the football field at Rice Institute. It had been rather dry, and the only green looking grass on the Bermuda field was along the white chalk yardage lines. We collected soil samples and found that the native soil was distinctly acid. This example shows that Bermuda is affected by soil reaction, and that it responds to lime on acid soil even though it will grow on quite acid soil. One effect of lime on Bermuda and other grasses is to help it stay green longer during drought. The implication is not intended that well limed turf will stay green without any water because that is not true. The effects of drought will show first on an acid soil.

Just a word in closing about fertility. It is what most of you expected me to discuss first. When soil samples are sent for testing, the first thing that the letter says is what fertilizer must be used to grow grass. Some of the samples are not analyzed because they are unsuited from the physical standpoint. The first thing that must be done is to modify soil structure and make it satisfactory from that standpoint. Until that is done there is no use wasting time determining plant food deficiencies.

The fertilization of fairways will be discussed first. The principles used there apply to parks, cemeteries and to some extent on airfields. No weed control chemical is the sole answer to good turf. Dr. Grau will agree to that because he pioneered in that field and developed the methods for using sodium chlorate, arsenic acid and sodium arsenite. Turf becomes weedy because there isn't enough grass. The statement is so obvious that it seems rather senseless. Nothing is gained by killing crab grass, dandelion, or any other weeds if something is not done to increase turf density. A good Bermuda fairway of dense turf will tend to resist invasion by weeds. But if the weeds are killed and nothing else is done there will be another crop of weeds just as big or bigger the next year. Chemical herbicides enable us to do some things quicker than before and have a very definite place in the turf picture. Increasing turf density is the problem. The first thing is to find out if drainage is needed and install tile lines or improve surface run-off. Then check soil reaction to determine whether lime is needed. When the soil is acid it should be limed. After that fertility is the main problem provided

there is some grass which is suited to the locality. In most places down here it is Bermuda. Zoysia and St. Augustine have a very definite place in shaded areas. Zoysia will do well even in the central part of the state, but is slow to become established as turf. Bermuda is a grass that responds to fertilization faster than any grass used in the North. It does not have a high requirement for phosphorus and potash, and grows well on soils in which the level of available phosphorus is much lower than is required by Kentucky blue grass. Bermuda resembles the bents and fescue in respect to phosphate requirements. When the soil is extremely low in phosphorus superphosphate should be used. Otherwise a fertilizer containing from one-half to one-third as much phosphoric acid as nitrogen will suffice. When a mixed fertilizer is used something like 10-6-4 or similar analysis should be applied. If the soil is very low in phosphorus, a heavy dose of superphosphate at 400 to 500 pounds or more per acre can be applied once and it will carry the turf for a period of two, three, or four years, provided interim feeding provides enough nitrogen. Potash is seldom needed, particularly on the heavier soils because most of them have a generous supply, and the clippings are not removed from fairways. The phosphorus and potash in them is returned to the soil as the clippings undergo decay, so nitrogen is the main necessity. Potash may be needed on some of the very poor sands.

The rate for using nitrogen is a matter of applying 75 to 125 pounds of actual nitrogen per acre per year. In Southern Florida where Bermuda is green all year the feeding must be heavier than it would be in an area like Dallas where the grass is dormant during the winter. It is not uncommon for courses in Southern Florida to apply from 800 to 1000 pounds of fertilizer per acre three times a year. Fairways receive from 40 to 50 pounds of actual nitrogen each time. These rates may seem high and excessive but they are not.

Tomorrow fertilizer practices for greens will be discussed along with the topic of top-dressing and soil mixtures. A few remarks about the feeding of bent grass greens may be in order now. Clippings are being removed from greens so a crop is being taken off constantly. The greenkeeper is a farmer in that respect. Growth is maintained at a high level by constantly augmenting the rainfall with artifically applied water. Since growth is greater the level of fertility should be higher than on the fairways. Generally speaking enough phosphorus and potash can be applied in a couple of applications, one in the spring and one in the fall, to provide the requirement of these elements for the seasons growth. In the North from 5 to 10 pounds per 1000 square feet of superphosate, or its equivalent, is applied each time. About 10 pounds of potash, 60 percent grade muriate, is used per 1000 square feet twice a year.

Then the problem becomes one of nitrogen feeding. That and watering are the things to watch. When you learn how to use them you are on the road towards success with bent greens. One time at San Antonio an area had been seeded to seaside bent. The greenkeeper remarked that bent won't grow down here. The grass looked like fertilizer had been scattered unevenly over it. A 100 pounds of sulfate of ammonia

had been used. There was not more than a thousand square feet in the area so 10 pounds would have been too much. It was not strange that the bent went out. The growing of bent in Texas is not as simple in East and Central Texas as it is in West Texas. It will be difficult always. Success will hinge upon the proper soil texture, good drainage and the intelligent use of water and judicious fertilization with nitrogen. Nitrogen can be used more generously during the spring and fall, when temperatures are moderate and grass is growing good, than in the middle of the summer when the days are hot, and grass growth has been retarded by the high temperatures. About all anybody can expect to do when the temperature range is around 100 to 105° F., especially in regions where the nights stay hot, is to hold the bent. Just try to keep it, but don't attempt to force growth. Temperatures are too hot for it to grow. Overdoing nitrogen makes the grass too soft and lush and then it will scald and be preyed on by large brown patch and other troubles associated with hot weather. That doesn't mean that nitrogen should not be used in the summer. There are times when it is needed but the rates of application should be light at that season of the year, probably not more than 1/2 pound of actual nitrogen per 1000 square feet at any time. It is always possible to put on a little more fertilizer but once there is too much nobody but God can take it off, and he won't do that for you.

It is now 3:20 so I am going to stop. Some in the audience may like to ask Dr. Jones, or ask me some questions. Let them fire away.

QUESTIONS AND ANSWERS

Q. Will the soil profiles be available for observation and study?

A. I have more soil profiles here and will have them on display so anyone who is interested can come up and look at them.

There is one thing that I did neglect and maybe I should have mentioned; I always talk about tree roots in greens. Here is a profile showing tree roots in the soil. If there are tree roots in the green they will rob the soil of moisture and of plant food, and when the soil once becomes bone dry, water applied on the surface will water log the green because the water is not absorbed by the soil. Instead of moving down 6 to 8 inches or 10 to 14 inches as it should, water stays on the surface and makes the green sopping wet.

Q. I have the chemical analysis of Dallas water and would like to know if it can be used on bent greens.

A. Quality of the water used on bent greens is a very pertinent question to raise. I have a number of analyses of Dallas water in my portfolio. Some of the well waters at Dallas contain up to 1600 parts per million of dissolved salts mostly in the form of sodium chloride, sodium sulfate and apparently sodium carbonate. The chemist who made the analysis suggested to one of the golf courses that alkalinity could be corrected by the addition of acid. Trouble caused by the use

of this water will not be caused by alkalinity. It would be due to the presence of too many soluble salts. If the soil reaches a point where the salt concentration becomes detrimental it is an alkali soil. Now I have not seen anything in Dallas which leads me to believe that water has been responsible for the loss of grass. Soluble salts have not helped but they have not made it impossible to grow grass. Somebody said the water must be too alkaline because they used it on a rye green and the rye grass died. That is dangerous reasoning. When I studied geology the teacher was an exceptional man. He described a geological formation and asked a student to give the sequence of events which occurred. The student gave him the answer and was told, "Your reasoning is just about as reasonable as to walk down State Street (which was the Main Street of Wisconsin University) and conclude that a chicken walking across the street was a human being because it had two legs." The distinguishing characteristic between a chicken and a human being is not the two legs but something else. This has been a very bad season for rye grass and there was a lot of trouble obtaining stands of it. I think most of the trouble was due to damping-off. The soil should be sufficiently porous so the salts can be washed out through the tile drains. Then there will not be a build-up of salts in the soil.

Dr. Jones--We had some examples of salt in water from Waco. It was highly charged with calcium carbonate and bicarbonate. As you say that situation can be handled very easily, but where there is a high charging of sodium carbonate running up to 1800 parts then the condition is similar to the one in Bryan before we got out new water system. You really have a problem with that much sodium carbonate.

Q. How can soluble salts be removed from the soil?

A. When the soil is open the salts can be flushed out by thorough leaching. We received a soil from a greenhouse at one time. The crop was poor so we determined phosphorus and potash. They were sky high, so we doubted that trouble was due to too little plant food. We decided he probably used too much and had made an alkali soil artificially. Then we determined the soluble salt concentration and found them out of all reason. So we went to the greenhouse and stayed while he watered. When you say to leach the soil, most people simply overwater. We have learned that by experience. It is necessary to pour water on the bench until it runs out below. He did that and in six weeks the crop was growing in a normal manner.

TURF GRASSES FOR THE SOUTHWEST

R. C. Potts and G. C. Warner
Agronomists
A. & M. College of Texas

There are over 500 different native grasses growing in Texas. During the past ten years the Texas Agricultural Experiment Station has tested over 300 introduced species from all parts of the world having similar climatic conditions to those found in Texas. Thus over 800 different species of grass plants have been considered in determining those which are suitable for turf purposes.

The number of grasses that make good turf is limited. Most of the native grasses are bunchgrasses, and do not respond favorably to close mowing. The turf grasses of most value are those which, in their native conditions, are more or less short and which are not injured by close grazing or mowing.

The current pasture plant improvement program at the A. & M. College of Texas was started 10 years ago. It was the third effort made by the Experiment Station to establish a grass and pasture program. The first grass and pasture work was in the years 1898 to 1903. The second period of activity in relation to grasses was in the years 1913 to 1916. During this period the Angleton substation in the Gulf coast prairie, and the Chillicothe substation in northern Texas, received and tested all the introduced grasses which were available to the USDA, Bureau of Forage Crop Investigations. In 1936 a comprehensive program was initiated for the development of range and pasture research. This program has been in operation for 10 years, and recognizes the wide public interest in it. The public has taken with enthusiasm those activities pertaining to improvement of pasture plants, soil conservation, revegetation and proper land uses, and turf work which you have so forcefully endorsed by your presence and cooperation in this first turf conference.

The nature and requirements of the program started 10 years ago was to develop improved range and pasture plants. It is our desire to improve the quality of pasture forage as indicated by increased minerals, protein, and longer green growing seasons. The quantity, or yield of forage is another characteristic we are improving. Yield is influenced by the type and nature of the plant, soil fertility, and available moisture, among other things. In the western part of Texas, moisture is usually a limiting factor in producing high forage yields. During so called "wet years", most plants grown in West Texas respond by producing "bumper" crops. During the years of average rainfall, the plants grow, make seed, and sometimes spread vegetatively, because they are very efficient in the use of water. Therefore any program to increase the productivity of native western grass plants must be built around increasing the water economy of those plants. Considerable progress has been made in improving the drought and cold resistance of a number of plants.

The improvements made in forage production has often been of such a nature as to make plants less desirable for turf. Generally long leaves and height of plants are associated with high yield. Thus selection for high yield has been in the direction away from desirable turf types. An example is the high forage producing Coastal Bermuda grass developed at the Tifton, Georgia station. Coastal Bermuda grass grows two to four times as tall and is only one-fourth to one-third as dense as the Bermuda grass commonly found growing in Texas. Coastal Bermuda grass very often grows knee-high, and is cut for hay. There is no way of estimating how many different selections were discarded in developing this tall, high yielding, low density strain. It is certainly true in our work here that we have been obliged to eliminate many types of grasses that probably would have been very desirable for turf. Our program did not include the saving or selecting of turf types.

We desire to operate a well-rounded program. In many instances we have put in extra time or borrowed time from the pasture work in order to have a small bit of turf. However, under such circumstances the limit as to how far we could go was soon reached. If a program of development of turf grasses or turf types could be included as a part of our present work, it could benefit from the current pasture improvement program. An example can be cited. Four years ago Dr. Brittingham started a forage yield test on eleven different introduced grasses, including common Bermuda grass. The Bermuda grass was to be procured as pieces of plants from that found growing locally. During the process of cleaning up a garden plot at his home, he saved the Bermuda grass which was removed from the garden plot. This Bermuda grass was planted in the test along with live plant material of the ten other grasses. The plots received two fertilizer treatments, one being at the rate of 40 pounds of nitrogen per acre, the other being 40 pounds of nitrogen and 40 pounds of phosphoric acid per acre. The plots were cut six times the first year. The yield of the Bermuda grass on all six clippings was only one-fourth of a ton per acre. Three years later an additional application of nitrogen was made, but there was absolutely no response on the Bermuda grass. Many people have looked at these Bermuda grass plots during the past four years. Most all of those people are in agreement that by accident, a dwarf or short growing selection of Bermuda grass was made. This selection is as dense as one could possibly want, but so far we have not been able to do anything to it to make it grow big. This particular selection of Bermuda grass may well be called a desirable turf type. It has been maintained for four years, but has no value as a pasture or forage producing type. If a coordinated turf program were in effect, good advantage could be taken of having found this desirable turf type in the course of the pasture grass improvement program.

There are three native turf grasses adapted to the drier parts of the state, buffalo grass, curly mesquite grass, and blue grama grass.

Buffalo grass is probably the most widely adapted native turf grass. It grows throughout the great plains from Canada to Mexico and is a valuable turf grass in all this range of adaptability. Buffalo grass initiated our present pasture grass improvement program, and we

know much of its value for turf. Our original grass nursery had several thousand individual buffalo grass plants from all of the great plains states. Under the conditions in Brazos county it was very evident that those plants originating to the north did not grow as fast nor yield as much forage as those from more southerly locations. They grew rather slowly, but made a dense, short-leafed turf. Their yield of forage and of seed was low, and as a consequence were not desirable pasture types. For turf purposes however, they were superior to selections procured locally and to the south of this area. While we did not save those turf type selections, such types could be re-constructed again by planting seed harvested from areas to the north of the location desired to establish a buffalo grass turf. Such responses to changing environment as was exhibited by the plants just mentioned offers one method of approach to a low maintenance requirement turf.

Buffalo grass under conditions in Texas is found primarily in areas having a heavy type of soil. It prefers a clay soil or one having a considerable amount of clay in it. However, it is adaptable enough that it will grow in sand, as was shown in the pictures presented last night by Dr. Noer. Buffalo grass was grown in our nursery on a poor fine sandy loam for about six years. It was, however, a never-ending battle to keep the Bermuda grass from taking the Buffalo grass.

The native grass plants of dryland areas have been able to survive down through the years because of their relatively low water requirements, and their efficient use of the water they did get. We cannot do much in a relatively short period toward changing the water economy of the native dry-land grasses. Selections in the direction of increased density are usually those which have more leaves and leaf growth. If, however, the limiting factor, water, is not available to support the extra vegetation of the dense growing plants, they will not exhibit the density expected of them.

Buffalo grass is a sod forming grass of very high quality. It will withstand very heavy usage, as indicated in many places by heavy livestock grazing. Some people acquainted with Buffalo grass will plainly say that it cannot be grazed too closely. However, it can be grazed too closely, and it can be damaged by too heavy traffic upon it. This is true, among other reasons, because buffalo grass spreads vegetatively only by runners. There are no underground stems, or rhizomes, to provide new leaf blades when the top vegetation has been worn off.

Buffalo grass is different from most grass plants in its flowering habits. The pollen bearing and the seed bearing flowers are usually on different plants. The male plant produces pollen on stalks that are from 6 to 8 inches or more in height. The female plant produces seeds on short stalks, often not over one inch tall. A buffalo grass lawn having mixed male and female plants will make a somewhat spotted appearance during the blooming season, however, the pollen stalks are easily removed by mowing. This is not very objectionable, for some pollen bearing plants are needed to assist in seed production. Seed fall to the ground, germinate, make new plants and thus help maintain the density of the turf.

Blue grama grass is the second grass that will be discussed. Blue grama is native to the great plains region, and is widespread in its occurrence throughout the region. In Texas it is found most commonly in the high plains region, and to some extent in the rolling plains. There are a number of other grama grasses native to this area, and under certain conditions several of them will make a fairly desirable turf. Blue grama, however, is the most widespread of the gramas, and is quite versatile. It will grow on clay soil, sandy soil, and all gradations between these two textures. Blue grama is naturally a bunch grass, growing under some conditions up to 12 inches high or more. However, where it is seeded rather thickly, it does not get too tall, and under such a condition forms a rather desirable turf. Blue grama grows well in a mixture with buffalo grass, and in many parts of northwest Texas the two are usually found growing together.

Another turf grass native to the western and dryer parts of the state is curly mesquite grass. Curly mesquite grass is adapted primarily to sandy land. Curly mesquite is a sod forming grass and spreads primarily from runners. The leaves usually are 2 to 4 inches long, and the seed stalks usually 4 to 6 inches high. It does not grow very tall or very fast, and does not need mowing too often. There is no seed of this grass available commercially. Where it is desired to plant a dryland area to grass, usually buffalo grass or, in certain places, blue grama grass is planted.

An introduced plant of considerable promise is yellow beard grass. Of the over 300 introductions which we have tested, yellow beard grass is one of the most versatile. It is native to areas bordering the Mediterranean sea, India, and perhaps China. We have introductions from Afaganastan, Turkey, India and China. While yellow beard grass is a bunch grass, and has stems up to 18 inches tall or more, the stems are very fine and do not seem to be a detriment in making a turf of this grass.

Yellow beard grass has been successfully grown everywhere we have planted it. It germinates quickly, and grows rapidly. It produces an abundance of good seed which shatter easily, are transported readily by wind, and germinate with the first good rain. In areas of fairly abundant moisture, such as we have in the local area, yellow beard grass seed planted in the spring have produced mature plants with seed which have shattered, germinated, and themselves made seed in the course of one growing season.

Under conditions of low fertility, yellow beard grass plants small, with stems rarely over 12 inches tall. With more soil fertility, such as is found in the soils of the Brazos river valley close by, yellow beard grass will grow twice as large.

It is a little difficult to mow isolated plants of yellow beard grass because the seed stalks are so willowy that they bend over in front of the cutter blade. In a dense stand where the seed stalks do not get so tall, it is easier to mow, and may be cut either with a sickle or reel type mower.

While yellow beard grass is a bunch grass, it grows well in a dense stand, and responds favorably to mowing. Mr. Potts has just indicated to you that he has seen yellow beard grass under close and regular clipping at San Antonio. It was mowed every week at a height of 1 inch to 1 1/2 inches, and made a very fine cover.

Yellow beard grass is very drought resistant. There are two very successful plantings at substations in the 20 to 24 inch rainfall area of the western part of the state. We believe that yellow beard grass has a very definite place in the drier regions of the state.

There is one other introduced grass that holds considerable promise for the dry areas of the state. It is presently called Caucasian beard grass. It is closely related to yellow beard grass, and is very similar to it in appearance. We are not too far along in the development of Caucasian beard grass as yet, but are well pleased with its prospects.

Carpet grass is native to the southeastern states, the West Indies, Central America, and the tropics, and is present in abundance throughout that area. Carpet grass grows naturally on soils of low fertility and in many conditions where drainage is none too good. It is fairly responsive to fertilizer, but does not require fertilizer to grow and produce a satisfactory turf. Carpet grass is a sod forming grass, spreading by runners and seed. It has rather wide leaves which grow 6 to 8 inches or more tall. Where it is allowed to produce seed stalks they may grow to a height of 15 to 18 inches, and are rather wiry considering their size. Carpet grass does have to be mowed to produce the most desirable type of turf, and under favorable conditions, it will form a dense sod.

