Proceedings

of the

21st Annual Northwest Turfgrass Conference

September 20-22, 1967

Harrison Hot Springs, B.C.

NORTHWEST TURFGRASS MEMBERSHIP DUES

	Annual dues
Golf Courses—	
Less than 18 holes	$20
18 holes or more	40
Nursery, landscaping and ground spraying firms	20
Architects and engineering firms	20
Equipment and material supply firms	20
All others	20
Cemeteries—	
Less than 400 interments per annum	20
400 to 600 interments per annum	25
600 to 800 interments per annum	30
More than 800 interments per annum	40
Park Departments—	
Less than 150 acres total area	20
150 acres or more	40

1. Annual Dues payable on or before May 15th each year. Dues are based on annual due date nonprorated.
2. Membership includes registration fee for one person at Annual Turf Conference. Other persons from member organization registration fee $5.00.
3. NO INITIATION FEES ARE CHARGED.
4. Nonmembers may attend the annual Conference by paying $10.00 registration fee. For further information on dues, contact Northwest Turf Treasurer.

Dick Malpass

I am indeed grateful that it has been my privilege, this past year, to serve as president of the Northwest Turfgrass Association.

The Northwest Turfgrass Association continues its growth in membership as more and more individuals and concerns realize the important contribution this organization has made to the management of fine turfgrasses in the Pacific Northwest. The impact of research sponsored and completed, and of that projected will continue to be of major importance to turf interests in this area.

It has been an honor to have served on the Board of this organization, and this past year, to serve as President. The officers, Board and Committee members have been most cooperative and are a fine group of fellows to work with. Especially to be commended are Dick Haskell, our hard-working treasurer, and Dr. Roy Goss, Executive Secretary. It is with considerable self sacrifice that many of these fellows participate in Board meetings and affairs of the Association, yet so sincere are they in the belief that the work they are doing not only helps them in their own turf problems; but that they will be able to provide assistance to anyone else maintaining turfgrass, that without hesitation they gladly give of themselves.

Beginning with the fine conference at Salishan Lodge, on the Oregon Coast, highlights of the past year have been the Superintendents bus tour to California golf courses, the annual Turf Field Day at Puyallup, the visit of Walter Boysen, National Golf Course Superintendents Association President to the Field Day and afterwards to the annual meeting and tournament held at Fircrest by the Northwest Golf Course Superintendents Association. We are very grateful to this particular group for their fine hospitality both to Mr. Boysen and myself.

We wish the Association continued growth and success. We are sure, that given the continued cooperation and participation of its members, it will continue to be a highly respected factor in the successful management of turfgrasses in the West.

NORTHWEST TURFGRASS ASSOCIATION

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WELCOME

Dick Malpass, President
Northwest Turfgrass Association

Welcome to the 21st Annual Conference of the Northwest Turfgrass Association hosted this year by our British Columbia members and friends. Perhaps this is one reason we enjoy such good attendance and get to meet so many new faces because of our policy of rotating the annual conference sites between the States of Washington, Oregon, and Idaho, and the Province of British Columbia. Opportunity is thus given, to those who might not have attended otherwise, to attend a conference close at hand.

Knowledge concerning the proper management of turfgrasses has increased greatly the 21 years our Association has been in existence and it is gratifying to know how much we have participated in this growth.

We have been very interested in varietal development of turfgrasses for specialized uses. Research proposed and carried out has materially assisted in controlling our major turfgrass diseases. Chemical control of weeds in fine turf has been furthered by our efforts. Soil compaction studies, light intensity studies, fertilizer formulation and application studies, and many other problems met by the professional turf manager have been solved or helped by financial assistance of our organization. True, we may not have been able to help, monetarily, in a large way, but at least we were able to point out the problem, help to a limited extent, and trust some of the capable, dedicated research people to come up with an answer.

Assembled with us these three days are a number of knowledgeable people who have some very interesting subjects to present. We are sure that there are topics which you came specifically to hear. Ample time will be given to question the speakers during the sessions and we hope you will take advantage of the opportunity. We request your participation in the program.

The Past, Present and Future of the Golf Course Superintendent[1]

Walter R. Boysen[2]

It seems appropriate at this time to review the role the man currently known as the Golf Course Superintendent has played, is playing, and is destined to play in the world of golf. The rapid expansion of this sport in recent years is indicated by the fact that approximately 200 golf courses are being built annually in this country alone. Almost certainly this rate of increase will continue and place an even greater responsibility on the industry to provide qualified people to construct and maintain these facilities.

In order to properly assess and evaluate the varied problems that are associated with the profession of maintaining a golf course, I think it necessary to go back and examine it's nature.

To begin with, golf courses, or links, were in many cases constructed on what were originally farms. To build the course, a natural tendency was to use the closest labor supply which, of course, was farm labor. As a rule, the courses were designed by experienced architects, and in many cases construction was supervised by experienced people. At this point, however, the completed course was left devoid of experienced personnel. The usual solution to the problem was to install one of the better farm workers as the man in charge. He was usually known as "the Head Gardener" or "Foreman". His knowledge of turf management was limited to what he was able to pick up from his association with the construction supervisor and the course

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[1] Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2] President, GCSAA; Supt., Sequoyah C. C., Oakland, California.

architect. If this man was unusually sharp the Club was lucky and a reasonably good golf course was the result. On the other hand, if the foreman was unable to get the "farm" out of his system, then the Club was in trouble. He had no one or no place to turn for help. It seems providential that, in the early days of golf in this country, many of our present day problems relating to such things as fungus, insects, weeds, etc. were relatively unknown. You could almost limit fungus diseases to brown patch and dollar spot in those early days. Insects and weeds were in an equally confined range. Contrast this with the broad spectrum of turf diseases, insects, and weeds we must contend with today. Had these been prevalent in the early days, I doubt very much if many farms would have become golf courses. Perhaps a logical reason for this progressive increase in turf pests through the years is directly related to the more sophisticated grasses we work with, and also to the ever-increasing demands by golfers for finer playing conditions.

It seems inevitable that the future will bring forth new diseases, more varieties of insects and weeds. Demands will continue to be made by golfers from all types of courses for finer grooming. No longer will they be satisfied with greens that in the early days were mowed twice a week, nor will they be satisfied with greens that are now being mowed five or six times per week. In some areas and on some courses it seems entirely possible that greens will be mowed twice a day every day, during the active growing season. Once over the fairways and tees was quite alright years ago, and the roughs were mowed when you got around to it. In many cases, way back in history, sheep took care of the chore. Not so today--fairways and tees are clipped at least twice per week, and roughs once or sometimes twice. It seems likely that the future will see more frequent mowing of these areas also.

Logically, of course, a completely new pattern of fertilizing has developed through the years as a consequence of the increase of mowing frequency and generally shorter heights of cut. Once-a-year nourishment of fairways with barnyard manure was a treat not accorded many golf courses in the early days. Today's improvements in equipment make it entirely possible to fertilize these areas in a matter of hours. The future promises even greater advantages in this area by continual injection of plant food materials in irrigation water.

Irrigation of golf courses years ago was usually confined to hose and stand sprinklers on tees and greens, with fairways left pretty much to natural rainfall. Of course, today we are in the midst of an automatic irrigation explosion. The future promises even greater refinements and improvements on the systems as we know them today. We are on the threshold of having these systems controlled not by man, but by moisture sensors. Ideally, then, the future should see all turfed areas on the golf course completely and automatically serviced with fungicides, insecticides, fertilizers, weedicides, and perhaps, in some areas, growth retardants.

Of course, in this review of the past, present and future of the Golf Course Superintendent, we cannot overlook the role of equipment as used on the golf course. I can remember when fairways were mowed with a single-unit mower--<u>horsedrawn</u>--this is one reason why fairways were only mowed once a week. Contrast this with the efficient hydraulic multi-unit machines of today. This is one area, however, in which the future seems unclear. True--we can expect refinements and innovations to continue as they have in the past, and there have been many, but the basic cutting unit consisting of a revolving reel and a bedknife has never changed. Although a minor defect, we still have a corrugated cut even on greens mowers.

I could continue with a like comparison of other areas of golf course maintenance, but those I have just mentioned are the major ones. The reason for mentioning them at all was to relate these things to the man we now call the Golf Course Superintendent. A basic premise upon which we should start in this regard is the part "pressure" plays in this relationship. The "head gardener" or "foreman" had very little, if any, pressure as we know it to contend with. His was a peaceful life. If the greens weren't mowed on Wednesday, then maybe Friday or Saturday would do. If the cups weren't changed last Saturday, he might get around to it next Saturday. In other words, his was sort of a "manana" way of life.

What do we have today? If the greens aren't mowed every day, except perhaps Monday, and the cups aren't changed almost daily including Saturday and Sunday, the Superintendent might just as well "start looking". The "pressure" of modern living has invaded the lives of present day Superintendents to a larger extent than most of us realize. It is possible that this pressure build-up has been accelerated by the vast expansion of the golf industry. Club members do a lot of traveling these days to other clubs near and far. They play the newest creations from the boards of the golf architects. They come home to their own clubs with new ideas and demand that many of them be used. This demand by golfers for finer golf courses and higher maintenance standards is placing heavy responsibilities on the shoulders of today's Superintendent. In fact, there have been cases where these pressures have been responsible for some Superintendents entering other lines of endeavor.

The term "head gardener" or "foreman" was gradually replaced by the term "greenkeeper". This came about, I think, because it was apparent that the former farmer turned "head gardener" had to have a little more on the ball to grow reasonably good grass. This was about the time that some recognition of the fact that it took special knowledge to grow grass on golf courses began to take a foothold with club officials. It was also about the time that such giants of the profession as John Morley and Joseph Valentine began to organize turf-interested people and to enlist the services of University faculties in an attempt to better understand the growing of turf.

John Morley, Youngstown, Ohio, C. C., Superintendent, just 40 years ago organized what is now the 2600 member Golf Course Superintendents Association of America. Joe Valentine, long-time Superintendent at the Merion Golf Club in Pennsylvania, is generally recognized as the man most responsible for developing the first turf research program in the U. S. at Pennsylvania State University. These men formed a nucleus of a small group of men who had the interest and the drive to launch the "greenkeeper" out of the abyss of forgotten men. For the most part, however, the typical greenkeeper was a humble man, one dedicated to his work, and one that was at the mercy of the vagaries of the weather. In most cases, he was seldom, if ever, seen in the club house, he had no voice in the general over-all planning of the golf course work, and was in many cases responsible to almost anyone or all of the club officials. Typical also with this man was the notion that if he was particularly successful in overcoming a problem he should keep his knowledge secret. He almost never visited his neighboring superintendent, and seldom, if ever, attended meetings of local groups attempting to organize themselves into an association. Since the greenkeeper had fewer problems associated with disease, weeds, insects, and relatively few demands from members, he felt little responsibility toward a public relations approach to his members. In a word, he was pretty much an "entrepreneur"--satisfied in his own little world.

But, of course, nothing remains stationary--times change--and so have the demands made upon the man in charge of a golf course. No longer can the "greenkeeper" remain in his small little world. Today, the man charged with the responsibility of building and/or maintaining a golf course must necessarily possess many talents and abilities unheard of by the former "greenkeeper". He is now known as a Golf Course Superintendent and rightly so. His responsibilities are manifold, and his qualifications are extensive. Over and above the basic requirements of being able to produce and maintain fine turf, he must understand in far greater depth than his predecessor the facts concerning soils, fertilizers, irrigation, drainage, insects, turf diseases, weeds, etc.

The present day Superintendent prepares regular reports and budgets. He attends meetings of the club officials, and his recommendations are received and considered. He is more conversant with his membership, and is encouraged to play golf regularly. In most cases he is very welcome in the clubhouse. No longer does he harbor trade secrets. He usually is more than happy to share the results of his procedures because he knows the value of the exchange of ideas. He has helped organize local groups of Superintendents, and attends their meetings when possible. More Superintendents are finding it possible to attend the National Conference at club expense. Some clubs insist that their Superintendent belong to these Associations and attend their educational conferences. They know that they are well repaid in a finer golf course. Today we find many golf clubs entrusting the care of their facilities to turf management school graduates only. Surely this is a far cry from the former "sharp farmer". But this only makes good business sense. With from a quarter of a million to 2 1/2 million dollars invested in perhaps 250 acres of grass, sound business thinking dictates that a qualified man with current scientific know-how is a necessity.

The modern Superintendent's headquarters is usually a fine, large, sturdily constructed building with a portion set aside for an enclosed, well-equipped office. Adequate washroom and meeting facilities for his employees are standard. A well equipped shop is absolutely necessary. The use of two-way radio equipment for better communications between the Superintendent and work projects is becoming common. Contrast this with the headquarters of the former greensman--it was usually called the "barn" or "shed". His "office" was an old beat-up table, and the washroom consisted of a "Chic Sale" and a water faucet attached to the shed.

So much for the past and the present in the life of the man in charge of a golf course. Now for the future! Of course, it is always hazardous to predict, but there are "signs on the wall". It seems apparent on the basis of what is now evident that the future Superintendent will, in most cases, be a university graduate. This will almost be a necessity in order to understand and evaluate the large flow of scientific knowledge that is being generated, even now, by various research agencies. As Paul Weiss, Sr., "the Pennsylvania Dutchman" of Lehigh C. C., Pa., in speaking to the 1966 Kansas City GCSAA Conference, referred to the academic entry into the program as "the time when the educated men whose courses showed they knew what, why, where, and when to do something, were separated from the hard-headed old-timers who were trying to keep secret what they didn't know".

The future Superintendent will necessarily assume more executive responsibilities, delegating the implementation of a maintenance program to his assistant. He will be obliged to take part in educational conferences on a broader scale. He will work more closely with research centers. He will develop an effective public relations program not only within his own club, but also at the community level, and the opportunities in this area will be mutually rewarding.