St. Augustine grass, from the best information available, is also native to about the same regions mentioned for carpet grass. St. Augustine grass differs from carpet grass, however, in that it requires a considerably higher level of soil fertility and somewhat better drainage to make its best growth. St. Augustine grass has gained much of its popularity because it is very shade tolerant. It will grow better under more shade than any grass we have available for the southwest. St. Augustine grass is by nature a warm climate grass, however, it will stay greener later into the fall than will any of the other turf grasses adapted to the same area. St. Augustine grass is sometimes partially killed by cold weather in north and northwest Texas, however, from the Ft. Worth-Dallas area southward it withstands most winters without injury. St. Augustine grass is susceptible to several of the more common turf grass diseases, however, there are control methods for those diseases.

There are several introduced grasses which would have been discussed if the time had allowed. Centipede grass is an importation from China which produces a very dense turf on low fertility level soils. It grows very well on poor sandy soils having fairly good drainage. It will grow on black land, however, we do not know its full range of adaptability or response on such soils. To date our knowledge of Centipede grass enables us to recommend it only on the sandy soils generally south of an east-west line drawn through Waco.

Bahia grass is native to the West Indies and tropical South America. It has been grown for a number of years in the southern parts of states bordering the Gulf of Mexico. It spreads primarily from seed and very coarse fleshly rhizomes produce a very dense and tough sod. It is adapted primarily to the warmer parts of the southern states.

Bermuda grass is a native of the Mediterranean region and India. It is widely adapted throughout the southern states, and is the most extensively used of all adapted turf grasses.

Manila grass (Zoysia matrella) is a native of the Phillipine Islands and other island areas of the Central Pacific. Manila grass produces a very dense fine-leaved, wear-resistant turf. It grows very slowly in comparison to the other turf grasses, but the slow growth rate reduces the number of mowings necessary to maintain it at a desirable level for lawns.

Dallis grass is a native of South America. It is a bunch grass but spreads slowly from short, fleshy rhizomes and from seed. As isolated individuals, Dallis grass is often considered a nuisance or a weed in other types of turf. However, in a solid stand, Dallis grass provides a very durable, wear-resistant sod.

QUESTIONS AND ANSWERS

Answers -- R. C. Potts

Q. How would it be possible for the college to do some work on turf?

A. It would be necessary for us to set up a program on research in turf grass. All of our money comes for the research for pastures and it is specified that it must be for range and pasture. Anything that we have done for turf grasses has been on the side.

Q. How do you differentiate between Carpet and St. Augustine grass?

A. It is rather easy to tell the difference in the two grasses. St. Augustine grass has a quarter twist where the leaf blade joins on to the sheath, whereas in carpet grass the leaf will come out straight without any twist whatsoever.

Q. Has St. Augustine grass been used on greens?

A. According to the representatives from Houston and Beaumont it has not been used for greens.

Q. Are there seeds available for St. Augustine grass?

A. I believe I can answer that--there are no seeds.

There is one or two things that I would like to point out Mr. Chairman if I may--in just a minute. There has been a lot of interest in this grass here that most of you have seen. I'll give you some of its good and bad characteristics. This is a very dense turf

here as you see it in this pot. This has been in the greenhouse for about three weeks and it has started to grow again. The turf you see in front of the pot has not been in the greenhouse. This grass was set out in the field three years ago on the foot centers and given excellent care. It took two years for the grass to cover and make turf as you see it here. That is very, very slow and to me that is the big objection to this particular grass. If you have a long time to wait we have no grass in the state that will make a better turf.

Now to the people who are interested particularly in heavy turfs--roadsides, maybe fairways, I would like to recommend this grass. This narrow leaf Bahia grass. It has a dense sod, and I believe the toughest turf of any of the grasses that is up here. If you will notice after the meeting this morning; if you will come up here and look at some of the rhizomes of this grass you can see they are very heavy and very dense and it will stand a lot of traffic. To give you some idea as to how much traffic that might have--a few years ago we started to plow up a plot of this; we had two mules and a little 10-inch turning plow, the mules were 17½ hands high and we could only take 4 inches of the sod at a time. That is all those mules could pull. Their belly was touching the ground at that. So you can see just how tough it is. You can take an ordinary sized tractor, when the ground is wet and run over it with the tractor and you can't see your tractor print in the ground. So there is none other quite as tough as that particular sod.

Q. How cold tolerant is zoysia matrella?

A. Zoysia is fairly cold resistant. It will stand the cold in Texas. Bahia grass is going to have to stay pretty well south of Waco.

Q. Where is Bahia grass adapted?

A. Bahia grass is adapted only to the humid or subhumid part of the State where the temperatures do not go below 10-15° F.

TURF WEEDS

H. B. Parks, Curator, Museum
A. & M. College of Texas

The number of species of grasses, native, or introduced into the State of Texas, which are especially adapted to the building of turf covering is extremely small in comparison to the number of those species of plants which come into competition with them. While any two plants growing in close proximity are in competition with each other as far as sustenance is concerned, there is a large number of small and specialized plants which find a home in turf and are protected by it. In considering the relationship of turf plants and turf weeds the areas upon which the turf forming plants are used are divided into:

Small Lawns, including all small plots of ground on which plants are carefully protected and cared for in order to have a smooth plant covered area as a basis for a front yard. These plots, no matter how carefully cared for, harbor many species of other plants which are considered in this paper as weeds.

The second division is large lawns. These are the grass covered areas around public buildings especially churches, schools, hospitals, and larger and better cared for plots around the large estates which surround almost every large town. In these larger lawns are found all of the weeds of the smaller lawn and additional set which find a growing place in the greater areas which are not so carefully worked as those of the small lawns.

Acreage lawns are those enormous blocks of land on which it is desired to have a smooth turf covering either for looks, or for both looks and utilization for certain maneuvers. In this class are the lawns on golf links, army and air fields, the campuses of large schools or institutions where many people are concentrated, and in cemeteries, especially those that maintain a smooth sod covered surface over many acres of land. Again this third division makes possible space for a third set of turf weeds to maintain themselves in spite of the continuous work of the caretakers.

The fourth and last division undoubtedly covers a greater area when completed than all of the other sections combined. This is the roadsides of the far reaching highways of the State of Texas, along which exist areas which will be easy to turn into permanent and easily maintained lawns, much of which is already completed. Many acres, by continuous work will be added to that already in existence, but over many miles of these roadsides the turf must be developed from soil imported, or by the use of something besides the present known ground covers. This huge area contains in great quantity not only weeds which must be combatted in the lawns of the foregoing sections, but has many additional plants that have maintained themselves against the most strenuous assailants of nature until the controlling and subduing of these areas into well cared for roadside lawns is next to an impossibility.

A turf weed can be defined as a plant where it is not desired. While this is somewhat different from the common definition of a weed, it is necessary that this definition be used, as many times the component of the turf designated as the weed is itself a well-known turf plant, but does not happen to be the kind of turf plant desired by the owner. "Turf" as used in this paper is a homogeneous covering of grass-like plants which is maintained as a beautiful and useful surface for a certain piece of land, and turf weeds are those plants, either grass-like or otherwise, that may mar the surface of this ground covering.

To enumerate these weeds, it is thought best to divide them into the following classifications:

1. Small Lawns--generally on homesites.
2. Large Lawns--those which are found on the grounds of large institutions and in small parks found in cities.
3. Acreage Lawns--or those found in large cemeteries, golf links, college campuses, and air fields.
4. Roadside Lawns--those which should be maintained along roadsides, and especially where roadside parks have been set apart for the use of travellers.

The weeds of all of the turf surface of these lawns will be inhabited by approximately the same weed flora. To obviate repetition, the naming of those plants which are definitely undesirable, and therefore weeds, will be given. We will begin with those principally combatted on small lawns found in cities. To show the magnitude of the area which was studied in the preparation of this list, it is to be said that the city of San Antonio was used for this purpose. As nearly as can be estimated there were about 25 square miles of lawn observed.

Of the larger lawns studied, Randolph Field, which is approximately 12 by 16 miles, and Brooks Field, somewhat smaller in dimensions, were studied at least once during the three year of observation and during the same three years almost every cemetery in Bexar County was visited.

The weed comment on roadsides comes from many thousands of miles of travel by automobile made for the purpose of collecting plants and plant notes.

Beginning with the weeds of small lawns, as one would suspect, the most troublesome are small plants which were in the soil long before it became the front yard of a city residence. Having lived through the formative period of city growth, only hardy perennials are left. Among those most evident are bulb plants. The common White Rain Lily, Cooperia Drummondii, which blooms after rains in the Spring, and the White Rain Lily, Cooperia pedunculata which blooms under the same influence in the Fall of the year, accompanied by Hybranthus texana, the beautiful Copper Texas Lily, are about the worst weeds of the Spring and Fall periods throughout much of the State. The bulbs of these

three species are located about six inches below the surface of the soil and under the influence of a one inch rainfall, they will come into bloom within 36 hours. While they are in bloom they are of considerable ornamental value, but they go out of bloom within a few hours and then give the lawn a very ragged appearance. If the lawn is clipped, the next morning it is found that the stems of these plants protrude from two to three inches above the surface of the cut grass. Another cutting will bring another growth of stems. This generally ends the trouble from the first bloom, but the plant will bloom every time the right amount of rainfall occurs. During many seasons these three species become a protracted nuisance for a period of nearly two months and due to the fact that their bulbs are deep underground, it does no good to mow the plants. The only remedy is to remake the lawn and screen out the bulbs when the soil is being transferred. These lilies are mentioned as they are perhaps the most universal of lawn weeds in most of Texas.

The other set of plants given in detail are native asters or plants of close kin. About the middle of summer small white Aster-like flowers with an occasional yellow one, commence to appear in the lawns. These flowers are so near the same height of the lawn grass that it is impossible for the lawn mower to clip them, and as the season advances the number of such flowers increases immensely. The only way that these plants can be combatted is by fingering in the grass and finding the tap root of the plant a nd then by carefully pulling the root and untangling it, one is able to extract from among the grass roots a number of long branches of the Aster or Applopappus. These plants, if they grew anywhere else but in a periodically mown lawn, would grow to the height of three or four feet and produce only a few flowers at the ends of long branches, but under the lawn environment they produce their entire crop of flowers just even with the top of the grass cover. This is a remarkable adaptation which nature itself makes to satisfy the need of perpetuation of a species. The only way to combat such plants is by watching the lawn and at the time the first Aster or Aplopappus flowers appear, find the tap root of the plants and pull the root from the ground. This will end the trouble for a year. Another class of weeds which is found in small lawns is grass which is not of the same variety as the majority of the lawn. One of the worst intruders in lawns where Bermuda Grass, St. Augustine Grass, or Bluegrass form the desired covering, is Dallas Grass, a plant which, when it is used entirely for a lawn forms a beautiful surface but when one or two plants of it occur among the plants of the desired variety, it becomes a most unsightly weed. The only way to do away with undesirable lawn grasses is to carefully uproot them. To comment on all of the species would require an immense amount of time, so the list of those commonly occurring in small lawns is appended.

Small Lawns

Having discussed the small lawns and the characters of the weeds found, it is evident that with each of the following named sections, all sections will contain approximately the same kind and number of weeds per square area, but as the weeds more important to an area are

mentioned they will not be re-mentioned in the following divisions. For each division is given the Latin and common names of the most commonly occurring weeds. It is also apparent that it is not necessary to give even a majority of the weeds present, as the treatment for one of these intruders is generally the treatment necessary for all. Unless one is very interested in some one little known or stray in the lawn under question, he has little need for the name of the plant. In such a case it is very easy to obtain the name of the offender by sending a specimen to any of the departments of A. & M. College which are concerned with the maintenance of vegetable ground coverings.

Weeds of Small Lawns

Pasalum ditatatum Poir., Dallas Grass
Cyperus esculentus L., Northern Nut Grass
Cyperus rotundus L., Southern Nut Grass
Cooperia Drummondii Herb., Large White Rain Lily
Cooperia pedunculata Herb., Small White Rain Lily
Hybranthus texanus (Herb.) Stued., Yellow Rain Lily
Bowlesia incana R. & P., Rabbit Lettuce
Dichondra repens Forst., California Ground Cover
Torilis nodosa Gaertn, Knotted Hedge Parsley
Lamium amplexicaule L., Henbit, Spanish Kill
Veronica peregrina L., Water Wort.
Linaria texana Scheele, Toad Flax
Nama hispidum, A. Gray, Red Sand Bells
Capsella bursa-pastoris L., Shepherd's Purse
Plantago heterophylla Nutt., Grasslike Plantain
Plantago virginica L. Wideleaf Winterfat
Gnaphalium falcatum Lam., Rabbit Tobacco
Cenchrus pauciflorus Benth., San Burs
Rumex pulcher L., Fiddleleaf Dock
Sonchus asper (L.) Hil., Sharp leaf Saw Thistle
Sonchus olerasens L. Round Leaf Sow Thistle
Aster ericoides L. White Aster
Aplopappus divaricatus, False broomweed
Allium mobilense, Regel Wild Onion
Nothoscordum bivalve (L.) Britton, Crow Poison

Weeds Found in Large Lawns

Modiola caroliniana (L.) G. Don., Red Cheeses
Malva parviflora L. Cheeses
Sida spinosa L., Spiney Oak.
Lippia incisa, Small, Frog Fruit, Matoh Head
Mollugo verticillata L., Carpet Weed
Glinus radiatus (R. & P.) Rohr., Carpet Weed
Hordium fussillum Nutt., Little Barley
Callirrhoe involucrata (Nutt.) A. Gray, Wine Cup
Gaura sinuata Nutt., Small Yellow Primrose
Bromus carthariticus Vahl., Rescue Grass
Chloris cucullata Bisch., Crowfoot Grass
Setaria geniculata (Lam.) Beauv., Foxtail

Oxalis viloacea L., Violet Sheep Sorrel
Geranium carolinianum L., Wild Geranium
Euphorbia Serpens H.B.K., Sparge, Flux Weed
Argemone intermedia Sweet. Wild Poppy
Lepidium virginicum L., Pepper Grass
Sagina decumbens (Ell.) T. & G. Pearlwort
Arenaria Nuttallii Pox, Chickweed
Stellaria media (L.) Cyrill. Chickweed
Gossypianthus languinosus (Poir.) Moq. Carpet Weed
Monolepis nuttalliana (Sch.) Greene, Poverty Weed
Vinca major L., Hardleaf Blue periwinkle
Evolvulus sericens SW. Dward Morning Glory
Nama jamaicense L. White Sand Bells

Weeds Found in Acreage Lawns

Andropogon glomeratus Walt. B.S.P., Bush Beard Grass
Andropogon divergens, Hachel, Little Blue Stem
Andropogon virginicus L., Broom Sedge
Iva angustifolia Nutt., Narrowleaf Marsh Elder
Cuscutta glomerata Choisy, Common Dodder
Convolvulus incanus Vahl. Gray Bind Weed
Ipomoea trichocarpa Ell. Tie Vine
Uniola laxa (L.) B.S.P. Bunch Oat Grass
Hymenopappus, Scabiosaeus L'Her, Wild Cauliflower
Liatris punctata Hook, Button Snakeroot
Opuntia macrorhiza Engelm. Pad Cactus
Euphorbia marginata Pursh., Snow on the Mountain
Schrankia angustata T. & G., Shave Vine
Melilatus Alba Desv. White Sweet Clover
Indogofera suffruticosa Mill,, Indigo Vine
Cleome gynandra L. Spider Flower
Cocculus carolinus (L.) DC. Coral Berry
Typha angustifolia L. Cattail
Selaginella Riddellii Van Eseltine, Wire Moss
Pteridium aquilinum (L.) Kuhn. Upland Fern
Cladium jamaicens Crantz, Saw grass
Scirpus Americanus Pers. Bullrush
Yucca Arkansana Trel. Bear Grass
Polygonum hydropiper L., Water Smart Weed
Eriogonum Multiflorum Benth Willd., Buckwheat

Weeds Found in Roadside Lawns

Kallstroemia hirsutissima Vail, Caltrop
Tribulus terrestris L., Puncture Plant
Croton Lindheimeri Wood, Goat Weed
Polanisia trachysperma T. & G., Slick Weed
Froelichia Drummondii Moq., Snake Cotton
Centaurea americana (Sox) Nutt. Star Thistle
Cirsium horridulum Michx., Giant Thistle

Cirsium virginianum (L.) Michx. Roadside Thistle
Biders bipinnata L., Snapnish Needle
Verbesina virginica L. White Crownbeard
Helianthus annuus. L. Sunflower
Lepachys columnaris (Sims.) T. & G. Nigger Toe
Parthenium hysteropharus L. Feverfew
Baccharis neglecta Britt. Baccharis
Erigeron canadensis L. Horseweed
Heterotheca subaxillaris (Lam.) B. & R. Camphor Weed
Gutierrezia dracunculoides DC. Blake Broom Weed
Eupatorium seriotinum Michx. Big Boneset
Xanthium saccharatum, Wolbr. Cockle Bur
Ambrosia aptera DC., Blood Weed
Iva cilliata Willd., Rough Marsh Elder
Cicuta maculata L. Wild Parsnip
Eryngium hookeri Walp. Thorny Eringium
Sorghum halepense (L.) Pers. Johnson Grass
Andropogon saccharoides SW. Silver Beard

CONTROL OF WEEDS IN TURF

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It is well to consider weed control in turf in two phases. These are Weed prevention and weed eradication. Of these two phases weed prevention is much the easier and more important. If a weedy turf is renovated and the weeds eradicated, the problem of preventing a reinfestation still exists.

The maintenance of a dense, vigorous turf is the best insurance against weeds. Weeds cannot thrive in a turf that is dense enough to shade seedling weeds and to compete for moisture and plant food. Proper height of mowing, proper irrigation, and providing plant food through fertilization at the optimum time for the encouragement of desirable turf species are all phases of management which are helpful in maintaining weed-free turf.

There are a number of ways in which weed seeds may be introduced into turf areas, both in the establishment of turf and in its maintenance. The use of manure or topsoil which may contain weed seed and the use of grass seed which may contain high percentages of weed seed are two of the chief ways of introducing weeds into an area on which a turf is being established. On established turf areas, weed seeds may be brought in by overflow of water from an adjoining weed-infested area. Weeds must be controlled on the adjoining area or the overflow must be prevented. The use of manure or topdressing which contains weed seeds may be another source of contamination.

Sterilization to kill weed seeds in manure or topdressing is often profitable especially in the case of topdressing to be used on putting greens. Weed seeds may be killed by composting for long periods by the use of nitrogenous materials in the soil mixture or by treatment with chloropicrin. Though these methods are quite expensive, their cost is small compared to the cost of labor involved in the hand weeding of a putting green.

Turf areas which have become infested with weeds must be treated according to the percentage of weeds in the plant population. If the area is small and if there are only scattered weeds in the turf they may be economically hand picked or spot treated with one of the herbicidal chemicals. Areas in which the weeds have more or less taken over the turf it may be desirable or even necessary to eliminate all the vegetation and start over. Much more numerous are the areas where the weed population is too great or the area too large for successful spot treatment or hand picking but where weeds are not serious enough to warrant complete renovation. It is on these areas that some of the herbicidal chemicals may be used to a good advantage.

Most of the earlier herbicides developed depended upon a caustic effect for their herbicidal action. These often damaged the desirable turf species as well as the weedy plants which were to be eliminated. Some of these herbicides produced a more or less specific action but usually a great deal of care has been necessary to obtain good results and the uncertainty of success has kept these materials from being used more widely.

Until recently, the arsenicals were probably the most effective herbicides available which could be used successfully against a large number of the troublesome weeds. In the use of arsenicals great care is necessary to prevent serious damage to turf. Their poisonous nature is another feature which has prevented popular acceptance in weed control work.

Sodium chlorate is another herbicide which is selective for some weeds. It has not been used widely because of the fire hazard. Finely divided particles of sodium chlorate on organic matter such as dead foliage or clothing burns with explosive violence. When carefully used it is a very effective herbicide.

Other materials such as kerosene, iron sulfate, ammonium thiocyanate, and the various dinitro compounds have been used with varying success but none of them have found popular acceptance for use on turf.

The most recent herbicide to be developed is 2,4 dichlorophenoxyacetic acid, commonly known as 2,4-D. 2,4-D is a growth substance which has much greater effect upon some plants than upon others. This differential in quantities required for toxicity is the principle upon which the herbicidal action of 2,4-D depends. 2,4-D is non-poisonous and non-injurious to most grasses when cut at lawn height. Some of the bents show some injury and Bermuda may be injured at putting green height. 2,4-D is one of the most promising of all the turf weed control agents that have been developed, yet it must be remembered that 2,4-D is merely a tool in the over all management program, and a weed-free turf is primarily dependent upon sound management practices.

2,4-D is available in a number of forms. The pure acid is not soluble. It has been used in spray mixtures by dissolving the material in a carrier Carbowas (a polyethylene glycol), and then dispersing the mixture in water. Soluble forms include the sodium and ammonium salts, and the esters.

Most of the work with 2,4-D has been done by applying the material as a spray. There are a great many areas where spray equipment is not available and it may be desirable to apply the material in a dry form. Mixing with fertilizer has been satisfactory in some cases.

The standard recommendation for rate of application is 1 3/4 pounds per acre. If rates are expressed in parts per million, then the amount of water to be applied to a given area must also be stated.

Shrubbery or flower beds may suffer severe injury if spray of 2,4-D is allowed to drift. Sprayers must also be thoroughly cleaned following weeding operation since minute quantities of 2,4-D left in the spray tank or hose may cause serious injury to plants if the sprayer is used later for a different purpose.

To summarize -

A good stand of grass is the best insurance against weeds. Management practices which will aid in developing a good stand of grass are the best weed control measures. Herbicides may be used very effectively for weed control if they are used as tools in the management program. If herbicides are used as a "cure" for weeds without consideration of other factors involved in preventing reinfestation, they are not likely to be successful.

RODENT CONTROL

W. P. Taylor, Chief
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I suppose those of you who are directly and intimately concerned with maintaining fairways and greens, lawns, and turf would agree that when you get a lot of rodent mounds on a nice cool green turf that the experience is exasperating. I am going to discuss some of these rodents.

In eastern Texas we have fairly common in some places the mole, which is not a rodent, but which nevertheless may cause a lot of damage to turf. As you folks know the mole moves along almost like a swimmer through water pushing up nice little ridges wherever he goes. As a matter of fact the mole doesn't confine his activities to these ridges. Occasionally the mole digs deeper for nesting purposes and sometimes he gets the notion of throwing out a lot of dirt all in one place and so you have a little miniature hill or mound from 12 to 18 inches in diameter and several inches high. The mole is fairly widespread in the eastern part of Texas. If any of you here are from west of the 100th meridian you won't have any trouble with moles, because there just aren't any in that country. But in eastern Texas the mole is quite abundant.

One of the important rodents is the pocket gopher. We have about five different kinds of gopher in the state. They are found widely over Texas. The food habits of the mole are largely beneficial since it feeds most often on white grubs, earthworms, and other insect pests like that, which sometimes do damage to the greens or vegetation on top of the soil. Most of the mole's food is confined to animal matter, whereas the pocket gopher confines its attention, from the standpoint of food and sustenance, to vegetation and is well known for its habit of eating off the roots of the plants on which it feeds. It feeds on a great variety of plants, so nothing is safe where you have pocket gophers.

Like the mole the pocket gopher may throw up mounds of earth. You can tell the pocket gopher's mound from that of the mole by its shape and size. In East Texas you may run into both of them on the same green or fairway or lawn, so there you may have a double problem.

I ought to say too, with reference to these burrowing animals that have to do with turf, there are a whole lot of other animals, some of them relatives of the mole and others of the pocket gopher, who like to use the tunnels. Thus you have a number of kinds of small animals. These may eat off the grass and herbs underneath the surface of the ground and so add to our trials and tribulations if we happen to be interested in maintaining that turf in a good usable condition. I don't need to go into detail as to how these things make it diffi-

cult to maintain a nice turf. You can't run a lawn mower over gopher mounds or mole ridges. They make the turf unsightly, and they ought to be gotten rid of; it is entirely possible to get rid of both the mole and the pocket gopher wherever you may find them.

Now in some of the Western country, that is west of the 100th meridian in Texas, you will find other rodents coming in and doing at least some damage to the grassy surfaces. Little ground squirrels, the 13 lined ground squirrel, the Mexican ground squirrel, and the spotted ground squirrel. These are not nearly so detrimental as the others. They just burrow up to the surface where they can come out and look around sometimes during the daytime. All you have to contend with is the small round opening of the furrow. Control is fairly easy, whether by drowning, or poison gas, or poison grain. In case of the species previously mentioned, that is, the mole and the pocket gopher, one has sometimes to resort to both trapping and poisoning.

Another animal which gives us trouble in turf sometimes is the crayfish. In real moist soils you know what these crayfish do to the surface. They are a nuisance and no mistake, sometimes occurring in great numbers in the moister soils. Those of you who come from the points of heavier precipitation in the state will know exactly what I am talking about.

Still another animal that we have in Texas is the armadillo. While the armadillo is not a rodent, nevertheless it is an animal that gives us some concern sometimes because it has the delightful habit of running its nose around over the surface of the ground and making unsightly rooted up places. It moves dirt about like a little pig and, as a matter of fact, is doing it for the same purpose the pig would, namely trying to find some termites or some other bugs or eatables in the surface layer of the soil. It is a difficult hombre to control sometimes too. The best control I know is a caliber rifle 22 late in the evening. To control the crayfish put a few drops of carbon bisulphide or kerosene in the chimneys and that will settle that gentlem n's hash.

A proper combination of trapping and poisoning, or drowning, or gassing will take care of all these pests. There is no excuse for having any of them in a well kept fairway. I am going to ask Mr. Poore, who is Extension Specialist with the Fish and Wildlife Service and the Texas Extension Service, to show you some of the types of traps he has brought over here. Some of the mole traps and some pocket gopher traps.

Mr. Poore
Texas Extension Service

I believe Dr. Taylor has pretty well covered the subject, I just want to show you some of the things we use to control the pocket gopher. First, I want to say a word or two about the mole. About the only thing we have found that is very successful in controlling the mole is trapping. We have tried poisoning with varying degrees of

success, tried poisoning earthworms, apples, and things like that and putting them in the moles runway and the results have not been too good. But the mole can be trapped. I have here one type of trap. I like what they call the harpoon type trap best, but mine has gotten away from me and I don't happen to have one. It is just a simple trap that you set on the ground whenever the mole comes along and pushes the pedal up in front between the jaws and as he runs through he gets caught.

The pocket gopher is very easily controlled. It just takes a little time and effort. The two methods that we use are trapping and poisoning. There are some traps on the market that are very good but for trapping we find this Macabee Gopher Trap to be most satisfactory. We usually use two traps. The gopher mound is not completely round. There is a depression on one side ordinarily if you will dig down a few inches on that side you will find the runway, enlarge that and often you will find a double runway, one coming in from one direction and another from another. Always open that up and leave it open. Then set the traps, using a wire to attach and stake them down, if you don't the gopher may run off with them. Lots of time you put one as far in the runway as you can and another in another runway in the other direction and leave the opening open where the gopher can see light. The gopher will come back there with soil to try to stop up the hole. Ordinarily you can catch the gopher. If you are trapping around midday you will generally catch a gopher within two to two and one half hours after you set the trap, sometimes earlier than that. Trapping is very satisfactory with light infestation and is quite a bit of fun besides.

The other method is poisoning. In San Antonio our service has a mixing plant where we mix a great many tons of strychnine poison grain each year for the control of gophers. This goes out to the county agents over the state and to the counties. Just to give you one example we have in the last three months shipped to Rush County 2000 pounds of posion grain for the control of pocket gopher. Of course farmers use that mainly, along with poison we also have gopher probes, nothing more than a pipe with the end of it folded up and a handle put on here so that you can punch it down. You can use any kind of a rod get a hole down into the runway, don't get the hole below the floor of the runway. If you get the hole below the floor of the runway the grain will be below the floor and the gopher will run over the grain. Pour the grain, maize in this case, in the hole, and then cover it up. Ordinarily we kick the mounds down, when the gopher throws additional mounds you can see where they remain.

One pair of gophers will throw up quite a lot of mounds. You will see a chain of mounds. It isn't necessary to treat each mound. We have found that by treating land with this poison grain you can ordinarily kill 75 to 85 percent of them with one treatment of the grain. There will be some left and you can go back and clean them up with the grain or the traps. The grain sells at $12.00 per hundred, charges prepaid to any part of Texas. Anyone that wants it can get it. The county agents keep it for the farmers, sell it out to them in small lots. If there are any questions I will be glad to answer any that I can.

QUESTIONS AND ANSWERS

Q. This man wants to know something more about the control of crayfish.

A. Use carbon bisulphide and kerosene. That is out of my line and I am going to ask Dr. Taylor to talk to you a little more on that.

A. Dr. Taylor--

This is a pretty big subject. As a matter of fact I expect we could spend about half a day on different phases of it. Most interesting too, but we aren't going to have that much time and I want to call your attention, before we quit, to a couple of bulletins which have some of the required information, and which some of you may be interested. Mr. Poore has others in his office. One is on pocket gopher control, that's Bulletin 22 of the Fish and Wildlife Service and the other is on mole control, Bulletin 16 of the Fish and Wildlife Service, as far as these will last you are welcome to them. And if you need more write to the Experiment Station or Extension Service and ask for the bulletin on the Control of moles, pocket gophers, or crayfish for that matter.

On this crayfish proposition the directions are very simple as I said awhile ago about 10 drops of carbon bisulphide in the burrow and close the entrance to the burrow. That's all there is to it according to this bulletin.

DISEASES OF TURF GRASSES AND THEIR CONTROL

Fred Grau, U.S.G.A
Washington, D. C.

I notice that I am the tail-ender this morning, this afternoon, and again tomorrow morning. It must have some special significance.

I am not a pathologist. I have been in the position of just being a practical man interested in the development of turf, and so any one of you who knows more about pathology than I could tie me up in knots. But what I am going to try to give you is just a few simple fundamentals on some of the more common diseases of grasses as we have seen them and studied them. That has been one of the most important functions of the United States Golf Association Green Section over a long period of years.

The diseases that occur particularly on putting greens are often induced by improper management, or induced by the intensive management which is necessary to produce the type of turf we want for a putting green. We have encouraged disease in many cases, by over-watering, over-feeding, or under-feeding, that is improper balance of nutrition, and by the formation of excess mass of grass which tend to hold the disease organisms.

The time of watering has had a great deal to do with disease incidence on bent putting greens. I do not know very much about diseases here in the Southwest, but if it is a brown patch it is the same brown patch that occurs in the North so the control is very much the same, maybe with some minor differences. Before I go into this I am going to show one picture which several of you have evidenced interest in, and that is--we have been talking about aeration of the soil, and aeration of the fairway, lawns, and larger turf areas is becoming quite important.

This is a new machine that has been developed for the rapid low cost aerifying or aerification of soils under turf without damaging the turf, without taking it out of play, by actually cultivating the soil without disturbing the surface. The first machine built is in use at Pine Valley on the fairways, where it is very difficult in that fine sand to get air down and keep air to the roots for proper root growth. We have just begun to develop some experiments in connection with the use of this particular machine which at the present time represents probably the nearest approach to large scale rapid aerification of soils on large areas. I don't know what the application of it is going to be. It was built for fairways primarily but it has already been used on some putting greens; in some cases with disasterous affects, in other cases the effects are very good. It may have a place in pastures; it may have a place on airfields; I don't know, that's in the future. But that is the aerifier. It's the principle that was described in the Greenkeeper's Reporter. Experiments on it are being

conducted at Penn State. That was started last fall. If any of you have any further questions regarding it, you can see me later.

This is dollar spot, which frequently occurs on bent grass in the cooler days of the year when warm days and cool nights occur. I don't know how much of that there has been on bent putting greens in Texas, but during the winter which is rather open around Washington, D. C., and where the conditions are right, that disease will be prevalent all winter. In the summer it does tend to disappear because the temperatures are too high but in the cool days of fall and spring it is rather a serious disease because it pits the surface of the putting greens with little pockets that destroy the quality of that turf for putting and it is one of the bad ones. It is accentuated by the accumulation of a mat some of which have been shown in these samples which Noer has taken with his sampler.

The accumulation of a mat on the surface definitely aggravates the control of dollar spot. Dollar spot can be partially controlled by fertilization. It is very much easier to control it with chemicals if the fertilizer balance is correct. Nitrogen-starved turf is usually more susceptible to dollar spot. Anybody here report dollar spot down in this region? Do you recognize it? I see several of you, well then it is very much in order.

Nitrogen at 2 pounds per 1000 square feet each time in comparison with no fertilization has resulted in very good dollar spot control, that is where the greens were starved for nitrogen to begin with. Brushing the greens or poling them in the morning tends to break the mycelium and so the greens dry more quickly and the disease is not so serious. Calaclor or one of the mixtures of bichloride of mercury and calomel in the proportion of 2 to 1 has been one of the most satisfactory controls for dollar spot.

Mercury has been a specific. That was developed by the Green Section a number of years ago and it has continued as a standard practice. Two to three ounces to a thousand square feet or less. Three ounces is about the maximum and it is better to use the mercury in the cool parts of the year anyway. There is less danger of burning the grass. Mercury applied to the finer grasses check the growth and make or may cause burning if it is not applied properly.

Many times you wonder why you are getting clover in a putting green. Well check back and you may find that at one time you failed to control one of these diseases. The grass was thinned to the point where clover could come in easily. Don't overlook that possibility. As Mr. Ferguson said earlier, the prevention of weeds is often times easier than their correction after they are established, so by watching the greens, preventing the disease from damaging the grass, you can often prevent the encroachment of those undesirable plants.

One of the standard practices in the North on a bent putting green is to use the mercury fungicide during the cool parts of the year, and and Tersan during the hot weather. Tersan does not burn or discolor

or slow up the grass as much as the mercury fungicide and that combination has been a very effective one and could almost be called standard in most of the better golf courses throughout the North.

There is a good illustration of brownpatch. You may call it a large brownpatch but brownpatch is the accepted common name. It occurs in rather large circular areas sometimes a foot or more across, sometimes running together. I found a lot of it out at El Paso last August because as I told you last night the humidity from the flood irrigation, the hot weather, made the conditions just perfect for the development of brownpatch and that can hit and ruin you that quick. It hits very fast, much faster than dollar spot. You have got to be on your toes to prevent it, and from talking with a number of you I learned that after Noer and Ferguson and I were here in August brownpatch came in and hit a lot of your turf areas including St. Augustine Grass. I don't know whether it will be worthwhile to attempt to treat St. Augustine grass for the control of brownpatch; I'm not prepared to say. Possibly not, if it recovers satisfactorily without encroachment of weeds.. But where you are trying to grow bent grass it is very important during that season of the year when you can logically expect brownpatch to make periodic preventive treatments. It is much better to lock the stable door before the horse is gone.

You will find many times in the humid areas after an attack of brownpatch that algae begins growing in those areas where the turf has been thin. Algae is that minute green plant which grows in an abundance of moisture and where there is not a satisfactory cover of vegetation such as we have in a dense putting green turf. But when that turf is thinned and there is plenty of moisture there look out for algae. If you get that algae probably one of the best ways to check it is with a light dusting of hydrated lime. You may say, my soils are already highly calcareous and full of lime, but I think you will find a light dusting of about 2 pounds of hydrated lime to 1000 square feet, sometimes to a green, will turn the trick and check the algae and give you a chance to get the grass recovered.

There is a great deal of difference in the resistance of various strains of grasses to disease attacks. Boys that have worked with the Green Section over the past years, Gordon Jones, Marvin Ferguson, Moncrief, and the rest of them all remember those experiments at Arlington Turf Garden where so much of that work is carried out. The development of these superior strains of bent grasses and other grasses clearly demonstrated that we need more resistant strains of grass just as much as we do the right kind of chemical treatments to prevent or cure the disease.

I am not going to say much about snow mold. That is a snow bank and in those areas where snow mold occurs you will usually find the snow mold developing at the edge of the snow bank as the snow is melting. It grows right under the snow. The preventive treatment is about 4 ounces of calocloror similar mixture in the fall just before you expect snowfall.

There has been a new disease reported I think it was first reported by Dr. Keil at Penn State. It is copper spot which you may or may not have encountered. I am not going to discuss it very much because I don't believe it is serious down here. It isn't too serious in other areas except that it has been reported. It has been found damaging some putting greens but so far the application of Puraturf at the recommended rate has controlled copper spot.

Dieback on Bermuda grass is next. Mr. Ferguson reported that samples have come in have been examined by our pathologist indicate that the same organism is present that causes brownpatch. Now whether you will call this brownpatch or continue to call it dieback I don't think makes a great deal of difference, but it does occur under much the same conditions that we find brownpatch occurring.

There again I want to point out that many of these diseases are much worse and can be induced by poor management pratices. A healthy grass is your best insurance against disease, and the healthier you can keep that grass by cultural methods, deep rooting, well aerated soils, proper balance of fertility, proper watering, the less trouble you are going to have from diseases. That is most important in the warm humid regions where you are trying to grow bent grass. There you have got to have every condition as nearly perfect as possible. You can make more mistakes in the cooler regions of the country and get away with it. But you don't make many mistakes down here according to my observation.

Occasionally you will find disease occurring on rye grass particularly if the rye grass has been seeded rather early in the season and you get warm moist spells after that seeding. A large part of that trouble may be damping off. Damping off has been one of the scourges of people working in the greenhouses, especially where plants are growing close together. If you are seeding twenty-five, thirty, forty, or fifty pounds of rye grass to a thousand square feet to produce a really fine putting surface for the winter play then you are making conditions more perfect for the development of that damping off, because those plants are so closely crowded together and the disease can spread easily from one plant to another. That is different where the plants are spaced and are not touching. We are not going to cut down the rate of seeding rye grass, just to prevent damping off, because we have got to produce putting greens. We do have to find out a better method of control for damping off, and at the present time our methods of control are not too well worked out. One thing is certain by keeping the available nitrogen at the time of seeding rye grass down to a minimum you can reduce damping off to a minimum because an excess of nitrogen at that time makes the grass more soft and lush and much more susceptible to the attacks of diseases. After the grass is established then you can apply your nitrogen with very little danger of damping off.

Where blue grass is grown, one of the most damaging diseases has been leaf spot, caused by Helminthosporium. You don't have to bother about that name because it's a little hard to say. But leaf spot disease hits the blue grass particularly in the cool spring and fall when there is abundant moisture present and thins it to the point where the invad-

ers can come in. There has been no satisfactory chemical control worked out for this disease. The most satisfactory control has been the development of disease resistant varieties or strains. One of the strains being increased for seed at the present time is B-27 blue grass which was selected bt the Merion Cricket Club in Philadelphia about 1928 as I recall, and has been a very satisfactory blue grass. In all of our test plots the other blue grasses will be brown and thin from the leaf spot and the B-27 blue grass will be standing out nice and green with very little disease on it. We are pushing that production of seed and this is important in your more arid regions where you sow blue grass on irrigated areas, because you can get leaf spot there just as well as you can any place else. We expect or at least hope to have about 5000 pounds of that special blue grass seed at the end of this season. Now that is not going to go very far. It is going to cost more than ordinary blue grass but it is going to be worth it. We hope to build that up to the point where you can go out and buy on the market B-27 blue grass seed. By that time it will have been named.