His headquarters will be refined and improved versions of present installations. Automatic irrigation with plant nutrient injection, will be controlled by moisture sensing devices, and possibly aided by computers. All of this will likely be centralized in the office of the Superintendent. He will be in complete and instant touch with all phases of irrigation, fertilization, fungus, and insect control materials. Experimental installations of this type are even now in existence. The use of radio equipment will be expanded as a means of communication between equipment operators and the Superintendent's office. Radio may also find a place in automatic irrigation control.

Of course, the new breed of Superintendent will be aided by improvements on present, and the development of new products, equipment, techniques, and varieties of turfgrasses. It seems that he will spend less time in actually growing grass than he will in areas not directly concerned, but certainly essential to the production of the final product, which is the finest possible turf upon which to play the game of golf.

He may be confronted with attempts to displace natural turf with the synthetic variety. All the more reason for his determining to produce turf so fine that "phony turf" will never be accepted.

His remuneration will be commensurate with the time and cost of preparing himself for the exercise of his profession.

Labor relations are likely to experience change. Indications are that labor unions will expand their activity to enlist golf course workers and we can expect that almost complete unionization will exist in all but deep rural areas. The cost of labor will most certainly rise, and this, combined with the expected increased cost of all materials used, will place even greater responsibility on the future Superintendent to exercise every care to get full value for all monies expended for goods and services.

This is my considered opinion of the future of the Golf Course Superintendent. And I would end this paper with a credit to Herb Graffis, Editor of GOLFDOM magazine, when, in paying tribute to the late Marshall Farnham, a Past President of the GCSAA, said, "the Golf Course Superintendent is one person who has combined the pursuit of happiness and the opportunity for conspicuous achievement for the delight of many".

Recent Advances in Controlling Winter Injury to Turgrass[1]

J. B. Lebeau[2]

INTRODUCTION

Winter damage is the most serious problem in turfgrass culture throughout the Canadian prairies. Even in the Pacific Northwest considerable damage to grass during the winter has been reported (9). This injury is due to some type of disease or physiological breakdown in the plant tissues caused by low temperatures, desiccation, ice sheeting, alternate freezing and thawing, or low-temperature fungi. All of these factors could contribute to the damage in one season but usually only one or two are involved. The turf disease caused by low-temperature pathogens is called snow mold. Snow mold is widespread throughout the temperate zone.

Fungicides that prove satisfactory in controlling snow mold in one geographical region are often ineffective in others, presumably due to differences in climate and the pathogens involved. For example, Meiners (9) reported effective control of snow mold on turfgrass in the Pacific Northwest with Cadminate but the same chemical was ineffective in Alberta (6).

The construction of new golf courses and the conversion of greens from sand to grass on established courses in Canada have greatly increased the culturing of grass species that are highly susceptible to winter injury. Consequently, there is a greater need for effective methods of grass culture designed to ensure greens of good quality in the early spring.

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[1] Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2] Canada Department of Agriculture, Lethbridge, Alberta.

SELECTION OF GRASS STRAINS

Turfgrass failures are often traced to the wrong selection of grass strains suitable for the location. Monocultures of grass in golf greens scarcely exist on the Canadian prairies. Most greens have been initiated with the colonial type of bentgrass. These soon undergo succession to annual bluegrass and various wild strains of creeping bent. All greens in Western Canada eventually contain mixtures of these three types with the predominant species being annual bluegrass. The more northerly the area, with severe winter conditions, the more rapid this succession occurs. Most golf course superintendents accept this succession as inevitable. I am still of the opinion that with proper management a monoculture of a suitable grass can be maintained in golf greens in Western Canada.

Grasses suitable for golf and bowling greens are more susceptible to damage from low temperatures and snow mold than grasses generally used for lawns or recreational grounds. Grasses that are resistant to cold injury and desiccation are also resistant to snow mold (8). None of the grasses suitable for bowling and golf greens survives the severe winters of the Canadian prairies uninjured, although some strains are more resistant than others to winter damage. Creeping bentgrass, for example, is more resistant to cold injury than annual bluegrass (2).

Tests at Edmonton and Lethbridge, Alberta, showed great variation among creeping bentgrass strains in winter survival. Strains tested were: Penncross, Northland, Henderson, Williams, Manitoba, Fogelvik, C115, Toronto, Congressional, Arlington, Metropolitan, Penn. Lu, Pa 10, and Washington. Annual bluegrass and the New Zealand form of Colonial bentgrass were included. Most of the creeping strains were more winter hardy than Colonial bentgrass and annual bluegrass. Damage during the winter was caused by snow mold and low temperatures.

Grasses suitable for golf greens on the Canadian prairies are chosen not only for winter hardiness but also for player acceptance and ease of management.

Several strains of creeping bentgrass are being tested in Alberta for golf geen culture. The most promising strains are: Northland, Waukanda, Toronto, Penncross, Congressional, and Cohansey.

Penncross and Northland have been tested in Alberta on modern golf courses. To date Northland has met all requirements better than Penncross. Northland has shown good resistance to cold injury and snow mold and persisted as a pure stand for three years in greens at the Willow Park Golf Club at Calgary, Alberta. The greens at Willow Park are under close observation for winter survival, resistance to invasion by annual bluegrass, and player acceptance.

Northland does not solve all problems involved in culture of greens for the prairie region. If managed properly, however, Northland is recommended for our northern climate; it is not suitable for warmer regions with humid summers. Northland is vigorous and must be thinned periodically, but this is not a difficult task with modern thinning equipment. It is easier to thin grass than to grow it, particularly when spring temperatures are below optimum for growth.

WINTER PROTECTION OF TURFGRASS

Snow cover is the natural protector of perennial plants from winter damage. Observations have indicated that about one foot of snow provides an ideal protective cover for turfgrass. Methods of trapping snow on golf greens with snow fences or brush can give disastrous results. If the snow drifts are too deep, water and ice form on the surface of the turf and may cause severe damage during the spring thaw. Severe damage often occurs to turfgrass when the winter snow cover is formed on unfrozen ground. This presumably provides ideal conditions for the development of snow mold pathogens.

Various methods for protecting turfgrass during the winter are in use in Canada and the United States. Grass is protected from snow mold by the application of inorganic mercury compounds once or twice in the fall. Greens are protected from desiccation and cold injury by covering with manure, peat moss, brush, or polyethylene.

Watson, et al. (10) made a major contribution to the protection of turf in winter with their work on polyethylene covers for turfgrass during the winter. Their techniques are being widely used in the Northern United States and in Canada to prevent winterkilling of golf greens. The cover prevents extreme drops in soil temperature and lessens cold injury and damage caused by snow mold and desiccation. In southern Alberta polyethylene covers increased the effectiveness of inorganic mercurial fungicides for control of snow mold; less than half the recommended rate was adequate to control the disease when the turf was covered with polyethylene sheets immediately after the treatment. The method of protection, however, has several disadvantages: the plastic covers are difficult to fasten securely to the ground in windy regions; the grass is not always protected; the cover cannot be removed safely in the spring until threats of damage by freezing are over; grass often grows rapidly under the cover but cannot be clipped; considerable labor and expense are required to supply and maintain covers each year; and, the turfgrass is not usuable during the long period of cover.

Treatment of turf with fungicides and the use of various types of soil-insulating material have reduced winterkilling. These techniques have many disadvantages and do not always produce the desired results. Soil warming below the surface appears to be a solution to this problem; the technique likely will be used on golf greens and football stadiums to bring turfgrass through the winter in a satisfactory condition.

SOIL WARMING

Soil warming equipment consists of two main parts, the means of supplying heat to, and distributing it over, the area in which the plants are located and the means of controlling the quantity of heat supplied (3).

Results from experiments conducted at Lethbridge, Alberta, since 1960, indicate that turf heating with electircal cables can ensure winter survival of non-hardy turfgrass. Snow mold and other causes of winterkilling were controlled by raising the temperature of the soil a few degrees during cold periods. Minimum temperatures at a one-inch depth in turf plots were maintained by thermostatically controlled soil-heating cables (7). Results indicate that consumption of electrical energy required to bring turfgrass through the winter in a healthy condition is in the economic range. Turfgrass held at minimum temperatures of 3 and 6^{o} C was severely damaged by excessive heat and power consumption was uneconomical; turfgrass held at minimum temperatures of 0 and -3^{o} C survived the winter in good condition and power consumption was economical.

The first practical test of turf heating in Canada was initiated in 1966 when electric cables were installed under a putting green at the Banff Springs Golf Course. The project is a joint venture of the Canada Agriculture Research Station at Lethbridge, Canadian Pacific Railway Company, Calgary Power Company, and Canadian General Electric Company.

The heated putting green encompasses about 5,100 sq. feet under the influence of soil warming. Lead sheathed General Electric heating cables were installed 10 inches below the soil surface. The plot was divided into three parts, A, B, C; each heating cable requiring 216 volts was 108 feet long and the power requirement was 7 watts per lineal foot of cable.

Plot A was 1,500 sq. feet, and had 21 heaters placed 8 inches apart. Thus plot A required 5.55 watts per sq. foot. The power was controlled by a Honeywell thermoregulator, which actuated a General Electric 3-phase 60-amp magnetic switch.

Plot B was 1,900 sq. feet and also had 21 heaters but they were placed 10 inches apart. This plot thus required 4.49 watts per sq. foot. The power was controlled by the same kinds of regulator and switching unit as plot A.

Plot C was 1,700 sq. feet and utilized 16 heaters, which were placed 12 inches apart. This plot required 3.79 watts per square foot. The power was controlled by similar regulator and switch units used for A and B.

Before covering plot B, a 6-inch mesh steel grid 10 feet by 10 feet was placed in the corner of the plot, 1 inch above the heating cable. This was installed to test the effect of the steel grid on the dispersion of heat.

Temperatures were determined by thermocouples from 15 positions at a 1-inch depth and recorded by a Honeywell single position recorder with a 15-position selector switch. The thermocouples were placed in the center of plots A, B, and C between the cables and over the cable in C. Readings were taken from: an unheated area, above the steel grid in B, at a bend in the heater, and at 6, 8, 10, and 12 inches out into unheated area. A similar set of readings were taken away from the influence of the steel grid, that is, from above a bend in the cable and out over the unheated area at 6, 8, 10, and 12 inches. These two sets of temperature records should make it possible to determine the lapse rate away from and above the cables and also find out if a steel grid aids in a more even distribution of heat.

Data on power consumption and soil temperatures under the various conditions should be available in 1968.

DISCUSSION

For optimal growth, all growth factors must be optimal; the most important factor at any one time is the one which is sub-optimal. This acts as a brake on the rate of growth, and in some circumstances, soil temperature can be that brake (3). Soil temperature is often the sub-optimal factor for growth of turfgrass in the early spring. Soil warming of turfgrass is proposed in Canada mainly for prevention of winterkilling and the promotion of growth in the early spring.

Soil heating is used in turfgrass culture in the United Kingdom, United States, and Sweden (1, 4, 5). It provides year-round frost-free turf in some regions, rejuvenates heavily used areas of grass, and stimulates growth from new sod or seedlings. Green color is retained in late fall and early spring. In Western Canada this technique will ensure turf survival following a severe winter, will prevent ice sheeting, and will promote rapid growth during cool spring weather.

Electrical heating of golf greens is still in the experimental stage of development. Cost of installation and operation of equipment will limit its use at present to high-budget golf courses. On the Canadian prairies, winter survival of golf and bowling greens can be improved by introducing a winter-hardy grass in greens with a proper soil base, treating for snow mold in the fall at the recommended rate with an inorganic mercurial fungicide and by determining the best techniques for protection of each green.

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We Are Going To Be Challenged[1]

W. H. Bengeyfield[2]

At a time when golf is booming across the land, good jobs available and the outlook for golf course superintendents apparently rosy, it seems unlikely that a note of discord will stir much attention. But this is a note of discord; intended to be provocative, not offensive, to stimulate, not tear down.

Every profession, every business, every individual

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[1]Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2]Western Director, USGA, Green Section, Garden Grove, California.

at one time or another will experience a very real challenge and undergo a new testing of mettle. Today the golf course superintendent's profession may well be entering just such a test period. On the horizon, danger signals are beginning to show that stormy waters lie ahead.

> "Blessed are they who expect nothing; for they shall not be disappointed."

Our testing will come from four sources. Both challenges the individual superintendent's total skill and ability. Whether the challenge will be successful in destroying our profession will depend entirely on how well you--as an individual--handle your professional duties.

The First Threat

The first threat lies in the recent development of synthetic turf. Without going into detail, be assured that the synthetic turf industry is in its infancy and has a long life expectancy. There are at least 12 companies now in the field. The "Astro Turfs" of today are only the forerunners, the Model T's if you will, of what will come from tomorrow's test tubes.

To be sure, the young industry still has many problems to solve (for some, there may be no solution) before synthetic turf will have any chance of golf acceptance. But work is already underway and a chemist is a person not easily discouraged. Synthetic turf is now in use on baseball fields, tennis courts, playgrounds, and football fields. What new areas lie ahead?

The Second

> "We get just what we deserve", is one of the most difficult of life's lessons to learn. And it is one most people never learn."

The second threat to our tranquillity is "Contract Maintenance". In large, densely populated areas with many golf courses close by, consideration has already been given to consolidation of operations between clubs. You and I know it will never work! There are just too many variables involved to be handled by "remote control". But we'll never convince that Visionary on the Board of Directors who is "sold" on the idea. Besides, someone is bound to remember what they said about Robert Fulton. He was a visonary, too.

Contract Maintenance although it has many serious drawbacks, does have some advantages that will be explored in the future. We are going to be tested.

The Third

Then there is the threat from an evergrowing army of "Super Salesmen" and "Super Consultants". This type has always been around, but never it seems in such large numbers. Reference is not made here to nationally known and recognized turfgrass authorities. Rather, it is the fellow who was a shoe salesman last year and is suddenly a 'turf expert' this year. When will we learn there are no cure-alls, no magic formulas, no elixirs that will solve our problems overnight? There is only hard work and diligent application.