There is an illustration of the disease resistance of some of those improved strains of blue grass. You can get more by implication, by the color difference there than anything else. The brown color is due to leaf spot. We have been saying that carpet grass, and zoysia are practically immune to diseases but in Florida recently I looked over a large zoysia matrella lawn. The grass pitted with spots was half way between dollar spot and brownpatch. We have not as yet identified them as a disease. We have tentatively found damage from insects but haven't caught the insect yet. We have found holes where he has been working, and we still don't know what that is but apparently it does get something which has not as yet been recorded. We have smut fungus, we have milddews, neither of which are serious. A lot of people write in, send in samples, ask what it is, and is it going to hurt my grass. The answer is no. Take a hose and wash them off and there is not much else to it.

Fairy rings have been in the literature for centuries. While I was at the University of Maryland doing my graduate work we found the front campus simply peppered with fairy rings and Dr. Norton asked me to make a study of them and write a paper. Well, I wrote a better paper then than I could now because I didn't know as much about it. But fairy ring has been quite damaging in many fairways. Shantz reported that in Colorado these fairy rings sometimes start in a single spot and with the passage of time they may be two miles in diameter and the outer circle at certain seasons of the year are just peppered with these puff balls. Many species of fungus cause fairy rings. The damaging effect on turf grasses is caused by the fact that the mycelium, which is a thread like mold that grows on bread, interlock and intermesh in the soil and trap air. Then the water cannot get in and the turf dies because it is dessicated. It can't get enough water. Here is a very good illustration of a fairy ring, and on a slope you will usually find that the circle is broken. It won't be a complete circle on a slope, the lower side will almost always be open. Occasionally you will find a complete circle on a perfectly level area, why

that is nobody knows. Probably the best way to get rid of the effect of that fairy ring is to punch that soil full of holes and saturate it with water to get it soaked then the grass can grow again and will probably grow better because as that fungis dies it releases certain plant nutrients which are available to the plant and you get a greener, healthier growth.

Many effects of improper management practices are called diseases. For instance, Dr. Noer took some pictures of calcium cloride washed off a parking lot down across turf areas causing severe burns which at a casual glance look like disease. A lot of those things can happen. Winter killing in the Northern areas, either from dessication or from the accumulation of ice smothering the grass looks like disease. One of these pictures which I'm sorry does now show, shows a particular strain of bent grass down in a hollow, nice and green, everything else winter killed. There's tremendous difference among the various strains and varieties of grasses to these various troubles.

Scald is one of those broad general terms applied to summer troubles of putting greens particularly. That can be attributed mostly to management, poor soil conditions, poor drainage, and resultant overwatering. You know if you have perfect drainage you can't over-water, but when you have poor drainage it is very easy to over-water and then scald becomes an immediate possibility. Now the first indications are the blue tinge caused by the wilting of the grass. It if isn't immediately treated, flushed, syringed with water to maintain the moisture content of those leaves and stems the wilting continues to the point of no return. You boys who were flying in the war know what the point of no return is; you go so far and you have enough gas to come back on; you go beyond that you don't know where you are going to land. Well that is the way with wilting in this scald if you don't take care of it to that point of return it won't return. You will have to re-turf the place.

Dessication from drying winds may sometimes be confused with disease. We heard about that in Oklahoma last fall and occasionally it may be necessary to irrigate dormant turf to prevent the high drying winds of winter from putting all of the moisture out of the plant when the ground is frozen and cannot pick up moisture from the soil.

Two new products have been tested in the past year for the control of turf diseases. One is 531, manufactured by the Linde Air Products Company in New York. The other is Puritized 1[illegible], manufactured by the Gallowhur Chemical Company of New York. They are new organic fungicides, with cadmium as the base instead of mercury. The tests so far indicate that considerable excess can be applied without danger of damaging the turf. The degree of control has been reported to be higher than with mercury. That is, the length of time of control from a single application seems to be longer. That was true on one of these areas which was tested at Philadelphia Country Club last summer in conjunction with the Botany Dept., Plant Pathology, at Penn State. The control was heavily pitted with dollar spot. The treated plots remained particularly free. I can't give you that whole story. That will eventually

be published for your use. These chemicals should be tested more widely before they can be recommended. What I have just said does not constitute a recommendation of those two products because they are not yet available on the market. I simply tell you this because I want to bring you new things while they are new, so that you will be ready to accept them when they come out.

TURF PROBLEMS IN PARKS AND CEMETERIES

C. B. McGeehee
Lubbock Country Club
Lubbock, Texas

I am going to confine my talk to the section of the country that is more or less missed. It is also new in the development of parks and golf courses. In the discussions of grasses for golf courses that we have already had we have gotten up to the Plains. So if you will permit me I believe I'll say a word for my home town in the Plains Country.

We have on the plains various soil types. We have tight soils and we have the sandier soils and some that are not much good at all except just to hold the rest of the world together. But there is one thing that we do have all over the plains country and that is an alkali condition. We can't get away from it. All of our soils have an underlining strip of from a few feet to quite a number of feet of just pure lime. And in cultivation the lime will start rising, that is why we have to worry about that particular type. We don't go in too much for tile drains because we don't use the kind of plant, we can't use those in our particular work that will not thrive in a lime soil. The acid in our soil, that is the pH in our soil will always run from a pH of 8 to 11. It's awfully high so we do have to be careful.

In the beginning Dr. Reynolds told you I had been with the City of Lubbock, Park Department for about 16 years before I went to the Lubbock Country Club and that is where I have had all my experience with grass. We have tried several grasses besides Bermuda and have completely failed on all of them except bent grass for golf course greens. It so happens that in the preparation of our soil in park work we have had time to prepare the soil. We are blessed with an abundance of barnyard fertilizer. We have lots of feed pens and it is available and we have used that in the preparation of our soil before we do our sodding which is always by the stolon method.

We go ahead, prepare our soil, plow it, pulverize it and add to it all the way from two to four inches of barnyard fertilizer as it comes out of the pens and mix it well, then go ahead with our sodding of stolons either by the shovel or plow method. I prefer the shovel method because the grass doesn't come up in rows then. We do have a lot of wind of course in West Texas and it blows the topsoil. If we have our grass coming up in rows then we will have a ridge which will spread to the next row and then you have a high place and a low place and it will take a long time to dispose of that ridge; so the spot method by using the shovel is, I think, the most practical one.

Bent grass wasn't supposed to do good because of our climatic conditions, too dry, but it has turned out that we have one of the best sections in Texas for bent grass. One of the reasons for that is we do have hot dry prevailing winds in the day time which carries off a lot

of moisture but we don't have the long periods of wet weather, and for that reason we can control our moisture, if we need some more we will put it on, if we have too much we will shut it off. We have been growing bent grass all over West Texas very successfully. Of course, we have to do a little bit more in the construction of our greens than you would otherwise but we still are growing good bent.

We have experimented with buffalo grass to a certain extent just to see what it would do under cultivation and fertilizer and we have had some wonderful results with it. It will respond to fertilizer, of course it doesn't make as heavy turf as Bermuda grass but it does make a nice turf for parks and cemeteries where there isn't too much traffic. Does a wonderful job of growing, you don't have the deep rich color in the buffalo as you do in the Bermuda but you do have a pretty heavy leaf growth on buffalo.

Now when we get over on the blue grass it can be grown but not successfully as far as South of Lubbock when you get to Plainview and Amarillo in the tighter soils blue grass will do fairly well, however the degree of maintenance is pretty high. It requires a lot of water, protection, care, and fertilizer. The grass that we rely on and depend on for all of our park and cemeteries is just the ordinary Bermuda grass and it is one that will stand traffic on our playgrounds and parks. Of course we have the same trouble with it not growing under the trees as you men have. We have very few places where we do not have Bermuda grass under trees. If we keep our trees pruned high so the sunlight can get under in the mornings and in the afternoons we probably get from four to five or possibly six hours of sunlight even though it comes in and out, that will carry Bermuda grass. We don't have as dense turf as a rule under a group of trees as we have without shade.

Bermuda grass is the only grass that is used in cemeteries up in our section, that is the Southern part of the Panhandle and on the South Plains. After you get farther north on the Plains you will find, as I said a while ago, that they are using blue grasses on the lawns. But where blue grass can't be cared for from day to day it is not used too extensively. Of course we have the same trouble with the control and the spreading of Bermuda grass as anyone else has. Spreading into a bed, spreading over into our hedges, and here, there, and yonder.

We conceived the notion several years ago, rather than to use structure metal or concrete around the shrub beds for the control of the spreading of Bermuda grass, to use diesel oil which is a low grade of fuel oil and the cost is very cheap. All of our shrub beds and along the walks are a little bit lower than they are up on the lawn. We paint those shoulders with oil about three times a season and that will kill all the stolon that comes out through the sides and the new grass that shows up and about all that has to be taken care of is the edge right at the top of the shoulder that can be hand clipped. That can be done very fast and your cost of maintenance is low.

Now there is one thing we do have to do in our section of the country, due to the fact that our rainfall is light, and as a rule it

will come during the season when we don't need it, that is we do have to irrigate in the winter. Now the purpose of this to my notion is to keep the plant full of moisture. We have sudden changes in temperature where the temperature is up 20 to 30 degrees in a few hours and if the plant isn't full of water and moisture, then when we do have a hard freeze it will freeze. Bermuda grass will freeze in our section if it is dry but if the ground has a good moisture content we very seldom have any freeze.

It just so happens that we have very few diseases on our grasses. I contribute that to the fact that it's still a dry section of the state. Of the diseases of Bermuda grass, about the only one that has ever hurt us has been a fungus that causes a wilt or mildew. About the only time we ever have mildew is during a long rainy spell and then when it does clear off we can hold our water off and it soon disappears but we have sprayed a few times for mildew. Every once in a while we have had an infestation of red spider but that isn't much of a worry either because we have never sprayed it.

The diseases of bent grasses of course are about the same as you will have anywhere else but not so severe because of our conditions and the fact that we can control the moisture content of soil by irrigation.

TREES AND SHRUBBERY IN PARKS

D. A. Anderson and S. L. Frost
Division of Silvicultural Research
Texas Forest Service

The Texas Forest Service was set up at A. & M. College by state law in 1915. Its work falls into six main fields of activity. In forest fire protection we are trying to protect an area of about 10 million acres of privately-owned woodlands in East Texas. We also have a program of reforestation to help landowners establish tree plantations or windbreaks.

There is a program of tree growing research and demonstration mainly being conducted at the present time on five small state forest areas in the East Texas timber belt. Another line of research is in the field of forest products where we are trying to find more uses for our trees particularly some 65 million acres of low grade trees here in our post oaks, cedar brakes and mesquite regions. We also have a program of management assistance to small woodland owners and farmers. Our sixth major activity is in the educational field to help stimulate an interest in trees and forests and provide citizens with information about them.

Mr. Anderson:

I welcome this brief opportunity to tell you a little about our nursery over in East Texas in which we produce forests trees for windbreaks, shelterbelts and general reforestation purposes. Located in Cherokee County near Alto, Texas, The Texas Forest Service has a 78 acre tract. On this nursery area we produce and have produced annually in the past between 2 and 3 million trees per year. This forthcoming year however we will produce in the neighborhood of 18 million seedlings. These trees mainly, pine species, are for reforestation of cutover or denuded areas in East Texas. Many species are being produced however in sizeable quantities for planting down in the valley (Rio Grande), and for West Texas. We are gradually expanding our nursery program in order to take care of the demand for all pine and hardwood seedlings that we are receiving from all over the state.

Next years production of tree seedlings will tax our nursery to capacity. What our production the following year will be cannot be foretold since interest in tree planting is steadily mounting. That is just a general overall program of our nursery activity.

I might add for your interest that most of our production, as in the past, will be in Southern Pines including short leaf, loblolly, long leaf and slash pine. Our major hardwood production consisted of black locust, bois d'arc, black walnut, catalpa, and red mulberry. In our expanded program we expect to broaden out to include 18 species of hard wood besides our four regular species of pine. These trees that we do distribute as a state agency are for reforestation in the state or for windbreaks and shelterbelts. We are not allowed under existing regula-

tions to compete in any way with commercial nurserymen in the sale of this stock, and so it should be. For that reason we do not cater to anybody desiring to put out ornamental plantings. The pine trees are sold at $2 per thousand plants. All hardwoods with the exception of black locust, which we sell for $2.50, cost $3.00. That is a very nominal expense to a woodland owner, farmer, or rancher.

QUESTIONS AND ANSWERS

Q. We have cedar elm on our golf course, very little grass growing beneath same. We desire to cut the roots of these trees to allow the grass to grow. To what extent can root pruning be done.

A. I can't give you a definite answer on how far you could go. It would all depend on the size of the tree and the circumstances involved.

Q. Should we get in an order for forest trees now or wait until fall?

A. It would be best to do so now. We already have orders for 12½ million trees, definitely promised for next year.

A REGIONAL GRASS BREEDING AND TURF MANAGEMENT PROGRAM

Howard B. Sprague, Texas Research Foundation
Dallas, Texas

When I was first asked to talk to this group I was a little hesitant because I am a newcomer in the state. Along about 1917 and 1918 I made a couple of trips across Texas in a troop train and I became very much impressed with the size and diversity of the state. And my later visits to Texas have confirmed the early impression that it is an awfully big state and that you have a tremendous variety of conditions. During the last four and one-half years I have become rather intimately acquainted with certain Texas men serving in the armed forces and so I have been indocrinated about Texas to some extent. What I have learned the last two months since I came into the state again has made me realize that there is a great opportunity in the state

This is an opportunity that we will have to very carefully consider if we are going to accomplish what should be done. I think though that Texans can solve these problems and I will point up my conviction by a little story of an army colonel, (a native Texan), in command of an army base in the state of Texas. One of the generals from Washington came down to make a routine inspection of the base and look over the program with the colonel. After the formal inspection, the colonel took the general over to his quarters and entertained him by dwelling at great length on the military accomplishments of the great heroes of Texas, beginning back before the time of General Sam Houston and continuing on down to the days of Admiral Nimitz. The general became a little bit irritated after a couple of hours of this monologue and said, "Well now look here colonel we all know that Texas has had some great military heroes but they haven't had all of them. Have you fellows ever produced a Paul Revere?" The colonel scratched his head a moment and said, Revere, Revere, Oh, yes, he is that fellow that went around yelling for help. In other words, Texans have always undertaken to solve their own problems, without running around yelling for help.

I have been pretty thoroughly convinced from my contact with native Texans in the last four and one-half years that if there is a problem they are pretty well able to take care of it. So I am not presenting this discussion with any thought that you need help from outside; I am thoroughly convinced that you can solve your problems with your own resources. What I have to say is necessarily based on my experience in other areas and so you may want to make your own mental reservations as I go along as to whether it applies to Texas or not. But if I were going to outline a turf program for the State of Texas, I think I would first of all set my objectives, and I have down here just three.

First, I think we need to keep in mind that we are undertaking to provide healthful recreation for the entire population of the state.

Experience in other areas is that when you solve your turf problems, partially at least, and you provide satisfactory golf courses, parks, and other recreational areas, it follows that a larger and larger percentage of the total population uses them. That increase in use is still going on even in the areas where they started turf work first. So I believe we should think in terms of healthful recreation for all.

The second objective is that we should provide space and surroundings that will give genuine relaxation and diversion. A fellow may work pretty hard on the golf course and parenthetically, I may say that like O. J. Noer, I refused to play golf for years and years, but I finally succumbed. An old Scotch friend of mine got me on a golf course in 1940 and I discovered to my amazement that a little hard work on a golf course was the best way in the world to forget all of my other problems, even if I could only play for an hour at a time. It is a wonderful way to rejuvenate both the body and the spirit. You get so damn mad at that little white ball that you forget everything else.

The third objective that I believe we should set is a sufficient general understanding of turf culture, and I mean general in the sense that all the people have some understanding of the principles of turf culture so that we will have reasonable use rather than abuse of it. And insure enough general understanding so that we will get the necessary financial support to keep the job rolling. The South, and I am including all of Texas although you have cold snaps in the Northern sections, the South as well as all of Texas have a great asset. I don't know whether you realize it unless you have lived in the North, but you can use your grassed areas almost 12 months in the year, and not 7 or 8, or maybe only 6 as is true in the North where a great deal of work has been done on turf grasses. So you have a great advantage in accomplishing your objectives right off, because of the climatic conditions.

Now then what kind of a program should you have. Well, I believe you might make this classification. You make some other, if you wish, but I would center it around the use that is made of the turf, and it is a good deal broader than just golf courses. Now maybe golf courses should carry the ball on turf research and education, including those who are golf professionals, managers, greenkeepers, playing members, and those who are in the business of supplying materials and equipment. However, I believe support of turf research should be much broader.

We may define three classes of turf: Class one--the turf that is cut one-half inch or less. That would include the putting greens on golf courses, bowling greens, tennis courts, and all of those show areas, lawns, parks, areas around public buildings, and other areas where we want a very fine turf--I would put that all in one class, very closely cut turf. Class two--the medium length turfs, where the height of cutting is 3/4 inch up to perhaps 2 inches. This class includes much more than fairways on golf courses. That is the thing that comes to mind first of all, but the problems there are very similar if not identical with those on the home lawns, and with private estates, most

cemeteries, most polo fields, most football fields, totaling a tremendous area of grass. The third group of turfed areas are the ones where the turf is cut two inches or longer, and that would include rough areas on golf courses; it would include nearly all of the airports that are not paved, nearly all of the highways, road shoulders and the right's of way, public recreational areas, and areas of all types of auto parking areas. So you see turf culture touches practically every phase of life of the people of the state, and not just people who play golf. I want to mention incidentally that the problems of areas that have to endure the traffic of vehicles or aircraft are in a little bit different category than those that do not have to endure such traffic, such as the fairways on a golf course which are subjected to foot traffic only. Because even the heaviest golfer is much lighter than an airplane or vehicle and the load-supporting factor is quite important on those areas that have to take heavy loads.

If we will consider for a moment the research that should be conducted for each of these classes of turf, here is the way I would analyize it. Maybe it is over-simplified but time will not permit me to go into too much detail. I want to digress for just a moment before I go into a research program. I believe that a research program is a very essential thing.

I want to make one comment following up what the first speaker said this afternoon and that is the adaptation of bent grass to the lime soils of the Panhandle and Plains. I can remember, and Dr. Noer and some of the rest of us, who had contact in the East, can remember when it was considered true that bent grass would succeed only on acid soil. Eventually we discovered through research that bent grasses would tolerate acid soils but they didn't actually prefer acid soils, and that discovery made a tremendous difference in the quality of turf, in the cost of maintaining turf of all these types that I mentioned in the classifications and types of turf, throughout the entire humid section north of the Mason-Dixon line, wherever bent grass was grown. It changed our viewpoint completely. If we had not had research we would still be throwing away money and time and wasting our resources in trying to produce dense turf under an abnormally acid soil condition. Most of these problems on which we would like to have answers are going to be solved by research, and not by talking about them.

Now on research, I would first of all determine natural geographic regions. In a state as big as this it is necessary to make some classification of regions--as to climate, as to soil, as to the original native vetetation. It is essential to qualify that classification by the determination of which regions are of greatest importance to the total population; in other words, where are the most people located in the state within each of these natural geographic provinces. When the regions have been defined and you have plotted the location of the people who are going to use these grasses, then I think research should be undertaken to serve the important regions. It may be very desirable and absolutely essential to locate certain fundamental studies in one place where most of your scientific talent is located, but have enough test areas in the other regions of the state so that one can determine

pretty satisfactorily the application of the fundamental facts to the local areas.

Here are some of the things that seem to be worthwhile in the plant research once we have set up the centers, based on climatic regions and population centers. First, let's take plant research. I believe that testing should be undertaken of all of the available species and strains of grasses that may be useful for any of these types of turfs. One of the first things that should be done is to absolutely identify the species and strains. Species are pretty easily identified; the botanist can tell you what species any one of the grasses falls in, but strains within a species frequently depend on characters that have not been studdied by systematic botanists. Since these strains are of the utmost importance, we must have some positive identification of them so that everyone may know exactly what strains he is working with. One strain will have one response, and another strain an entirely different response to growing conditions and type of use. You may be comparing notes with your friends in the belief that they are dealing with the same grass that you are when this is not true. If you know, each of you, that you are dealing with a specific strain within a species, you can harmonize your different observations very much more satisfactorily.