Unfortunately, the Super Salesmen prey largely on the naive, the newcomer and the young who will accept almost anyone's word. How much better off he would be if, rather than take the saleman's advice, he would consult with the 'old timers' in his area, seek out their help and counsel. It would be a refreshingly professional attitude!

It is also unfortunate but true, the mistakes the new man makes (whether he is qualified or not) reflects on the entire profession. It is especially grueling if he also happens to be a Class A or Class B member of a local Association.

The "Super Consultant" is a similar threat and he can bring devastation to any turf management program. He appears in many guises but usually with firm opinions on all phases of turfgrass culture. Sometimes his 'experience' can be misleading. For example, there are golf course architects and professionals who might fit the classification of "Super Consultants". Advise is given on agronomic and irrigation matters with great authority and yet, when critically viewed, an obvious lack of understanding of basic turfgrass requirements is evident. Indeed, the "Super Consultant" grows in numbers and threatens good management practices.

The Fourth -- and Greatest

> "Staying where we are and liking it is the essence of complacency. We do nothing as long as this is not disturbed."

Finally, we come to the last and greatest threat of all: our own acceptance of mediocrity within the professional turf growers ranks! If the golf course superintendent is to be recognized as a professional man, and he has every reason to be, much greater stress must be placed on QUALITY within the ranks--not QUANTITY alone.

More than ever before, golf needs good turf and this means men in the grass growing profession who are willing to do an 'all out' job for golf. All too often in recent years, the term 'prima donna' has been applied to some golf course superintendents. Club Presidents and other officials, men who have been extremely successful in their own fields of endeavor, are usually quick to spot any lack of enthusiasm or desire, any lack of growth potential in those with whom they come in close contact. Once again, we are being tested. As for the person so challenged, he would be wise to re-examine his thinking and not resent or resist new ideas for their sake alone.

What about turfgrass professionalism? What really are we talking about? Above all else, the professional turfgrass manager should take his job seriously--not himself. He must have his course in the very best of condition at all times. He's in love with it! He talks success. He has plans for correcting shortcomings. He is ready for emergencies. This is the way to impress the world of golf. A coat and tie has its place; but it's not necessarily on the golf course. It does not guarantee any degree of professionalism there.

There is a great opportunity ahead for the establishment of ever higher standards and professional requirements by the GCSAA. Strict enforcement of these requirements can only lead to greater recognition and appreciation of the golf course superintendent. He is going to be tested but he need have no fear of the future if he refuses to accept mediocrity today. Second best is no longer good enough for any golf course.

The rewards are great, not only in a monetary way but, more importantly, in personal achievement and satisfaction as well. Be a professional turfgrass manager. Golf needs you. Now!

Developing New Parks and Recreation Areas[1]

Paul Beistel[2]

Park development in the United States has been completely revolutionized in the last five years. Recent developments which have changed the whole picture can be enumerated as follows:

A. Market Research

1. Psychological analysis of recreation experience.

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[1] Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2] Lane County Park Supt., Eugene, Oregon.

2. Sociological studies of recreation behavior.

   a. Distribution in Private, Commercial and Governmental domains.

   b. Quantitative analysis of recreation demand and need.

B. Resource Planning

   1. Nationwide and river basin planning.

   2. Statewide comprehensive planning.

   3. Local comprehensive planning.

   4. Resource unit planning.

   5. Park site planning and design.

C. Local Government Assistance Programs

   1. Land exchange, lease and grant programs.

   2. Financial assistance.

      a. Acquisition

      b. Development

The net result of these developments is that park land acquisition and development operations have become fantastically complex. Let me cite a few examples.

McKenzie Hatchery Tract - 46 acres, offered for sale by State Game Commission for $75,000.

A. Sale of surplus timber	$10,000
B. Price reduction for restricted deed	10,000
C. Contribution by electric utility	25,000

D. Contribution by Lane County 30,000

$75,000

Dorris Tract - 230 acres @ $2,500/A. = $575,000

A. Reduction for commemoration of owner's name, $115,000

Reduction for income tax write off, $60,000

B. Purchase of property by non-profit corporation for $400,000 and immediate liquidation of saleable assets:

1. Timber - 25,000

2. Gravel - 20,000

3. 5-year orchard crop contract - 25,000

C. Exchange with abutting property owner to block up river frontage and to dispose of good subdivision land overlooking park.

D. County apply for federal Open Space grant of $115,000 and state Willamette Greenway grant of $57,500.

E. Purchase tract from non-profit corporation by County for additional $57,500.

Fir Butte Park - 18-hole golf course and recreation complex on Fern Ridge Reservoir.

A. Owner of 175 acres of good subdivision land abutting large government ownership on shore of reservoir is willing to donate 60 acres of his land to County if they will build a recreation complex on donated land.

B. County leases an additional 110 acres from Corps of Engineers.

C. County sublets both tracts to private golf course developer and operator on long term lease.

D. Soil Conservation Service works with golf course architect on technical aspects of course design and carries out land improvement project.

E. Developer completes course construction

Orchard Point Park - 40 acres under lease from Corps of Engineers.

A. Minimum basic facility contracts of Corps of Engineers		$212,000
B. Lane County general fund		
1. Miscellaneous non-tax income	$131,000	
2. Property tax funds	24,500	155,500
C. Grant funds		
1. State (boat license and boat gas tax funds)	55,000	
2. Federal (park entrance fees and boat gas tax)	33,500	88,500
Total development costs		$456,000

Comments no Park Planning and Construction[1]

John Sandusky[2]

THINK BIG - remember the population in the west will double in the next ten years. Little patches of green grass when surrounded by high rise apartments will be as precious and as beautiful as emeralds. We are dedicated people trying to help the present and future generations keep their sanity through the preservation and development of peaceful, restful park areas. With the mental institutions bulging past capacity, anything of permanent and natural beauty should be given our support necessary to develop these oasis in the modern desert of smoke, dust, odors, noise, traffic, confusion, turmoil, and modern pressures.

Europe, Canada and the United States are finding that almost the entire population increase is being added in the urban areas. Existing cities grow rapidly, and new towns spring up within the larger metropolitan areas.

Some of the larger cities are planning complete reconstruction of entire areas with substantial Federal government financial aid. These plans include precious hints of beauty in the form of pin point areas of complete landscaping. Most of the la rger areas are excluding traffic, with ring roads encircling the central business districts because the traffic volume rate at peak hours in the urban areas is increasing at a rate 2 to 3 times faster than the population increase.

In the past, urban freeways and arteries have been planned and designed to use a minimum right-of-way to reduce displacement of people and businesses. In some urban situations the cost of acquiring whole

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[1] Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2] Park Engineer, Seattle Parks Department, Seattle, Washington.

blocks or squares of property would be comparable to, and only slightly higher than the cost of acquiring only the right-of-way, plus severance damages. Thus a city can acquire entire blocks along the route of a proposed arterial or freeway, sell the road agency the actual space needed for the road, and have valuable land available for other developments at a fraction of the cost of acquiring it separately. This land can be used for parks and recreational areas. If the cost and area is too large, planned high rise apartments, office buildings and parking structures on the surplus property can pay the way for parks and recreation.

I attended a Park & Recreation Conference at Banff, and found to my delight that there were some areas where the parks had more land than people. This is quite a contrast to Seattle, where a lot of our playfields and tennis courts are lighted and used all night by the people working for three-shift employers, and where there is a shortage of all facilities. This is nothing to be concerned about as long as we own sufficient property for future development.

As in all large cities, the cost of real estate has tripled in the past 10 years, as we witnessed recently regarding a boat ramp location. It behooves all of us that are concerned with acquisition and planning to get lined up with all the government agencies that can help finance new property and get all the area we can while the choice sites are available in large, undeveloped plots while they are rural and unplatted.

Think big, plan for the future, have a goal and keep it. When one approach fails, look for another--but keep going.

I can see there are some doers here who have had enough of the planning and dreaming and would like to get down to the actual work. You who work with nature and equipment, rather than people, are the lucky ones. Most of my experience has been in construction and it was always very rewarding--so let's change the pace and get into construction.

Nature, if left alone, requires little help as most things are in a state of equilibrium, but when man interferes, makes a cut or fill and is not content with the natural angles of repose of materials, he must work with nature to accomplish what he wants. The original selection of a site is very important as the final development must be kept in mind, or the cheaper site may be the most expensive when completed. Erosion is caused by gravity, surface and ground water, wind, sun and man.

Let's start with drainage because it is the largest single factor causing failures in all types of stabilization. The rain water starts as surface water and what is not picked up in drains of some form, enters into the ground and becomes ground water. Slopes as flat as 2% (2' fall/100') will carry water away, but if there are holes and cracks the surface water immediately becomes ground water. There are many ways to handle the water--slopes and ditches leading into natural bodies of water is the simplest, but usually some device must be used--to name a few: slopes, ditches, flumes, French drains, (be sure the bottom is sloped like and towards a storm drain) conduits of wood, concrete, transite, clay, cast iron, and galvanized steel and agricultural drains (straight lengths butted together and the joints covered with tar paper or plastic, bedded in and covered with a granular material (sand and/or gravel)). There is also an open graded concrete porous T & G tile that is very good for picking up and conducting the water. The product is called POROSWALL. Open joint bell and spigot comes in longer sections and is more for conducting the water than picking it up from the ditch but can serve a dual purpose very well. If this bell & spigot pipe will not pick up enough water, a perforated bell & spigot pipe can be used. On main lines bell & spigot pipe is the best for conducting water. Cement mortar joints can be used, but unless conscientious men make the joints, they look good on top but leak on the bottom, and if not swabbed inside while the mortar is soft, have rough joints and plug easily. Earthquakes may crack the joints and cause excessive leakage, making easy access for roots to enter. The rubber "0" ring has been found very satisfactory, easy to install, making flexible lines with water and almost root-tight joints. If clay and concrete tile both have the same freight advantage, the prices are very competitive (often exactly the same). In Seattle, clay tile in the small diameters is available in longer and shorter length than concrete, and can be handled with ease because the material is lighter. If the soil, sewage, or water is very corrosive, the clay tile will stand up best, but it is brittle and hard to cut and nibble, and is subject to abrasion if not glazed. A clay tile by INTERPACE called "Speed Seal" has the most root proof joints I know of, both male and female gaskets are formed in mandrels, making these plastic gaskets very accurate. Corrugated steel pipe is very good for temporary drainage, with flexible joints, long lengths, lightweight, strong and will bend. If it is to be permanent, use galvanized pipe with asphalt linings. Concrete pipe is usually more available, easier to cut and nibble; being heavier it is not so likely to float in a ditch before it is backfilled. (Be sure to backfill, or fill any line or tank, or it will float if the ditch fills with water.) Transite and plastic are light, in long lengths, resists most acids, and flow characteristics remain almost constant over long periods of time. Structurally, they are both brittle and weak. Cast iron is stronger and can be obtained with mechanical, or ball & socket joints, used vertically, for outfalls, and under shallow fills subjected to traffic. Tip on bell & spigot, if a manufacturing plant is convenient, damaged bell or spigot pipe that cannot be used for sewers can be picked up at a savings and used as drain tile with tar paper covers at the open joints. If clay tile roofing is being manufactured locally, rejects are perfect to cover 6" Ag. tile. Root control can be aided in tight lines with "0" ring rubber or plastic joints. A copper screen wrapped around tile joints before the tar paper is applied, or old copper wire laid on top of the line before it is backfilled helps retard root growth. If cement mortar joints are used, be sure the joints are swabbed as each length is laid while the mortar is still soft, to make it easier on the roto-rooter and prevent plugged lines.

Drain to a natural body of water, stream, lake, tidal water, or underground natural drainage, a storm sewer, or possibly use for irrigation, or a man-made pool, stream, or lake.

Permit me to digress for a second in the hope of saving someone trouble with his septic tank drain field which is the reverse of our drainage systems. The water is now fed from the main into the distribution lines - be sure to place a dam of clay or impervious material around the main and just below each distribution box, so the water that runs out of the branch lines will not enter the gravel and follow the main rather than continue down the branch lines.

I mentioned the natural angle of repose - it is the slope a material will assume if left alone and this varies from almost 0 in the case of clay that has been disturbed or had additional water incorporated. What takes place in clay when it is disturbed is that the microscopic specks of aluminum silicate surrounded by spheres of water are rearranged and the water runs together forming large spheres of water with a very small surface tension to resist any kind of external pressure. A classic example is when a wood pile is driven in clay it sometimes floats back up in the hole. When this rearrangement of water spheres occurs, clay that stood with vertical sides lays almost flat. Therefore, to get an angle of repose from a table in a handbook is only an approximation and all soils should be checked in the field under the actual conditions to be encountered before any type of stabilization is started. Your respective highway departments may be of great assistance to you in obtaining these angles of repose.

Slopes can be made quite resistant to erosion by compacting the original material. This can be most readily accomplished when the material contains the optimum moisture of 15% in compacted material and 20% in loose material, percentage of water be weight compared to the dry weight of the soil placed in the fill. By placing the material in the fill in thin layers, 6" thick gave 120#/cu. ft., and 24" layers gave 105#/cu. ft. with the same compaction treatment. With 6" lifts of graded sand and gravel we obtained almost as good compaction with the small, hand operated vibratory pans as with the large cat drawn vibratory rollers.

The surface of slopes can be protected in a number of ways; covering with sand, gravel, crushed rock, or rip-rap. Where quarry rip-rap is available, it is a good material as it can be placed with clam shell buckets for the small rock and grapples on the larger rock, with large equipment and very little hand labor.

For sea walls, groins, jetties and bank protection, rip-rap is a very good material as it continues to fit the base during settlement and erosion and usually gives some indication of failure before it happens. Repairs can easily be made and on normal installations amounts to approximately 1% of the original tonnage per year on well-built structures. These repairs will not look like a patch job, but will blend into the original installation very nicely. If at any time it is ever necessary to remove the rip-rap you will find it has value, while concrete structures are a liability.