We need to know for each of these strains and species something about their natural adaptation to soil and to climate, as well as their habit of growth, and usefulness they may have for these different types of turf. Some of that is already known but we need to have a more complete understanding than is now generally available, and that goes for any section of the United States; it doesn't just apply to Texas.

Also, we need to have a much more accurate understanding of the normal physiology of these various grasses. When one speaks of adaptation, we generally think in terms of general suitability to a set of conditions. But if we begin to study adaptation in detail we must know something about the physiology of the grasses, and of the individual strains and species. Some of these strains within a species are as different in physiology as goats are from sheep. Now to a city dweller who has never been in the country, goats and sheep might easily be mistaken for one another. They are about the same size and sometimes about the same color and although the odor is a little different most of them don't get close enough to know that. Those of you who are not agrostologists may be just as lacking in detailed knowledge of the physiology of strains of grasses as the city dweller is of the characteristics of goats and sheep.

The only way we are going to get that detailed knowledge of the physiology is by research; and careful, painstaking research occupies a lot of the time and a lot of effort on the part of scientists. We need to know more about the seasonal growth of grasses. We need to know more about their resistance to cold. We need to know more about their tolerance or resistance to drought. We need to know a good deal more about their capacity to respond to favorable conditions; some grasses have a great capacity for response and some will have no response at all to the same treatment.

We need to know a lot more about the physiology that effects the susceptibility of these strains and species to diseases and to insect pests. We also need to know the plant structure and the physiology which makes them sensitive or insensitive to different kinds of fertilizer, and different amounts of fertilizer. In the case of grasses, of course, nitrogen is going to be one of the dominant fertilizer elements, but nutrition needs will not be limited to nitrogen fertilizers, since phosphorus, potassium and some of the minor elements are also very important. Now I think when we get into the high lime soils which occupy a large portion of Texas we may find that some of these minor elements are of the utmost importance in getting normal growth. In the Eastern part of Texas, I know that lime is going to be an important soil amendment, but in the Western part we may be dealing with other methods to counteract excessive alkali or other unfavorable conditions, and I know that you are going to be very much interested in organic matter whenever it comes to building greens, and to other soil improving materials.

One of the most striking things about grasses is their difference in response to different heights of mowing. As a matter of fact we immediately class a grass as being a putting green grass, or a fairway grass, or a rough-area grass, because of its capacity to adjust itself to specific heights of mowing. Not enough is known about the well known grass strains, and before a new strain can be put into practical use we should know how it will respond to mowing at different levels; whether close mowing will gradually starve it and kill it or whether it will tolerate close mowing very satisfactorily, or even be benefited by close mowing.

The difference in strains and species in wearing quality under traffic is another very important thing. We know practically nothing about that now, in spite of all the attention that has been given it. I will cite an illustration. During the war a B-29 airplane made a forced landing on an airfield in Nebraska. It landed on the grass portion of the field, and not on the paved runway. In spite of the fact that there had been a lot of rain, in spite of the fact that it was a blackland prairie soil, (a true prairie and not blackland prairie such as you have in Texas), that B-29 made a very satisfactory landing, and did not damage the turf a bit. That turf had tremendous capacity for supporting a load. It was so unusual and so far beyond anything that had been thought possible by most airport engineers that quite a lot of interest was shown in it. The highway people also have become interested in the capacity of turf to support traffic. Now on golf courses, and in parks and estates foot traffic is the principal traffic factor, but the problem is deeper than that, we need to know a great deal more than we do at present about the capacity of grassed soils to support heavier loads and that goes for Texas as well as for any other state. What characteristics do grasses contribute to the soil, and what are the contributions of the grass soil to this traffic supporting capacity? We can go a lot further than we ever thought we could in grassing traffic areas.

How far can we go in converting our sticky, clay soils into a usable turf twelve months in the year, 365 days in the year, with the conditions of rainfall that are natural in this area? I don't know. But I do know that in many other areas it is found that grass can do virtually wonders in converting what would be otherwise absolutely impassible into conditions that are very satisfactory for traffic.

Let us consider the response of strains and species to top-dressing. We know from experience now in the Northeast that some species should be top-dressed very little. Other species should be top-dressed very heavily, in order to keep them playable, thinking in terms of putting greens. And the right kind of top-dressing must be used also. There is an inter-action between the kind of growth that the grass species makes and the type of use that you are going to make of it, and the kind and amount of top-dressing needed. The answer will be learned only by actual trial, and it should be trials made under controlled conditions so that you will know what the principles are that are involved. We need to know also how these grasses react to the various chemicals that are used in weed eradication or insect control, or for disease control. There is a tremendous difference in their reaction.

I haven't said anything yet under this heading of plant research, about breeding improved strains, not because it isn't very, very important but because it is going to take you a good many years to breed an improved strain, to adequately test it, to produce enough seed or stolons if it is a vegetatively propogated species, and to get it distributed to the people who are going to use it. In the meantime we ought to be doing all these other kinds of research on the species and strains we already have. A breeding program should be started early but it should be accompanied by all of this other work so that we will have some immediate benefit. In the long run a breeding program will give tremendous benefits but it is going to take a long time to develop new grasses.

Now in Soils Research I will just mention a few of the broader aspects. First of all I think we need to study the present conditions of soils so that you know what you are working with. These soil conditions, and there are many of them in Texas, are totally different, or partially different from those in other states. It seems that East Texas has conditions that are somewhat similar to Louisiana, Mississippi and the Deep South, but a lot of the other soil types in the state are not. There are soil groups in Texas not duplicated in any other section of the country. We need to know what group of soils we are dealing with, what are their characteristics; what is the normal profile of each of the soils, of its depth. By profile I mean what do you usually find in the first horizon down to the point where it changes in texture or color. What is the characteristic of the next horizon, and what is the parent material underneath? If we do not know the soil profile we may come to some wrong conclusions. For example, these blackland prairies and the grand prairie soils of Texas look superficially very much like the black corn belt soils of Iowa, and Southern Minnesota, and Illinois, but they are entirely different. They are located on rolling prairies and they are black; that is about as far as they go in similarities. So

we need to know exactly what soil we are dealing with; what was its mode of formation, and what is happening to it.

In the physical characteristics, it is important to know the texture, layer by layer or horizon by horizon, the soil's permeability to moisture, its water holding capacity, the organic matter content, and its aeration. When you start comparing notes with somebody else, and each is dealing with a soil with different physical characteristics, you are not going to see eye to eye with him about treatment. It may be that you are both right, or you might both be wrong if you don't know enough about your soils.

As to chemical characteristics of soils, I suppose the first one to mention is the pH or the degree of acidity or alkalinity, and we have the whole range here in Texas from the exceedingly acid soils to those that are exceedingly alkali, and in addition we have soils with no lime in them and other soils that are completely saturated with lime. I mentioned those two points of pH and lime separately, because pH is a measure of active acidity, or alkalinity, but the reserve supply of lime is also of very great significance. That takes us to the point of "base exchange". To what extent is the colloidal fraction of the soil saturated with basic elements, and what type of basic elements predominate? If the basic elements present are desirable you may have very good soil; on the other hand you may have high base exchange capacity with the bases composed of elements that may be very toxic. The supply of the essential nutrients may be largely controlled by the physical make-up of the soil, or by the presence of toxic substances.

In the further study of the present condition of soils one should not ignore what has been done to the soil since man came on the scene. To what extent has it been degraded by cropping? To what extent has it been degraded by erosion, or by flooding, or by grading which removes the top-soil or exposes the subsoil or increases the depth of the top-soil in some areas at the expense of others? To what extent has it been changed by soil treatments? All of those are very important. If you have no knowledge of those present soil conditions, then the research will have to start with that study. Once we know what the present condition is, then we are in a position to know about the correction of these unfavorable conditions from the standpoint of what the plant requires to grow satisfactorily, and from the standpoint of what is required to produce the type of turf desired.

I am going to hastily go over, just by naming, some other kinds of research. We have the research on insects, and entomologists will be able to make contributions on that. Some insects that are of no importance agriculturally at all, become dominant factors in turf for non-agricultural uses. By the way, you might class all of this turf that I am talking about as <u>non-agricultural turf</u>.

Then we have the people who specialize on diseases of turf; there are a special group of diseases that are serious on turf that probably are of very little consequence or no consequence to the agricultural user of the same grasses. There are the problems on control of weeds;

weed problems are quite different on turf. There is another group of pests; the animals such as moles, squirrels, gophers, rattlesnakes. The animal pests are sometimes a limiting factor in turf culture.

Grass research must be so organized that we can finally test combinations of treatments to provide the type of turf for specific uses. For example; on golf greens we want to know what combinations of treatments are best for a given strain or species under a particular climatic condition and soil condition. What combination of mowing, top-dressing, watering, fertilizing, rolling, and rest from traffic in critical areas is required in order to achieve the goal of perfect turf for the maximum number of days each year. In other words, we must try to bring together all the individual phases of research into a management program.

I would not want to give the impression that you can only start at the top of my outline and work your way down through. I think that in a turf you are going to have to do a little of all of it, simultaneously. But there is a great danger of trying to do so many things that you fail to do a thorough job. An outline of a program is a very desirable thing, it enables us to say we will attack the problem here, and here, and here today; tomorrow we will add on this, this, and this, not forgetting in the meantime that some problems are of so great importance that we must try to find answers to them at once, even though they involve the interaction of a large number of factors. But in organizing a research program I would say these are some of the more important things to keep in mind. First select the most important items of study and explore these thoroughly; dig deep, where you dig. Make the studies thorough, not superficial. Avoid going off on blind tangents in research, but do retain originality of study. Retaining the proper balance in a research program is difficult because it is pretty hard to tell sometimes whether one is going off on a blind tangent or whether one is exploring a most fertile field. Sometimes this philosophy has been stated about handling research scientists; give them the most freedom possible, give them the facilities to work with and leave them alone as much as possible, but periodically ask them where they are and what they are doing. If you find they have gotten lost, then bring them back and start them over again. Some scientists have the happy faculty of doing that for themselves, and some others have to have help when they get lost.

In establishing research of the types I have indicated, I think you should not try to diffuse your efforts over too great areas. Some types of fundamental research is conducted just as well in one section as another and this work should be done at a central point. But some types of applied research must be carried out in the areas where the results are to be used. I think in a state as large as this you can hardly expect to do it all in one place. You should have a combination of perhaps one or two major centers, with several secondary centers for research on the applied phases.

In addition there will have to be skilled personnel to conduct the research, and the best is none too good. The finest men you can get to conduct the research are the men you want. Provide these men with

adequate material resources in the way of buildings, laboratories, greenhouses, fields, and all of the utilities that go with it, and then encourage them to use those resources to obtain the facts desired. One caution: There is certainly a very definite limit to the amount of speeding-up that can be accomplished in research. Research starts off slowly, but it is just like a snowball; you get very little at first but get a constantly increasing volume of facts as it continues over a period of years. And after the first few years, the facts seem to come out with much less effort.

Now then if you go to the extent of establishing a research program, I believe that those of you who are not engaged in research have this responsibility; first, you must follow the results of the scientists carefully and closely. Second, you must make your own application under your local conditions to see how it fits into your program. In fact, every one of you should be a part of this program. Finally, when the value has been established for any given new facts, do have the courage to make the full use of the benefits of those facts in the areas for which you are responsible. There are very few people managing turf who are as good managers as they know how to be. Sometimes it is due tto inertia, sometimes it is fear of criticism, sometimes we just can't make up our minds.

Another responsibility I think rests on each of you is to work very diligently to sell all the people who are using turf, on the value of research. After all they are the principal beneficiaries and are also going to pay for it in the long run so I think you have the responsibility to keep them thoroughly acquainted with the value of research to them, as well as to all other people, and what they are getting for the money that they are contributing indirectly or directly.

COMPOSTING SOILS AND TOP-DRESSING TURF

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Before discussing the topic assigned I would like to make a few remarks about the preceding speaker. I have known Dr. Sprague for a long time and am familiar with the work he did at New Jersey in the field of turf. New Jersey's loss is Texas' gain. While I don't know anything about Dr. Sprague's work in Dallas, I hope it will be possible for you to induce him to participate in the solution of your problems because his experience has been a rich one in non-agricultural turf.

Yesterday we discussed soil and I told you something about their makeup and what they are. Today I propose to cover the practical aspects of top-dressing mixtures and their use. I do not intend to tell you how to do the mixing or how to make the applications because most of you know these practical details better than I do.

I will talk about the principles involved and let you make the application. We said yesterday that a medium sandy loam containing about 25 to 30 percent by volume of organic matter is an ideal top-dressing material. About 25 years ago when I first became interested in turf, golf courses used top-dressing for two reasons. Top-dressing furnished the plant food which the turf got and it was used for the mechanical purpose of truing the surface and for the improvement of soil structure. Top-dressing is no longer the primary source of plant food for golf greens or for other turf areas in the North. The automobile brought this change by eliminating horses in metropolitan areas. Today it is almost impossible to obtain manure of good quality to make the compost which was formerly produced with manure which was an essential constituent of the top-dressing mixture. As a result it has been necessary to substitute other materials. The change has been for the better. Today top-dressing is used in the North for the simple and sole reason of improving soil texture and of truing the surface. Fertilizer is applied separately when needed.

The nice black clay soil of Dallas, mentioned by Dr. Sprague as being impossible to work when wet, is not the type of soil to use in a top-dressing mixture because of its high content of colloidal silt and clay. Altogether too much sand and organic matter are needed to appreciably change its physical condition. The first thing to do is to search for a sandy loam or a silt loam soil, rather than a clay loam soil, and then use it as the basis of the mixture. The soil survey in this state may be of assistance in spotting an area of good soil. Loam and sandy loam soils are frequently found along alluvial river bottoms. The Soil Survey Service can furnish information about where material of that kind can be found. By starting with a good sandy loam, modifying it with sand, and adding the organic matter that's needed is the way to make a soil of the right physical condition. The sand used, as we mentioned yesterday, should be coarse. The sand displayed here is too fine if anything. It came from near Montreal, Canada and is an angular

material which does very well up there. I venture to say that most of you use a sand which is much finer grained. The soil profiles that you saw on display yesterday showed something about the character of a desirable sand for putting greens. By adding from 25 to 30 percent of organic matter to the soil sand mixture you should have a good top-dressing.

Those who use peat should recognize the fact that a peat which has been dried to a very low moisture content, tends to resist wetting because it refuses to accept water. Then when top-dressings made with it are applied on a green and the green is watered the peat tends to separate and is washed into riffles to the detriment of play. If top-dressing is made several months before it is to be used, and is allowed to stand in a pile, the peat will take up moisture from the damp soil. After peat begins to absorb moisture it becomes a part of the mixture and will not riffle when the green is top-dressed.

This morning Mr. Ferguson mentioned the problem of weeds. Top-dressing is one source from which crab grass and other weeds are introduced into greens. The crab grass seed may come from the soil, or it may come from the manure, if manure is used in the top-dressing mixture. Sand rarely contains viable seeds of any kind. Peat is a better source of organic matter than manure because the weeds which grow on peat deposits are not the kind which thrive or live under putting green conditions. So you need not worry about peat as a source of weeds, I said yesterday we frequently fool ourselves about the amount of actual organic matter which is introduced into the top-dressing by manure. Manure doesn't have quite as high a moisture content down here because of the hotter weather. Normally there is 60 to 80 percent of water in manure, which means that the actual amount of organic matter at the start is not over 400 to 600 pounds per ton. Decomposition takes place rather rapidly in the compost pile and so the residual amount of organic matter is not very much.

Any one of the fertilizers materials Mr. Ferguson mentioned, such as cyanamid, cotton seed meal, soy bean meal, Milorganite, etc., can be used in the top-dressing to kill weed seeds. Probably even some of the commercial fertilizers should be satisfactory. Cyanamid is used at 14 pounds and the organics at 100 pounds per yard of top-dressing. They are added during mixing and the mixture is allowed to stand at least a week, but preferably for a month or two, before it is used. All of the weeds, excepting goose grass or silver crab grass, will be killed during that interval, and then the top-dressing does not become a source of weeds.

Dry heat and steam for the sterilization of top-dressing is a practice which is falling into disfavor. At one time some golf clubs built elaborate steam chests and steamed all of their top-dressing religiously. It is a thing of the past. Now nitrogenous fertilizers are used for that purpose and clubs depend upon a good thick heavy turf to help keep weeds out. That is the way to avoid extensive hand weeding.

There are two kinds of greens in Texas, the bent greens and the Bermuda greens. They must be handled differently with respect to top-dressing. Dr. Sprague mentioned the fact that some of the northern grasses require more top-dressing than others. That is true, and the reverse is true also. Frequently one can go onto a golf course where the greens are mixed south German bent and tell by the character of the turf what the greenkeeper's program is with respect to top-dressing and fertilization. It is not as strange as it may seem. If the greens are top-dressed lightly and infrequently, and not fertilized very heavily, velvet bent usually predominates in the turf. When the tendency is to top-dress generously and frequently, and to feed heavily, then the creeping bents predominate and there is little or no velvet bent. Seaside, commonly used in Texas, is a creeping bent. Velvet bents do not like too much, or too heavy top dressing. It is not wise or good practice to heavily top-dress bent of any kind in hot weather. If bent greens are top-dressed during that season the amount used should not exceed 1/4 to 1/2 yard for 5000 square feet. Generally speaking it would seem best to confine top-dressing of bent greens to the spring and fall and let them coast through the summer.

With Bermuda, the problem is different. One big objection to a Bermuda green is the fact that the runners are stubbly and coarse. The surface stems tend to make the ball hop. A good Bermuda green is one which is top-dressed frequently enough to keep the runners buried, and fertilized with enough nitrogen to keep the Bermuda leafy. By doing these two things you will have far better Bermuda greens than with any other practice.

When soil structure is bad, like some of these profiles, frequent and heavy top-dressing is necessary to produce a good column of soil for the grass to grow in. Linkogel at Westwood in St. Louis does not top-dress more than a couple of times a year now. When he started with the clay at the bottom of this profile he top-dressed every month in an effort to build away from it and obtain a layer of soil which was favorable for the growth of the bent. When it is necessary to change soil texture or improve the soil in the green it is best to top-dress more frequently and more heavily in the cooler seasons. That is what was done with the green which had the imbedded peat layer. It was forked first to break the layer. When there is a layered condition, greens should be forked twice a year, and maybe more, and then they should be top-dressed generously to break up the layers and try to convert the soil into one of uniform texture and structure.

Those with bent greens will experience difficulty due to top-dressing if there is a heavy layer of matted turf on the surface. This profile illustrates what I want to stress. It is from a bent green in Milwaukee. The turf became matted during the war because greens were not mowed enough. The greenkeeper buried the mat with top-dressing. The surface is spongy and not liked by the players. Fermentation of the buried stems and leaves during hot wet weather can cause serious loss of turf. Matted grass impedes and prevents the absorption of water by the soil. The tendency on some of the bent greens in Oklahoma and in Texas is to have a little bit heavier mat of grass on them than is desirable.

Greens are better from the standpoint of play and more satisfactory from the standpoint of maintenance and management when the turf is kept tight and not allowed to become matted.

Many of you use Bermuda for summer play and seed to domestic rye grass for winter. Some have had trouble getting a stand of rye grass last fall and asked me to discuss the problem. The closing few moments will be devoted to the seeding of rye and methods of speedily ridding greens of it in the spring.

Success in obtaining a stand of rye grass depends upon using a program such as I am going to outline. It works in Florida and in the Southeast section. If it works there it will work in Texas. Trouble arises from damping off immediately or soon after the greens are seeded. Damping off occurs generally when weather is hot and accompanied by heavy rains. However, greens may and have damped off even though the weather was favorable for the establishment of rye grass. Generally speaking that occurs from faulty management immediately before, during, and after the seeding of the greens. All grasses tend to be soft and succulent and at its tenderest stage during the seedling period of its growth. Soon after germination, plant tissues are tender and fall easy prey to pythium and the various related diseases which are responsible for damping off. The answer to the problem is one of doing the things which will accentuate sturdiness of plant structures. That means using a minimum of water and a minimum of nitrogen at seeding time. The best thing to do is to let the Bermuda grass partially deplete the soil of nitrogen for a month to six weeks before seeding with rye grass. Then thin the Bermuda turf by raking, apply superphosphate and potash, but leave the nitrogen out of the fertilizer that is applied before seeding. Phosphate and potash tend to make the grass sturdier and too much nitorgen makes it weak. Probably in 75 percent of the sases the grass that gets nitrogen will come along faster and will look better than the one which does not. But there is always going to be a bad disasterous year such as this one when a lot of nitrogen is going to be fatal to the rye grass. The smart greenkeeper is the one who is forehanded and prepared for that eventuality.

Rye grass seed is relatively large and contains a lot of stored food. It will make a considerable growth on the reserves of nitrogen that are stored in the seed and does not need any more until after it becomes established. So use phosphate and potash only before seeding. The top-dressing used to cover the seed should be a sandy loam, not too fine grained because then it will tend to crust and interfere with seedling growth. The top-dressing should have some large sand particles and I would be inclined to reduce the organic matter content to less than 25 to 30 percent and thereby reduce waterholding capacity somewhat. Avoid overwatering and if anything try to underwater slightly rather than overwater. A green which is already too wet becomes waterlogged quickly when heavy rains start whereas greens which are just a little on the under side can take a little extra water without serious consequences.

After the rye grass becomes established and is growing well is the time to use nitrogen to make it spread and form a thick dense turf.

That is the method which I am sure is fundamentally correct. In the spring when greens are being converted over from rye to Bermuda the time that they are bad for play can be reduced materially. Generally the rye grass goes out in patches, and not all at once. It is a patch here and then a patch there. The green is bad for play for a month or more. About the time the Bermuda is ready to start growth make a heavy application of sulfate of ammonia. A rate of 10 pounds per thousand square feet is not excessive. Water the green generously for a week. The combination of generous nitrogen and water makes the rye grass soft. When the grass is so tender that it bruises easily stop watering. The rye grass will disappear in a couple of days. The retarding effect of winter grass on recovery of Bermuda justifies seeding the greens with a little hulled Bermuda seed. Besides increasing the density of the turf there is another advantage. The new Bermuda grass from seed is somewhat finer textured than the native common Bermuda and stays that way for several years.

There are tremendous possibilities of finding a superior type of Bermuda grass for use in the parts of Texas which are not suited to bent grass. I am sure it is possible to find a strain of Bermuda which will have more of the characteristics of bent than anything you have today. Such a grass will make a more satisfactory putting green than you have now. The field should be explored because it may be a better answer to the greens problem in the more humid sections of the state rather than the headaches that come with bent grass. There are some likely looking strains of Bermuda in the greens at the Houston Country Club. The fine leaved ones that make a dense turf stay vegetative and do not produce seed stalks.

A statement about some of the new fungicides like 531 and 177 may be in order. They are believed to offer possibilities for inhibiting damping off. They should be tried to see if they will solve the problem. How they should be used is hard to say. Several methods should be tried. Seed treatments before the seed is planted, and soil treatment before seeding, during the period of germination and while the young grass is beginning to grow should be tested also. Dr. Thornton of Carbon and Carbide Chemical Company reports they have had very promising results with 531 in controlling damping off in greenhouses. A fungicide which prevents damping off would be of great value.

SOIL TESTING

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This matter of rapid testing of soil to determine its nutrient level has appealed to the public for a long time and interest in it has increased very greatly within the last few years. The general public opinion of soil testing places that subject a great deal higher than the facts warrant. Too many people think that they can take a soil, analyize it for a few minutes, or a few constituents and have the answer to the problem. For example, I constantly receive letters reading, "I'm sending you a sample of soil, please tell me if it is any good for strawberries (or some other crop)". Now that apparently seems funny to some of you but that happens right along. The importance of soil testing due to the ease of conducting the test and simple information needed to interpret the results has been greatly over emphasized in the public literature.

Having said that, I will say that soil testing, properly conducted, is an important tool in answering some soil questions. A soil analysis will not tell you what the physical condition of the soil is or what you can do to improve the physical condition or the drainage, or anything of that sort. There are soils which will give a low analysis on testing and which will respond very greatly to fertilization. There are other soils which will give a similar analysis and the response to fertilization will be very much smaller; other factors than the level of fertility controlling the response.

However in answer to a public demand for such a type of service, the Board of Directors of Texas A. & M. College last summer set up within the Division of Chemistry of the Texas Agricultural Experiment Station a laboratory for doing that work. We were immediately faced with the fact that a number of methods have been published in the literature, most of which when properly interpreted will give considerable amount of information on non-calcareous soils but none of those methods were any good on calcareous soils. A large number of our soils in Texas are highly calcareous and we have shown through the years in our research publications no relation has been found between the analysis of those soils by chemical means and response in the field, nor in the greenhouse under more clearly controlled conditions. It has been necessary to put a competent soil chemist on that question and I am very glad to say at the present time he is about ready to publish his results on his methods. I think that we have a method which will work when properly interpreted.

The matter of interpretation is another thing. As we have had no satisfactory chemical method which would work with calcareous soils, it is going to be necessary to make analyses of calcareous soils and correlate them with responses in the field from fertilized plots. That work still needs to be done. Analyses can be made only on soils which are taken according to direction which we issue.

The Board of Directors have set up the organization and subsidized it with a special fund for a period of two years. After this period it is contemplated that the work will be self-supporting. It was agreed that a fee should be charged in order to keep out the curiosity seekers. Otherwise, we would be hopelessly swamped. It is our desire, when Dr. Kapp has developed the methods which we think will be satisfactory for our purposes, to drop the prices so that the money involved will not be a limiting factor. At present we are set up to run by research methods a number of constituents and we have a regular mimeographed sheet which lists those constituents and fees which are charged for each one.

There is another thing that I think should be emphasized in this connection. An analysis of a sample of soil or anything else is absolutely worthless unless the sample is properly taken. Noer and I were talking about that yesterday. How best to take a sample is an important consideration particularly with respect to greens and fairways, because you have special limiting factors there which do not apply with respect to ordinary commercial agronomic or horticultural crops. If we should get a sample from you fellows and make the analysis by methods which we consider satisfactory for ordinary use, it will be necessary that we consider that you have a very special problem and that the chemical analysis is worthless unless it is properly interpreted in terms of recommendations for improvement under the conditions of the areas from which the samples were taken. That also is going to take some research work and it is going to have to be from both research and extension angles. We are going to have to make the analysis, go into the field for which the recommendation is made and see how that recommendation develops. I don't know anything about the standards for golf greens particularly on calcareous soils and I am sure Noer doesn't either although he has been working with this for a good many years. Those are some of the questions we are faced with in connection with soil analysis for green work.

QUESTIONS AND ANSWERS

Q. What do you use to check alkali soils?

A. We haven't done anything along that line because in all of our work we are running a Beckman and a Beckman from our point of view is just as good. It is quicker even than a quick test, so that I haven't done any correlation work between these various quick tests for acidity and the Beckman. I was particularly interested in getting our own work going.

Q. How should a sample of soil from a green be taken to properly represent the area?

A. Dr. Noer--The difference is that once that area is put into turf you do not mechanically disturb that soil. When phosphate or potash in particular is applied the tendency is for fixation to take place. They move down in the soil rather slowly. They are generally concentrated more in the upper levels than they are in the lower levels of the soil. When one starts to test soils that are taken from fairways it is possible to show almost anything you want to in the same method. In other words if you have applied phosphate, you can collect the soil samples

at various depths and show almost any phosphoric acid level that you want. I'm not trying to kid you althogether but nevertheless there is a certain element of truth in it and a method of sampling has got to be worked out. In our work we do set a standard of two inches. Samples can be taken from the exact depth of two inches and should be obtained with a tool that takes out a straight column; that is a column that is uniform in diameter throughout its length. As I said yesterday, the trouble is that in some of these areas the turf is rather matted. There is need for more work along that line. As Fudge said, it is necessary to correlate the results with what one is doing. We think that the level of phosphorus and potash should be higher in the green than it should be in the fairway, because you are cropping that green. It takes lots of clipping and you are also actually removing large amounts of plant food when you apply water so as to keep that growth up to a high level. All those things are important. If the top soil is highly calcareous the tests aren't as trustworthy as are soils that are neutral or acid. I think that is important. We don't test soils if they are sent to us unless they are collected in accordance with our instructions.

Q. What methods are you developing on the estimation of available phosphoric acid in calcareous soils.

A. Dr. Kapp is working now with a mixture of nitric acid and sodium acetate, a pH of around 4. So far that method is correlating very nicely with results of large numbers of greenhouse experiments which we have run through the years, and it is the only method which has ever correlated well on those soils.

We have done some work with the carbonic acid method. I worked some with that over 20 years ago at Auburn. But I have never been able to make it work. A group of soil chemists got together at Omaha at the meeting of the American Society of Agronomy last November and we wrangled back and forth on that point but never got anywhere. We did get to a common agreement that we would study these soils and use them back and forth and try to develop a method which would be satisfactory on such soils. Dr. Peach of Cornell has done a lot of work on methods for soil analysis. Many of these work admirably in non-calcareous soils but he has never had any luck yet on calcareous soils. The trouble is that all of those methods are based on extraction of the soil by a weak acid. In a highly calcareous soil, the acid in that extractant is almost immediately nutralized and all you are doing is running a neutral salt solution through the soil. You don't get the solubility on the calcareous soils as the method was originally developed for non-calcareous soil. So that, for example, you may have a considerable amount of soluble phosphate present in a soil which would be extracted if the extracting solution maintained its acidity as it was supposed to, that is, if it has kept its original pH. However, when it reacted with the calcium carbonate in the soil it went over to a less acid or even to an alkaline solution and you don't get any phosphoric acid out. Therefore one can put superphosphate on a calcareous soil, extract it with an extractant we have used so far and get practically no blue color at all when you develop your phosphorus color.

LOOKING FORWARD TO AN EXPANDED TURF PROGRAM FOR THE SOUTHWEST

Fred Grau, U.S.G.A.
Washington, D. C.

This is really rather a difficult spot right now. You heard Dr. Sprague outline a possible research program for turf. Fundamentally I have been a subject matter man and I can usually do better talking subject matter but now, with my position as Director of the Green Section a great deal of it becomes administrative and what you might call political but not in the sense of what you really think is political, but promotion and development, development of research and education that is. Dr. Lewis is going to speak tomorrow morning on a subject very closely allied to this one and that is the Future of Turf Research in Texas. So if I generalize a bit I hope you will bear with me.

I am tremendously interested in the development that is right here with us now. You fellows have all come from considerable distances and you came here thoroughly expecting to get something to take back home. I believe you did, or you wouldn't be here. I hope you have already accomplished that purpose. If you have not perhaps there is still time to get up and ask questions in order to find out some of the things for which you came, however, you can't continue to come back here year after year and expect the same or other speakers to continue to give you new information without it being backed by research which is developing new facts as Dr. Sprague pointed out to you. You may ask, what is my place in this whole picture? As Director of the U.S.G.A. Green Section, our primary interest and obligation is to our member clubs as you all know, I hope. We are supported entirely by membership dues from golf clubs which are eligible to belong to the U.S.G.A. Why are we interested in this broad development of an expanded turf program in Texas? Simply this, in a great agricultural state such as Texas, there is a tendency to relegate turf and turf research to the background in the greater interest of developing agricultural crops, the health of the people, and all of that. I maintain that the development of the turf program has a great deal to do with the health of the people even though it may add nothing directly to their nutrition. Yet it is a highly important factor to a great many people and I could go right down the list and enumerate those factors. You are completely aware of them, the only trouble is we haven't presented an organized voice and asked those questions, and presented those problems to the right people, therefore, nothing to date has been done, except as it has been interpreted from agricultural research. I commend the boys that have done that because their heart was in the right place. They had the interest, they had your interest, spent their time to do something for you.

We are attempting to develop a rather broad cooperative de-centralized program of research and teaching in the field of turf, even though, as I said before, our primary interest is to the golf courses of the country in trying to raise the standards of excellence and maintenance for the golf courses to promote the game of golf. There are millions

now playing it and many more are starting to play every day. Golf is one of the most healthful forms of exercise, recognized by the military forces, because nearly every hospital has a golf course for the rehabilitation of the wounded veterans. Probably some of you here even participated in that.

Our continued interest and support of an expended turf program in Texas is necessarily dependent upon the continued support that you give our organization. We are free of any commercial connections one way or the other; we are a research, education, and service organization. The research part of it has been outlined. The extension teaching part of it has not been outlined and it is a very necessary adjunct to a research program. Either one will fail without the support of the other. They must be completely inter-grated and correlated if you are going to get the most out of your program. Unless the results of research are brought to you in one form or another they are of very little value because they are tucked away in the files and nobody can use them. By the same token a man in extension teaching, such as George Warner and his associates, couldn't continue to go out and give the farmers information on pasture grasses and their use, unless there were research facts being developed from which he could teach. The same thing is true in our work.

Yes, you might say we are somewhat selfish, but we are selfish in the interests of the whole because if we can stimulate and promote the development of an expanded turf program in Texas it simply means that in the working out of some of the problems of parks, lawns, cemeteries, airfields, and roadsides, something is going to come out of that research that is going to do us some good too. We want to have a share in it and we want to help support it. We are extremely limited in what we can do. At the moment we are limited largely to a position of guidance, leadership, and information which has been developed over 25 years in cooperative programs and from other stations in furnishing materials, strains of grasses which have been developed and which we have collected at Beltsville in cooperation with the United States Department of Agriculture and various experiment stations making the information and materials available to an experiment station that wants to develop an expanded turf program. That is at the moment our part in the picture. Occasionally we can find a few dollars here and there where a program is well rounded and underway to devote some particular phase of the turf program. Naturally we would devote whatever money we might find lying around to promote some phase of golf turf because that is our primary purpose but in the hope that the research data that comes out of that work will be applicable to lawns, parks, cemeteries, and other turf areas. That has been quite true in the past. It isn't always directly applicable but by inference you can get a lot out of it.

I really give you fellows a lot of credit for sitting tight in your seats and taking this all in, because a lot of stuff is being thrown at you, and you are really taking it like gentlemen. I think most of you are secretely reveling in the fact that there's that machine and operator sitting over there taking all this down so that sometime in the future you can read it all again without having to take notes on it.

How are some of these expended turf programs operating in other states? Because we are a National Organization interested in the development of turf our de-centralized program must be cooperative. We can't do very much alone. The agricultural experiment stations by nature are ideally suited to take up the study of turf because of their long and close association with problems of grass as a whole. Many of the species that are used in pastures are the identical species that we use in turf. There are differences, of course, but there is some overlapping. Our objectives are quite different but the specialized management often is the reverse of what the pasture man wants it to do. Rhode Island was probably the first experiment station in the country to develop a turf research program and I believe that started about 1905 if I am not mistaken. Now that is a long time and they have been going continuously and they have continued that program right through this last war at considerable personal sacrifice because there wasn't much to work with. Most of the personnel was away working in war programs and they have tremendously expanded that since the war. We're supporting that program morally and financially. The financial end of it isn't very much but it is enough to maintain our interests and to let them feel that we are back of them in their program. They are getting some money from the state through their regular agricultural research program. They are getting some from industrial fellowships.

The program in New Jersey since Dr. Sprague left it several years ago has been revived and it is being expanded. It has not been revived long enough to assume a really definite pattern but suffice it to say that it is on the way and New Jersey is a highly intensive state in so far as turf is concerned. The industrial plants are landscapping with grass, by and large. Acres and acres of grass surrounding these industrial plants give a most pleasing and healthful surrounding for the workers in those plants. The golf courses are highly concentrated around the metropolitan areas, and turf really is big business in New Jersey.

Pennsylvania has carried on a program for about 18 to 20 years. It was my pleasure to participate in that from 1935 to 1945 as extension agronomist. I was the extension phase of that program in agronomy and Professor Musser was the research part of the team. In addition to that there were extension specialists in pathology and entomology, agricultural engineering, and other phases of the work that were continually available to the turf interests of the state at absolutely no cost, because all of that work is being supported on agricultural research funds. The way that is done, and those funds are not earmarked, the turf research committee in the state makes a couple trips to the college every year to reassure the administration that they are continually behind the program, they are supporting it, indicating the interests of the turf program of the state in the college and bringing enough pressure to bear here and there to see that the funds for agricultural research are sufficient to take care of the pasture program, the corn program, the other agricultural programs, and turf research in addition. There is nothing earmarked. It is all part of agricultural research.

A program has recently been started in Georgia, started largely by the golf interests because their problems are much more intensive than most of the other turf interests. It is being handled at Tifton, Georgia, under the direction of Dr. Burtin, one of the outstanding plant genetists in the country. His primary interest is in breeding and he has developed a number of turf strains from breeding pasture grasses. In his breeding program he's essentially a pasture man, but he saves a lot of these turf things that have come out of his breeding program and now is working them into this turf program. Those strains are available to experiment stations for testing. One good breeding station on Bermuda grass or centipede grass is probably sufficient for a large area but your testing program must be carried out under different conditions where that grass might be expected to succeed. There isn't much money in that program yet. They are starting rather, well you might say, on a shoe string. To start with the Department of Agriculture, Bureau of Plant Industry, and the U.S.G.A. Green Section put a few hundred each into that program to get it started. Then the Southern Golf Association got interested and they had some money lying around that they weren't using and they said we would like to support this and so they wrote us a check with the understanding that so many hundred a year would be devoted to research at that station for a period of five years. That five year period is very good because it gives the research man a chance to develop a program over a long enough period of time to get some results. Since then the Georgia State Golf Association has thrown in some, Florida Golf Association says they might contribute some and just last week up at the U.S.G.A. Annual Meeting in New York I learned that the Detroit Golf Association was planning to make a similar contribution to our research and education funds for use in Michigan, for the benefit of Michigan golf courses. Don't forget that all of this is contributed to the larger picture because as results are found out at one station those results are tried out in a number of stations, and so that information is immediately distributed over a large area, and we are very pleased to have the position whereby we can help to distribute that information to those that can use it.

A similar program is underway in the Midwest under the Midwest Regional Turf Foundation. It is set up a little differently. In fact no two are set up the same, but they are all operating and they are all getting something done. So the method probably isn't so important as the idea of getting something done.

We have a program at Beltsville cooperating with the U.S.D.A., Bureau of Plant Industry. We are trying to do certain fundamental work that has national significance. It must be combination of the two so far as we are concerned. We probably never will have the size and scope of gardens that have been developed before the war at the Arlington Turf Gardens before the Pentagon was built on top of them. That was quite a considerable loss to turf in the United States. Tremendous amount of work was being carried on there of untold value to golf courses and other turf interests all over the country. Since we cannot hope to duplicate that again at Beltsville we would like to see this program decentralized and more of it carried out in the areas where the problems exist. We can't very well work on the problem of Bermuda grass encroaching on a bent green in Washington because it isn't a bent problem

but it is down here. This is the place that has that particular problem. You could go on and enumerate others.