Before we leave the subject of sea walls and structures connected with bodies of water, let me bring to your attention the fact that the further any wall goes out into the water the more expensive it is to build and the maintenance required is a never-ending expense. Therefore, if possible, build retaining walls NOT sea walls.

To get back to the flatter slopes and other methods of holding banks, there are new methods and materials coming out all the time. To mention a few: soil, cement made with cement incorporated with existing soils, paper waste liquors, shot concrete, sprayed asphalt, fiber glass mats, and mats sprayed with asphalt. The latter is often used under bridges where plant material does not thrive. The establishing of seeded slopes requires some help to keep the bank from eroding and scouring before the root system can take over. These seeded areas can be dry mulched with straw, hay, or wood fibers. These materials can all be handled mechanically with power blowers and help materially in establishing root systems, and to protect the banks. The addition of asphalt emulsion jets into the stream of straw or hay helps to hold the mulch on the slopes and protects them to a further extent from the rain, wind and sun, and still the grass will grow through. Jute mats consisting of 3/16" diameter ropes on 1" centers can be stapled down over the seeded areas. The new product is dyed green and is fire resistant. The same fiber glass mats that can be sprayed with asphalt can also be used to cover the new seed if the ends and edges are dug into the bank 6" to 10" deep. This helps to hold them in place and is also recommended for the jute mats. Excelsior mounted on cotton mesh can also give some help. Besides being expensive, all these materials require workmen to walk over the slopes, often disfiguring them, and taking time.

One of the latest, and in my opinion, the fastest and most economical way to establish a root system to protect the slopes with grass is the hydro seeder--a large tank in which the seed, fertilizer and mulch are all mixed together and sprayed on the slope.

The following is my feelings regarding the comparison of TURFIBER as manufactured by International Paper Co. of Mobile, Alabama @ $120/ton at Seattle and SILVA-CEL #105 as manufactured by Weyerhaeuser @ $90/ton in car load lots at Snoqualmie Falls:

Turfiber is cellulose as in paper pulp and dyed green.

Silva-Cel is bundles of wood fibers--very fine and natural colored.

The Turfiber mixes up smoother and could be used better in improvised pumping equipment, but would not make quite as strong a mat when placed. Once in place, both give excellent results.

If slopes cannot be used, and the expense of a retaining wall is justified, literally hundreds of designs and materials can be used. If the materials have to be purchased for its construction, it is well to obtain the design from a qualified Structural Engineer. Here again, your Highway Departments can be of great help to you. (Some retaining walls designed for the Freeway through Seattle cost $1,000 per foot). Retaining wall design is a study in itself, so I will just touch the subject and say have sufficient bearing area, good drainage so the wall doesn't become a dam, and build it with a batter.

If fills are to be made, prepare the cavity as carefully as a dentist does a tooth before he starts his fill. If the fill is to carry a structure, or settlement is undesirable, clear the cavity of all vegetation and rough grade the humps into the hollows so the fill will be more uniform. If mechanical drainage is to be used, install in ditches. If natural drainage is desired and the original ground expected to accept the drainage from the fill, then the original ground must be combined with the new fill material. A good tool for this is one used for rototilling old asphalt surfaces. We use the same rototiller for mixing topsoil and sand with the fill, or original ground, before seeding to establish drainage.

THEY WILL NOT DRAIN IF NOT MIXED.

The selection of the fill material is a matter of economics. I have used a blue clay backfill, which was fine graded, at right angles, and then diagonally to very close tolerances. Incidentally, your asphalt or paving companies will have a man and a machine that can make this clay as smooth and water conducting as a roof. It has worked on slopes of 2%, where the bottoms of the sprinkler system ditches were graded as carefully as a sewer line and backfilled with gravel and connected to a storm drain.

Before the fill starts the fill material should be checked for its water content and provisions made to bring it to its optimum moisture, 15% in compacted and 20% in loose material. When the crew is assembled for the job it is well to explain to them just what you want, and how you are relying on their cooperation to get it done, and then to answer all their questions.

The thinner the lifts the better, and let the vehicles drive over a different track every load, usually with one set of wheels in the center of the last load. Keep the fill so smooth that equipment can dump on the fly and avoid stopping and backing as much as possible. If there is a slope to be built, stake it the first thing and be sure to get it started correctly. Dump and compact it as you go up. If you follow these rules it will be solid and finished with the fill and ready for any treatment it is to get. I, personally, prefer vibratory or rubber tire compaction and a loaded dump truck makes a very good roller. If granular fill material can be dumped into water, sluiced or dredged into place, this will make a very good fill when it dries out. However, don't set your spillways too high, or the fines you retain may take a year or two to dry out.

Just a few suggestions on simple structures.

I like to pour the footings and floor slabs monolithic, then the floor helps float the building. If there is poor bearing, a trench can be dug in the floor area and connected to the floatings to form beams as large and as close as required. They should be cleaned out by hand just ahead of the pour.

Due to vandalism we prefer concrete walls of some kind; precast, tilt up, or poured in place with some form of texturing. The Art Commission does not agree with our way of thinking, so many of our buildings have brick walls.

We use post tensioned concrete roofs which require no roofing, and are vandal and maintenance proof.

In our new comfort stations we have used "prision" type fixtures for the past four years and have escaped excessive vandalism.

Try to keep your buildings strong, simple, easy to clean, and of a material you can cover obscenities with spray paint.

I wish you luck.

New Concepts in Turfgrass Fertilizers[1]

J. D. Beaton [2]

Before discussing new concepts in fertilizers, it is desirable to quickly review several of the important changes that have occurred and are continuing to take place in the fertilizer industry.

1. Granulation

One of the major advances in the solid mixed fertilizer field in recent years has been widespread adoption of granulation. Granulation of mixed fertilizers started in the mid-1930's. The practice gained rapidly in Europe and indications are that over 90 percent of the fertilizers used are now granulated. Starting about 1950, granulation began to increase rapidly in the United States. More than half of that

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[1] Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2] Senior Agronomist, Technical Research Center, Cominco Ltd., Trail, B. C. Canada.

country's mixed fertilizers are now granulated. By 1970, 80 percent of solid mixed fertilizer consumed in the U.S. will be granular. Cominco Ltd. began production of granular ammonium phosphate at Trail, B.C. in the mid-1930's.

The main advantages to granulation are (a) improved physical condition of product, (b) granulation helps prevent caking, (c) aids in prevention of segregation of ingredients, (d) reduces dustiness, and (e) permits more uniform spreading.

There seems to be no direct agronomic advantage from granulation other than evenness of distribution, except in grades containing high water-soluble phosphorus where larger particle sizes reduce the amount of reaction with soil and thus favour crop response.

Widespread experience indicates that once customers have used granular fertilizers, they will no longer accept the nongranular.