Now what about the expended Turf Program in Texas? Get your sights set before you shoot. You can't build a research program without an extension teaching program. The two have got to go hand in hand and if you have to start on a modest scale do it and build up from there. In fact there is a very modest beginning here now, and that is something from which to build. I don't believe that a lot of you realize how much information you could get out of the various men and of the various departments of this college until you came here at this Conference. Primarily because, first you didn't know to whom to go, second, you didn't know what they had and you didn't know how to ask for it. I hope that is all dispelled because this is your institution and you can get help and a lot of good out of it if you go after it.

The area in grass in Texas is tremendous. The area in the type of turf in which we are interested is not so large but more important than that the turf in which we are interested is supported by a lot of people and to me people are just as interesting as grass, more so, and the people of Texas are more important than anything else. Really that is the keynote to this whole program, the effect on the people of Texas. And I believe you have more important people connected with turf interests, golf courses, parks, cemeteries, than you have in a lot of other agricultural interests. You can never get anything worthwhile without asking for it. I hate to repeat the old saw but it still holds--it's a squeaking wheel that gets the grease. If you don't ask for it usually you don't get it.

I just have to get this one more thing off my chest then I am about through. We have seen the development, Noer has been more of it than I have, of a lot of this work in other parts of the country. At the beginning everybody came into a conference hall or a meeting with a chip on his shoulder. He came in secretly knowing that he had something he knew about how grass was to be grown. He had a secret and he would be damned if he was going to tell anybody else, he has got to go out and learn it just the same as he did, the hard way. Fortunately that attitude has been dispelled in most of the areas where turf work is going on because everybody has come to realize that if you have an idea and I have an idea we exchange ideas now you have two and I have two. If we just exchanged dollars then you still have only one and I have only one. By the free interchange of ideas and information we help not just ourselves but our neighbor as well and our whole status in relation to our work and to society is improved.

We want to raise the standard of maintenance, the excellence of turf on golf courses to the point where the 100-shooter on the public course or pay as you play can play on just as fine turf as the top-star pros do on tournament courses. There is no reason why it cannot be accomplished. It is going to take time. There has got to be more men trained in the principles of growing grass under those highly specialized conditions. We can't be careless or indifferent about growing grass where we are working toward such a specialized objective as a

putting green or fairway or a tee.

I would be remiss if I didn't mention and give credit to the place that industry plays in the development of your program. Industry has a vital place in the development of your program in every way shape and form because it is almost impossible to do any of our work without adequate machinery, without adequate materials that go into our construction, our top-dressings, and I want to here put myself on record as commending the place that industry has played in the development of all the turf programs. So far as Texas is concerned I want to say that it has been a pleasure and a privilege to work with the Goldthwaites in developing that Texas Turf Tour that Noer, Ferguson and I took last August. I learned a lot more on that trip from you than you fellows did from me. We're learning all the time. Then again it is a privilege to come back down here and see the tremendous amount of work that has been done in stimulating interest in this conference. Everybody has to play his part. Those boys played a big part and I want to give them credit for it.

And lastly, you won't get very far acting as individuals. But working together and cooperatively there is practically nothing that you can't accomplish. Thank you.

QUESTIONS AND ANSWERS

Q. Will you tell us how we can go about organizing in Texas to develop a turf program.

A. That's a tough one. I could probably answer that and I appreciate your question and I know it is sincere, because by that question you have indicated your desire to develop this program. In the first place it has got to be your own organization. We have no part in it except to advise, to guide and to furnish whatever materials we might have to help it along. It has got to be your program. It has got to be your organization of leaders, and you have got to have a definite objective toward which to work. If you organize simply for the purpose of organizing then don't. Get your objectives clear cut. What do you want? Do you want a combination Research-Extension teaching program, if so make that your objective and everything moves toward that. You may want another conference. Probably you would like to have an annual conference. Maybe some of you are not so tired of sitting but that you would like to come back next year and do it again. Maybe we will have something new maybe we won't. Alright if that is the second point in your program make that number two and work toward that. And through your working committees with whatever type of an organization that you draw up, your committee will work with the responsible people at the college in developing that part of the program. I just don't know that I can be much more specific than that. But it will be an organization of men who are leaders in their respective sections in the country, I hope representating all of the turf interests.

Q. How have the other States set up their programs?

A. Well each one is so different that it is very difficult to lay down a pattern. It would be far better if your leaders who are clear thinkers will sit down and map their own destiny. I believe that the spirit of loyalty in Texas is so great that the challenge will be met and I don't think it will be difficult for the men of Texas to map their own destiny in this direction.

The time seems to be right if you miss it now it's going to be a while before you can pick up the thread again. And one thing is sure if this is the place where you want a program to develop and to emanate from, be sure that you maintain close contact with the people in charge of the work. And if you have the proper type of information, a postal card can keep you informed as to developments.

FUTURE TURF RESEARCH IN TEXAS

R. D. Lewis, Director
Texas Agricultural Experiment Station
A. & M. College of Texas

I am glad to have the opportunity to give the first official talk since your last evening's formation of the Texas Turf Association. If I could have followed my personal preference during the last few days I would have attended all of your sessions. Agronomy, in which most of your discussions have been, is only one of about fifteen subject matter areas with which I have to deal. Also a total of 33 research centers scattered about this state doesn't leave me much opportunity to follow personal preferences.

I was planning to discuss the items that I mentioned informally last evening. I have changed my discussion somewhat but I will undoubtedly repeat some of the things that were mentioned then and also some of the suggestions, maybe in a little different way, that other speakers have indicated as needed. I hope to mention how we may implement a few of the suggestions for research in turf problems.

To look at the future of turf research in Texas, it is necessary that we go back into the past to get a running start. Those who have worked with Texas Soils and Crops much longer than I would grant that intensive research with our legume forage crops and our grass forage crops is relative new in the South, as compared with the emphasis that has been placed on research with them in the northern states. Because of this lack of long-time emphasis we have not yet built the research organizations that are required to do a real piece of business in connection with turf and turf problems.

Not only that, but the problems are very, very complex with us. This map on the board shows the great diversity of native vegetation areas in Texas. Many of them are very closely related to fundamental soil conditions that occur in those sections. They are closely related also to climatic situations that exist in those sections. Based partly on factors of climate and soil and partly on economic situations our research men have set up on top of the soil and native vegetation map what we call "type of farming areas" in Texas. These may almost be called "types of turf areas". There are 18 main type-of-farming areas classified on our map, but some of the main areas are broken down into subdivisions so that the total of 36 subdivisions just gives you a little idea of the complexity of the problems from the standpoint of natural conditions with which we have to deal in approaching these turf problems satisfactorily on a statewide basis.

The kinds of grasses and the functions which we expect them to perform are also extremely variable. What we learn however in one area frequently has application in others. It isn't only kinds of grasses with which we are concerned. Dr. Sprague must have emphasized very emphatically yesterday that strains exist within each grass. I have worked with and have seen many comparisons of different strains within

a species of grass under different turf management situations. Some of these strains performed beautifully; others of them have shown to be very poor. I think there are some real opportunities in finding and in developing superior strains in many apparently good turf grasses.

To digress a little, may I remind you that, among flowering plants, the grass family is probably the largest the world over. In this state we find grasses in the marshes and in desert areas, in prairies and in woodlands, on sand and some of them on rocks and other non-fertile soils, from subtropic situations in our state, to areas of severe winters, from sea level to very high altitudes.

In the United States there are at lease 159 known genera of grasses and something like 1100 different species, a great many of which we have in Texas. You know that grasses undoubtedly are the principal food crop. Among grasses are the wheats, corn, sorghums, and rice. Those of you that are working with turf for instance may not realize that more than three-fourths of the world's food supply comes from grass. Many fundamental principles known to apply to these crops also aid in research on grasses used for turf. Particularily does that apply to those grasses that furnish hay or pasture.

Grasses are used in a great many of our industrial arts. Sugar cane is a principal example. There are a number of grasses that furnish us with fibers and aromatic oils of various sorts. One of the principal construction materials in the world is the grass, bamboo. For cleaning up we have another grass, broom corn.

We think also of soil holding grasses, many of them. This concept ought to be broadened a great deal, because in addition to holding soil, grasses, if properly used, also effect the physical situations in soils. In an experiment that I initiated ten years ago, we started with land average in productivity, varied the type of grasses and legume sod cups; and on one hand raised the soil nearly twice its former productivity, and on the other hand with little or no "grass" nearly cut the soil productivity in half. There was no difference in fertilizer treatments. On this soil physical problems were the primary consideration; through grasses the physical situations were improved.

We are talking here mostly about grasses for lawns, golf courses, airports, grass for beauty, for sports, and for commons. I do want to emphasize however that much of what we know from grasses, used in the other ways mentioned, may have its application. That is one advantage of being associated with a total research program where grasses are being investigated along those other lines.

To understand research needs for turf grasses we must know that we are dealing with complex systems of interrelations. This complex system has the following factors, each of which may be variable and consequently the end point may not be the same unless we take into account variations within each one of these factors.

The first factor is, of course, that of soil, which has been so ably demonstrated to you by previous speakers. Soil has its chemical, its physical, its biological phases. Water is the second factor. A third factor is nutrients. And a fourth the plants themselves. And then on top of these four we have management procedures. The treatments that are applied give variable results as illustrated in these soil sections that you have here. Mowing and other operations affect the turf. Pests, insects and diseases and over and above all, climate or weather , completes the list of main factors in this complex system of interrelations. To have a complete research program, however, we must know clearly the functions which we expect a particular turf to perform.

With respect to the plants themselves, it is my belief that one of our greatest needs is in fundamental research on the physiology and growth of grasses in the environment and under the management conditions such as obtain here in the Southwest. That type of information is inadequate even in sections where turf problems have been more intensively attacked previously. Until we know just what takes place in some of these grasses, not only above ground, but down underneath we will not be able to attack intelligently some of the problems of developing better turf. Not only is such fundamental information essential in relation to turf, but it will aid greatly in the use of grasses and legumes in soil building and conserving programs in general agriculture.

We must understand that this complex system of interacting factors is not a static thing; it is not fixed. It is changing and I suspect under intensive turf conditions it is changing much more rapidly than in many of our strictly farm fields. It is a dynamic changing system. Soil itself is dynamic. It's alive. That life sometimes is a very high life, a very good life. Sometimes it is just passive; and sometimes it is downright ailing and poor, even unto death.

One of the most important soil factors in connection with the growth and production of turf and a great many other crops is that of drainage. I don't know whether you have discussed this thoroughly this week or not. Mr. Houston mentioned it the first day. Good drainage may have far more to do with the success of obtaining good turf under Southwestern conditions that we have yet realized. Texas has at least 8 agricultural areas in which primarily because of poor drainage there is too much salt in the soil, too much alkalinity. Possibly where some of you greenskeepers have poorly drained soils and where you are adding a lot of water, "salt" or alkalinity may be one of the factors that contribute to poor turf. A lot of water that we use is very high in soluble salts.

You may feel that I overemphasize drainage, but I remember an experience that some good friends of mine had in construction of a golf course a few years ago. Drainage was the thing uppermost in their minds. Over the objections of the greens committee they insisted on putting in what they felt was adequate drainage, but what the greens committee felt was entirely excessive. As a result that course has the finest greens and fairways that I know of in that section.

As has been suggested at various times in this conference we need to know more about the variations within what now appear to be the better grasses. I am not sure that we even know which are the better grasses for many areas. You folks may feel that that is pretty well solved, but I am rather skeptical.

As we study and as we put these factors together into a system we would like to develop specifications, much as Drs. Noer and Grau are aiming to do. We would like to develop specifications that are based on a thorough understanding of these factors and that can be used as the basis for action programs. As I said last evening many of our researches will have to be done under conditions and with facilities that you folks probably can make available.

The Texas Agricultural Experiment Station has 33 research centers including the main one here. Mr. Potts has on our Brazos Valley Field laboratory an interesting planting of several grasses under different treatments, and primarily for pasture. But the results enable us to at least make some preliminary recommendations for grasses under similar types of soil situations for turf purposes.

If I can get across only one point I will be very happy. For some reason not nearly as many young men are going into agricultural sciences generally as we need. This is serious from the standpoint of future leadership in agriculture, of research, and teaching programs, and of a lot of the industrial programs related to agriculture. A series of scholarships or fellowships is needed which will enable young men and young women too to work in turf problems; to get their advanced training, with grass, with turf, with soil. Only then will they be prepared to take their places in research and teaching and out on the greens, fairways, parks and roadsides carrying out the programs and in advising such programs of turf improvement and management. The shortage of trained men jeopardizes the future success of these programs more than any one other factor that I now know.

What are the sources of funds that might be drawn upon for research work in turf? Neither you nor we can operate without funds. We might possibly, at this present session of the legislature, (that's up to you folks), get a special lump sum appropriation for such research.

Another source of funds that we use for research work is sale of material that have been grown in connection with some of the research programs. However, it is very unsatisfactory to have sales a required endpoint of research. In turf research there is little prospect of sales being much of a source of income unless you save all these clippings and maybe process them for special vitamin foods of some sort!

We have possibilities of utilizing some enlarged federal appropriations for research in turf, specifically those authorized last August under what is known as the Hope-Flanagan Act or the Research and Marketing Act of 1946. I hope that these funds will be great enough to permit enlargement of our basic research in grasses and

legumes; some of which will have their use in turfs.

Also other sources of funds are contracts and grants-in-aid. Some companies, associations, or individuals who are interested in solving actual research problems, contract through the Texas A. & M. Research Foundation for specific research. Others provide grants-in-aid directly to the research program, such as in turf problems. These grants-in-aid are used partially for the advanced training of folks in these particular areas. Last evening you may have noticed me going to Fred Grau, whom I have known for a great many years, to ask him when we could put in the application for that Greens Section Fellowship that he promised us, or didn't he? You folks will put the pressure on for that.

I'm hoping that Dr. Grau may be able to place that fellowship here soon to help us get that rounded program, turf program developing. As we work out some of these research programs together we would like to have from you turf men a listing and a classification of the main problems as you see them. We shall be pleased to work out the future research program that we should undertake in order of priority of problems. We would be very happy to have the privilege of setting up with you what might be called a turf research advisory committee.

I appreciate this opportunity of bringing to you some of the thoughts of our staff and some of my own with respect to both the opportunities and our hopes for future research in Turf.

ROADSIDE DEVELOPMENT

Jac. L. Gubbels
Texas State Highway Department

I now have the honor of addressing the Texas Turf Association. I was glad to see the Turf Association formed last night. I know there is a great deal we don't know about turf. We in the Texas Highway Department who are dealing with a vast territory of lands knew a great deal more about turf 15 years ago than we do today. We probably have more literature on the matter now than we ever had. Whenever there is a good deal of literature on a subject it is usually an indication that we know less.

There are approximately 197,000 miles of roads in Texas, of which 26,000 miles are maintained by the State Highway Department, comprising about 235,000 acres on the roadsides including shoulders. The only portion of the highway right-of-way which can be looked upon as permanent is the roadside. The paved ribbon is subject to deterioration, to wear and tear, while the roadsides, by means of the establishment of a turf, improve over the years to a point of stability. There are different methods by which that stability of the roadside may be obtained.

We have conducted a great many experiments in our state, but as Dr. Lewis pointed out a little while ago, it is generally conceived that the first and most important test in engineering is drainage; the next and most important test in engineering is drainage, and the third biggest test in engineering is drainage. That does not only apply to the ribbon of pavement, but it also applies to the vegetation along the roadsides.

We of course have heard a great deal of talk about our climatic conditions. It is very changeable and in great variety in the state. If we stop to think about it, we have approximately 265,000 square miles to deal with in 254 counties. We realize that there must be a great variation in climatic conditions. However, we have found in our work that it isn't a drought or excessive rains which cause the most damage to roadsides, but the cold waves which come into the state, such as we have recently experienced. They cause more damage to vegetation than any of the other elements. We think of West Texas as the arid country, and it almost seems hopeless, because the rainfall is very little annually in some sections. The rain often comes in two or three days - sometimes in a few hours - then no more rain the balance of the year. But in our effort to stabilize the roadside, that drought is not half as bad to work against as are the cold spells which come over the state.

Our greatest success of roadside stabilization, I believe, is in the Panhandle where the rainfall is approximately 20 inches, sometimes less. And yet our success is almost 90 per cent there compared to East Texas where our rainfall is much greater. The reason may be that we are just a little bit more careful, because we realize that there is a problem of drought, and therefore we give it a great deal more attention.

As stated before, there are different ways to obtain stability. First, the construction of diversion dykes in the lands adjacent to the right-of-way, in which the water will be absorbed in the earth before it reaches the highway. By this method a great many of our culverts under the highway could have been eliminated. This procedure, however, is not always advisable, and can only be practiced in the grassland areas where the rainfall is very sparse, where the ranchmen do not object to additional water. Then there is the diversion dyke within the right-of-way to divert the waters to the adjacent land, with the approval of the property owner, especially in such instances where the runoff is a considerable distance from a creek, river, or other channel. We have found that owners, especially in grasslands, are very cooperative. Of course, there is different story when we are in tilled land areas.

The next best step is to study the stability of the soil before the highway is located to ascertain how much rainfall the soil can stand before it erodes, then establish a profile of the highway proper, according to the stability of the soil. For example, a sandy soil profile would have to be fairly flat, and as the binder in the sand increases, the profile can be increased in steepness of grade. That method is, however, very cumbersome in many respects and cannot be carried out 100 per cent, but the knowledge of it cautions the engineer to study the soils before he develops his profile and cross-sections.

The next step is to have wide rights-of-way, providing sufficient space for runoff ditches rounded in a crescent shape. If sharp V-shaped ditches can be prevented, the scouring out of the soil is considerably less. This rounding shape also makes for a pleasing roadside, and a sense of spaciousness. In highway work I think spaciousness, or a sense of spaciousness, is the finest factor in preventing accidents.

The next step is to establish a turf on the roadside. In order to establish a good turf, it is of course necessary that the soil be of sufficient fertility to establish a turf. We often use soil-building legumes for that purpose, such as bluebonnets, lespedeza, sweet clover, and a few other clover varieties. In extremely sandy soils we have found that the working of cut straw into the soil to prevent it from eroding, then sowing grass seeds, is a successful method.

As a whole, so far the most successful grasses we have found are Bermuda and buffalo. This is true, however, only due to the availability of these grasses. There are other grasses as good as these, but the seeds or stolons are not always available, economically speaking. We have experimented with centipede grass, and found it successful in sandy soils, but it does not do so well in a tough, hard soil or coarse sand. This grass has been greatly over-rated in advertisements by commercial firms. For example, one statement they make is that it won't die if you don't water it, and you don't ever have to cut it. That is also true of Bermuda grass and buffalo grass - if you don't water it, it won't die, but it certainly won't grow, so you don't need to mow it. That is one of the tricks in advertising, and I believe such false statements mislead people, then when it is found that it has to be

watered and mowed, the people lose confidence in centipede grass. But it is a very short grass, and the chief advantage of it is that it develops under the ground more than it does on top of the ground, if the soil is pliable and the aeration is good. In a large organization such as the Highway Department, we can always have experimental plots in different sections of the state and then watch the results under the most trying conditions. We never try to pet a particular vegetation. If it isn't hardy enough to support itself after we have given it the proper start, then we don't want it for roadside use.

We have gone far with the St. Augustine grass. In Pecos and vicinity we have established some very fine St. Augustine grass lawns. Ten or fifteen years ago we didn't think it would grow further north than the Rio Grande Valley. As early as 1935 we pulled it out of the Valley and planted it near Bryan and near Texarkana, and in different sections of the state, and we have found it to be one of the finest grasses, especially along the Gulf coast. We have many miles of highways now covered with St. Augustine grass along the Gulf coast highways. In our experimentation with this grass we planted it in conjunction with Bermuda and centipede. In the experiment, we did not irrigate the grasses, and the St. Augustine grass finally won out over the Bermuda and the centipede grass. In other words, it withstands the drought as well as any other grass we have in the state.

In the beginning of the war, the South African government sent grass experts to the state to find a grass which would be successful for airports in South Africa. These men finally decided on the vine mesquite as being their best possibility. This vine mesquite is apparent mostly in West Texas, but is especially luxuriant around Jacksboro. We find that vine mesquite offers great possibilities for our roadsides, and I see no reason why it should not be excellent for many other uses, such as lawns and golf courses.

The soil conservation people have experimented a great deal with Weeping Love Grass and other good promising grasses to establish a solid turf of rather short varieties.

Before the war we were able to buy sufficient Bermuda grass, and we were most successful with the mulch-sodding method. That means the grass soil was plowed, lifted up and loaded in a truck, then deposited on the roadsides of about 5" compactness on sterile soil. That method cost as little as 30¢ to 65¢ per cubic yard. Now we are often unable to obtain Bermuda grass, since the farmers have become more conscious of their own grass problem and are not so eager to sell their pastures to us.

We are now experimenting with asphalt mulch or a cutback asphalt, by applying first a topsoil, then a residue of natural fertility, seeding then with Bermuda grass, using from 5 to ten pounds of Bermuda grass seed per acre. A thin coating of non-toxic asphalt is applied to retain the moisture in the soil to prevent the soil from drying out during the time of germination of the seed, regardless of drought. If this asphalt were not used it would take about 11 gallons of water per square yard to successfully grow Bermuda grass. That is a great deal of water, especially

if it has to be hauled considerable distance. That is all right in cities, but in the country, it proves to be very inconvenient and expensive. Before the war we have paid as much as $3.00 per thousand gallons for water in some territories, and that is too much, when we consider the vast area of our roadsides over the state. Also when asphalt is not used, we would have to use a straw mulch where seeds are planted. That is not always successful, since it induces fungus growth and a great many other pests. We have also tried sawdust, but the results were not worthwhile. We have experimented with cotton burrs. Cotton burrs in the soil is probably still one of the finest ways of introducing mulch and aeration in the soil. In many places this method is used extensively. The application of asphalt not only protects the soil from drying out during a drought, but protects it against erosion by hard rains as well.

The specification for the application of non-toxic asphalt is approximately 0.2 gallon per square yard, and the temperature of the cutback cannot be higher than about 150 degrees Fahrenheit when applied. If more heat is used it may do a great deal of damage to the seed. As I stated before, we are still in the experimental stage with asphalt, and as yet we have very little information, but undoubtedly in the future we will know a great deal more about it, since we are experimenting with it in different sections of the state. We are really expecting a great future for asphalt covering.

We have a slogan in the Highway Department that it is better to use one handful of seed than a truckload of rocks for the prevention of erosion. We use in our work a great many types of wild flowers, especially the low-growing varieties, such as bluebonnets, paint brush, primroses, and other varieties of low showy types which will add to the recreational facilities, as well as protect the soil from erosion.

When I came to the Highway Department about 13 years ago almost all of our engineers had a hobby; they were interested in one particular phase of highway work. Some were specialists in concrete; others were specialists in location, or in asphalt or drainage. Now we no longer have specialists. These men, everyone of them, are interested in all phases of the roadbed and the roadside. They cease to be specialists, and I believe, as I have heard so often, that if we cease to be specialists and give a little more attention to the picture as a whole, we might be able to pick up a great deal more information and make our work just a little bit more pleasant.

QUESTIONS AND ANSWERS

Q. Does the centipede grass do better in the eastern part of the state than it does in the western part?

A. I should say that the cold weather has a great deal to do with that. In other words, centipede grass is considerably susceptible to cold waves such as we have had this winter. I know that the centipede grass can be grown elsewhere as successfully as in East Texas. I believe that

it has great possibilities in sandy soils almost everywhere in the state.

Q. Can this grass be obtained commercially?

A. Yes, I believe that there is a firm operating in North Carolina, but it is very expensive. We have our own plot of about 5 acres which is enough to cover this state.

Q. Is it not true that this grass grows better in acid soils?

A. Well, we have a considerable acid condition at Tyler where it is doing well. We have an alkali condition in Austin, and the grass is doing as well, if not better, than at Tyler, so I don't know whether that statement will hold up.

I might say here that we have specifications on asphalt treatment and it is available in our department.

TURF FOR AIRPORTS

Sydney H. Watson
Army Air Corps
Dallas Texas

Dust is a hazard to flying operations, causes excessive wear on airplane motors as well as other precision equipment, and is injurious to personnel. Flying hours between engine changes have been more than trebled as a result of dust control, and respiratory disturbances have been reported eighty-five percent less following elimination of dust. The cost of dust control is infinitesimal when compared to savings affected by reduced damage to equipment and savings in productive man hours.

A good grass cover is very effective in controlling dust and water erosion, and if properly managed, can be maintained under intensive use, including pedestrian and aircraft traffic.

The turfed airport lends itself in an excellent manner to those airport sponsors who are uncertain as to the future of aviation for their municipality in that this type of airport may easily be so planned and designed that it is the first element in stage construction. As such, the facilities offered may be adequate for years to come, but may be readily expanded and improved whenever the expenditure of additional funds appears justifiable.

The subject of the turfed airport immediately presents to mind a multitude of construction problems, some of which are not completely solved. Of prime importance in this type of installation is an economical but adequate turfing treatment to provide stability and dust and erosion control even though subjected to intensive use by planes in all kinds of weather. Wherever climatic conditions favor its establishment the most satisfactory but inexpensive solution to date is a dense cover of sod-forming grass, growing on stable, well-drained or soil-like material. It is primarily with this phase of construction that the following remarks are applicable.

Site Selection

The importance of proper site selection for a turfed airport cannot be too strongly emphasized. In the site selected must be a composite of the many factors that properly combined will produce an airport which is easily accessible to the using agency and patrons, satisfactory to the aviator from the standpoint of operation and yet economically constructed and maintained. Both from the agronomic and the engineering standpoints there are certain requisites that an airport site must have if satisfactory results are to be obtained. The incorporation of these requisites in the site selected can save thousands of dollars otherwise expended in performance of construction measures necessary to rectify deficiencies.

Drainage

No discussion of turfed airports can be considered complete unless it points out the great importance of drainage in the establishment and maintenance of turf grasses and in providing a landing area which may be used during periods of wet weather. Without going into a discussion of drainage systems, which is a topic in itself, it will have to suffice to emphasize the fact that surface water drains more slowly from turf than from pavements, and therefore more pitch or slope is required to remove water quickly from a grassed area than from a concrete or asphalt surface. In addition, a soil covered by dense vegetation may have as much as three times the absorption rate as the same soil void of vegetative cover. For this reason, porous loams or mixtures of loam and clay soils with more than 50 per cent sand are of great advantage from the standpoint of drainage on a turfed airport. In certain instances the use of agricultural drainage tile in limited areas may be feasible. While the costs of securing adequate airport drainage may appear excessive and the results are not readily apparent, it is a feature of construction which should be carefully designed and executed if satisfactory wet weather operations are ever to be obtained.

Topsoiling

In preparing an airport to be turfed, one of the first problems which presents itself is the advisability of saving topsoil. The stockpiling and replacing of large quantities of topsoil involves considerable delay and expense. Assumption that this operation is an absolute necessity should be challenged in view of the fact that in many localities the subsoil is suitable for plant growth from a physical standpoint and will produce a satisfactory turf provided sufficient plant nutrients in the form of fertilizer are added. The advisability of saving topsoil is particularly questionable in some sections where the topsoil itself is relatively infertile. The cost of fertilizer represents only a small fraction of the cost involved in moving or saving of topsoil. Accordingly, while the practice of topsoiling is beneficial in some localities and under certain conditions may be essential to the eventual success of planting operations, it should by no means be considered a "must" item of construction. In this connection, however, there is a great deal of room for improvement in dirt moving and grading specifications to devise methods of saving the maximum amount of topsoil at a minimum cost.

Fertilizer

As previously mentioned, the application of adequate quantities of commercial fertilizer is requisite for the establishment of a satisfactory turf, particularly on infertile soils. The fertilizer requirements of grasses for turf purposes are very different from those of most field crops. Grass produces a large amount of foliage for which nitrogen is primarily required. Because of this, together with the fact that nitrogenous salts are readily leached from the soil, nitrogen is usually the element which is likely to be most deficient in a soil. In general, therefore, the fertilizers which are recommended for turf are high in nitrogen.

Soil analyses, when considered in relation to the requirements of the grass to be planted, are very useful in helping to determine the types and amounts of fertilizers to be applied. Inorganic fertilizers of 10-6-4 and similar grades, however, usually should be applied at a rate of 80 to 120 pounds of nitrogen per acre.

For most conditions inorganic fertilizers are more satisfactory than the organic from the standpoint of cost as well as quick availability to the grass. The organic materials, however, have the advantage of being more lasting in effect due to slower decomposition and accordingly may be used to good advantage on sandy soils or in regions of high rainfall where inorganic fertilizers are leached rapidly.

Grass Species

The wide range of climatic conditions prevailing in Texas made it necessary to give close attention to rainfall, temperature and other climatic factors in selecting the right grass for a given site.

The most ideal grass for landing fields in Texas at present is Bermuda. This turf-forming grass is adapted westward without irrigation to approximately the 100th meridian.

West of the Bermuda territory and overlapping it for many miles East is a native grass territory which will sustain the growth of Buffalo, Blue Grama and other native grass species under considerable airplane traffic. The western limits for airport use of these native grasses are hard to define due to variations in climate, elevation and soils, but established stands are known to survive traffic as far west as Lubbock and Amarillo, Texas.

In general, unpaved airport sites within the native grass territory must be selected primarily for the cover of native grass already on the site and requiring a minimum of leveling or grading, inasmuch as two or more years are usually required for establishment of a dense stand of native grasses. A dense cover of Bermuda grass, however, can be established within a period of from three to six months, depending upon rainfall, soil conditions and maintenance subsequent to planting operations.

Native grasses are established principally by seeding, whereas Bermuda grass may be established either by seeding or by vegetative means such as sprigging. The latter method is the more feasible in the colder and drier sections of the Bermuda grass territory due to the fact that such plantings are less likely to winter-kill and will withstand more drouth during the initial stages of its establishment.

Much time could be spent at this point in discussion of planting methods, particularly sprigging. However, suffice it to say that methods have been improved and satisfactory sprigging machines developed, the net result of which has been a cost decrease of from $150 per acre or more during 1942 to an average cost of $32.50 per acre in 1943, '44, and '45.

Costs of Turfing

A few average figures have been assembled from construction cost records to present some idea of the relative costs involved. Before going into these cost comparisons, it might be well to clarify one point. These comparisons are in no way a reflection of one method against another. They are simply statements of fact and as such should be judged on their own merit. In other words, turfing operations on airports should be considered strictly as engineering with vegetative materials and should be evaluated as such.

Most of the Army airfields in Texas requiring all-over landing facilities were sprigged with Bermuda grass. The average total cost of this operation including tillage and fertilizing was approximately $50 per acre or about one cent per square yard. Bermuda grass seedings, including tillage, seed and fertilizer, cost about $25 per acre or one-half of a cent per square yard.

Irrigation

In order to establish and maintain grass for intensive use under arid and semi-arid conditions, it is necessary to supplement rainfall with irrigation. Observations made during the past several years have led to the conclusion that a minimum of thirty inches of water per year is required to produce an adequate Bermuda grass cover to control dust under intensive traffic.

Irrigation has been successfully utilized on many Army airfields in the semi-arid Southwest to establish and maintain Bermuda grass cover.

Once it has been determined that sufficient water supply can be developed to supplement annual rainfall to insure a minimum of thirty inches of moisture per year, the cost of the system can be determined. Sources of water supply include deep wells (750 to 800 feet in depth), irrigation canals, sewage effluent and nearby streams or lakes. Irrigation is accomplished by sprinkling, since dykes utilized for flood irrigation would naturally render the field unusable by planes. The main supply lines are buried. The number required depends upon the size of the field, for example, a single line is adequate for a field up to three hundred fifty acres. On a field of this size, the buried supply line is placed through the center of the field. Valve boxes are placed along the main supply line as required for connection of portable supply lines. Above-ground secondard portable supply lines take water to portable sprinkler lines. The diameter of burried supply mains is usually eight to ten inches, depending upon the size of the field; portable supply lines, six inches; and sprinkler lines, four inches. All above-ground pipe is galvanized lightweight, sections being from sixteen to twenty feet long. (A 20-foot length of 4-inch pipe weighs forty pounds and can be easily removed by one man). Sections of portable pipe are joined together by quick coupling devices, requiring no wrenches or other tools for joining or disjoining. This type of connection permits rapid movement of lines when watering in a given area is completed.

Cost of the airfield irrigation system naturally depends upon size of the field, source of water supply and related factors. The following are actual costs of irrigation systems on three separate fields. In each case, the system was designed to apply one inch of water over the entire field in a minimum of ten days.

Field No. 1,
(1) Acreage irrigated -- 690
(2) Source of water -- irrigation canal adjacent to field.
(3) Total cost of irrigation system -- $39,334.00.
(4) Total cost per acre of irrigation system -- $57.00.

Field No. 2,
(1) Acreage irrigated -- 575
(2) Source of water -- wells.
(3) Total cost of irrigation system -- $52,103.00.
(4) Total cost per acre of irrigation system -- $90.43.

Field No. 3,
(1) Acreage irrigated -- 295.
(2) Source of water -- wells (three 750 to 800 feet deep).
(3) Total cost of irrigation system -- $63,393.06.
(4) Total cost per acre of irrigation system -- $211.50.

The average cost of installing irrigation systems on the above listed fields was $99.25 per acre, and the cost of planting Bermuda grass sprigs, overseeding, fertilizing and watering of grass until established was averaged approximately $65.00 per acre or, in other words, $165.00 per acre through the establishment phase. One hundred sixty-five dollars per acre is a lot of money to spend growing grass; in fact, it is almost three and one-half cents per square yeard -- .034 to be exact. But is there a less expensive method of control of dust on intensive use areas under low rainfall conditions? It has cost as much as $500.00 per acre for oil dust palliative which is temporary and not satisfactory for intensive plane traffic.

Designed capacity of irrigation systems varies with the size of the field. For a 600-acre field the design is for approximately one thousand gallons of water per minute, which permits applying an acre inch (approximately 28,000 gallons) in twenty-eight minutes actual watering time. At this rate, the entire 600 acres can be watered in approximately 300 hours.

The length of sprinkler line or lines, number and spacing of sprinklers and capacity are contingent upon size of sprinklers and pressure at the sprinkler head. In general, sprinklers are spaced forty feet apart, and a minimum pressure of approximately thirty pounds at the sprinkler is required to insure uniform coverage of all areas.

Sequence of irrigation is arranged in such a manner that not more than one-fourth of the field at a time is closed to operations. Fields are usually divided into four equal quarters. This leaves a large "L" shaped area available for use at all times, thereby interfering only slightly with flying operations.

From three to six men are required to operate an average size irrigation system. Movement of portable supply and sprinkler lines is the big labor item. Cost records for a field having a thousand-gallon-per-minute system on an allover grassed field show an operating cost, including labor, fuel, cost of water and supervision, of $2.454 per acre inch of water applied or $24.54 per acre per year to apply ten inches of water. At another field with a 625-gallons-per-minute system, the cost per acre inch was $5,04. Total maintenance cost, including irrigation, mowing and miscellaneous work, on still another irrigated field consisting of 295 acres was $27.61 per acre per year. This field has had an average of 650 landings per day, is absolutely free of dust and grass has not been damaged.

Studies have been made of use intensity of paved runway fields as compared with all-over irrigated field. At a particular station having an irrigated auxiliary field consisting of 295 acres and a runway auxiliary field with three sets of paved dual runways 150 by 3,000 feet plus connecting taxiways, the average number of landings has been the same; namely, 650 per day. Maintenance cost on the irrigated field for a year was approximately eight thousand dollars, while on the paved runway field it was slightly less than twenty-nine thousand dollars, including resealing and resurfacing.

Irrigated Bermuda grass has been successfully used on drill fields and athletic areas. Under such conditions, it is usually possible to connect sprinkler lines to existing water mains in the cantonment area. The cost of providing a portable irrigation system on one specific area consisting of ten acres was $112.13 per acre. The area involved consisted of a combined officers and cadet recreational area and was utilized intensively every day except Sunday by a total of one thousand one hundred fifty officers and cadets. Approximately forty-two thousand gallons of water per acre was applied during each period of watering. The time required to accomplish watering was approximately eight hours. Irrigation equipment utilized for this area consisted of 840 linear feet of four-inch portable supply main, 460 linear feet of three-inch portable sprinkler pipe, 1 four-inch hose fitting, 2 four-inch, ninety-degree fittings, 1 three-inch fitting and 12 sprinklers. Sprinklers were placed forty feet apart. The total cost of grass establishment, including portable irrigation system, fertilization and grassing was $157.13 per acre. Total maintenance cost over a period of one year was $26.08 per acre. This cost includes cost of water and its application, cost of mowing and other miscellaneous maintenance activities.

Oiling for dust control under similar conditions costs not less than $200.00 per acre and usually much more. It is usually necessary to reoil a minimum of twice a year at a cost of over $200.00 per acre as compared with $25.00 to $50.00 per acre for maintenance of irrigated grass.

Can irrigated, grassed landing fields which will be satisfactory for heavy aircraft be developed in low rainfall areas? Maybe, and if so, the cost would be only a fraction of that of pavement. Dry soil

will withstand tremendous loads, and grass with its five to ten tons of heavy root mass increases stability. Possibly some inexpensive method of obtaining added stability should be investigated more thoroughly.

Conclusion

In closing, it is probably well to emphasize the fact that turf specialists are fully aware of the limitations of turf for airports. Nevertheless, after allowances are made for all of its limitations, there still remain many possibilities for its effective use in the planning of postwar airport programs.

At present, we are in many ways still pioneering in this program of airport engineering with vegetative materials. Such a program necessitates the closest of liaison between the agronomist and the engineer. With such a liaison in both research and construction, however, the ceiling and visibility are unlimited for future construction of serviceable, inexpensive, unpaved, all-weather airports.

ORGANIZATION OF THE TEXAS TURF ASSOCIATION

The Texas Turf Association was organized during the business meeting held in conjunction with the Turf Conference at Texas A. & M. College January 21, 1947. This organization is to be comprised of individuals having an active interest in turf, all phases of turf being represented including home lawns, parks, athletic and recreational areas, highway shoulders and roadsides, and airports. The primary objectives of the association at present will be that of promoting an interest in the effective use of turf and in securing adequate funds for a research and extension program to be conducted by Texas A. & M. College.

Officers

President ..... Gordon H. Jones
Chief, Turfing Section, Civil Aeronautics
Administration, Fort Worth, Texas

Vice-President ..... Howard B. Sprague
Director of Agricultural Research, Texas
Research Foundation, Dallas, Texas

Vice-President ..... Sam Schneider
Professional, River Oaks Country Club
Houston, Texas

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SOUTHWEST, A. & M. COLLEGE OF TEXAS
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JANUARY 20-22, 1947

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Alexander, Robert M., Ft. Worth, Tex., Supt. Colonial Country Club
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Aulback, George, Amarillo, Tex., Amarillo Country Club
Ayles, Richard E., Houston, Texas, Pine Forest Country Club Greenkeeper

Banks, Ben D., Dallas, Texas, Pro-Mgr., Cedar Crest Golf Course
Bebb, Kenneth, Houston, Tex., City Forester, City of Houston
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Dugan, Marian A., Longview, Tex., Greggton Golf Coarse
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