2. Higher Analysis Fertilizers

One of the most important advances in the field of fertilizers, both in the United States and worldwide, has been higher analysis fertilizers. Higher analysis materials and mixtures everywhere have been on the increase. This trend will probably accelerate for three important reasons. First, a major portion of the cost of fertilizers to customers, about 40 percent, is associated with the cost of shipping, handling, storage and bagging. Strenuous competition for markets assures that various members of the industry will take advantage of any savings possible in high-analysis materials. Second, as developing countries become more sophisticated in fertilizer use they will demand high-analysis fertilizers in order to counter their poor transport and storage systems, lack of port facilities and need for ocean shipment. Third, we have the necessary high analysis products already well established which will permit average nutrient contents to approach 50 percent. A number of new high-analysis products already appearing on the market or under development will further spur the concentration trend.

The following analysis will illustrate the consistent increase in nutrient content:

United States		United Kingdom	
Year	total content of N, P_2O_5 and K_2O	Year	total content of N, P_2O_5 and K_2O
1929-1930	18 %		
1949-1950	23.2 %	1957-1958	31.1 %
1962-1963	34.3 %	1962-1963	35.9 %
1965-1966	>40 % in certain states*		

*technology is available to increase this to 50 percent.

The improvements responsible for these upward trends are (a) high analysis synthetic nitrogen materials, along with ammoniation, have replaced low-analysis natural organics, (b) normal superphosphate (19-20% P_2O_5) has been replaced in part by triple superphosphate (45-46% P_2O_5) and the ammonium phosphates, and (c) low-analysis kainite ($KCl.MgSO_4.3H_2O$ containing 14.4-20.4% K_2O) and manure salts (KCl and NaCl mixture containing about 24% K_2O) are being replaced by refined high analysis KCl (60-62% K_2O) and K_2SO_4 (50-53% K_2O).

3. Liquid Fertilizers

The actual beginnings of the use of liquid fertilizers is very old and apparently antedates large-scale use of solid fertilizers. In 1842, Sir James Murray mentioned the new practice of supplying fertilizers in dry form; the earlier products (pre-1841) were liquids sold in 30-gallon casks. Until about 20 years ago, liquid fertilizers were an insignificant part of the fertilizer industry. The decade 1940-1950 appears to be the beginning period of modern liquid fertilizer development. During this decade, direct application of anhydrous ammonia attained some consequence as did nitrogen solutions. Production of liquid mixed fertilizers became significant, beginning in the Pacific coastal areas of the United States.

Use of liquid fertilizers either as direct application materials or as liquid mixtures has steadily increased during the past 20 years. The nitrogen liquids; including anhydrous ammonia, low pressure and non-pressure solutions have forged ahead so rapidly that they now account for 64 percent of the nitrogen used for direct application. In 1947 they supplied 8 percent of the nitrogen used and by 1962 they supplied 56 percent of the nitrogen consumed.

Mixtures applied in liquid form during the 1964-1965 fertilizer year in the United States totaled 5.7 percent of the total consumption of mixtures during the year. Consumption of liquids is expected to reach about 10 percent of all mixed fertilizers used by the end of 1975. In the period 1964-1965 in California liquid mixtures represented 35.7 percent of the total mixed fertilizer consumed. Second ranked Illinois applied 26.0 percent of the mixtures as liquid. The average analysis of liquid mixtures in 1964-65 was 8.12 percent nitrogen, 15.18 percent P_2O_5 and 5.71 percent K_2O with an average total of 29 percent primary plant nutrients.

Consumption of all forms of liquid fertilizer in the fertilizer year 1964-65 was 18 percent of all the fertilizers consumed in the U.S.

Some of the reasons for this growth in consumption of liquid fertilizers are (a) economical sources of plant nutrients, (b) easy to handle and apply, resulting in increased efficiency in use of both labour and machinery, (c) with the exception of anhydrous ammonia are adaptable to blending with pesticides, herbicides and micronutrient fertilizers, and (d) may be evenly and accurately applied with a precision heretofore unknown.

4. Fertilizer Marketing and Distribution

Bulk blends or mixed fertilizers consisting of a mechanical mixture of granular fertilizer materials have enjoyed a phenomenal growth in the United States in the past few years. An indication of this growth is shown in the material presented below. It has been estimated that bulk-blended fertilizers will account for 30 to 40 percent of the total fertilizer market by 1975.

Fiscal Year[a]	Bulk Fertilizers Mixtures and Materials (Thousand Tons)	Number of Bulk Blend Plants	Liquid Fertilizer Mixtures (Thousand Tons)	Number of Liquid Mix Plants
1954	1,830	N.A.	28	N.A.
1955	N.A.	N.A.	N.A.	N.A.
1956	N.A.	N.A.	N.A.	111
1957	N.A.	N.A.	245	196
1958	N.A.	N.A.	N.A.	260
1959	2,742	201	464	335
1960	3,309	441	N.A.	390
1961	3,847	736	587	538
1962	N.A.	908	N.A.	556
1963	5,563	1,326	796	617
1964	N.A.	1,536	872	717
1965	N.A.	2,551	N.A.	N.A.

a. Plant numbers on calendar year basis.

Bulk blending is generally a small operation of 1,000 to 4,000 tons annually, located in a consuming area within about a 25-mile radius of the plant. The prime producer usually sells materials directly to the blender. The blended fertilizer, in contrast to conventional dry mixes, is seldom stored in bulk at the blending plant but moves directly to the customers, usually in the blender's own spreading trucks. Storage, production, transportation and spreading are all cheaper than for conventional dry-mixed fertilizers. Low capital investment, high analysis, and flexibility of nutrient ratios which can be compounded to meet the customer's exact needs are major advantages.

Among reasons for the rapid growth of bulk blending, is that bulk blenders are offering services that are wanted and required by their customers, services beyond those available from most merchants of compound fertilizers. Probably the most important single service is bulk spreading which relieves the customer of an onerous job. Other important services are soil testing, farm management and consultation, spreader hiring and bulk delivery.

The materials most commonly used for bulk blending are ammonium nitrate, ammonium sulphate, triple superphosphate, diammonium phosphate (18-46-0 or 16-48-0), and potassium chloride. Less commonly used materials include urea, ammonium phosphate nitrate (30-10-0), monoammonium phosphate (11-48-0), ammonium phosphate sulphate (16-20-0) and ordinary superphosphate.

An innovation of bulk blending aimed at accomplishing similar objectives is the three-hopper truck spreader. Separate compartments are provided for nitrogen, phosphorus and potassium fertilizers, some trucks being equipped with a tank for liquid rather than solid nitrogen. All materials are applied simultaneously at desired rates. Fertilizer dealers provide the straight materials and usually provide custom spreading with their own spreader trucks.

Another change, closely related to bulk blending, is the trend toward handling most fertilizers in bulk rather than in bags. Purchase in bags now accounts for about 85% of all fertilizer delivered on the Canadian Prairies. Until recently it wasn't available in any other form. Purchase in bulk and application in bulk offer certain advantages that will decrease the percentage purchased in bags. As equipment and facilities for handling bulk fertilizers become more available, handling in this form will probably increase to at least 60-70 percent of all the fertilizer used on the Prairies.

The advantages of bag over bulk handling are (a) easier to store since special structures not required and it can be placed in common storage with other materials, (b) better suited to small tonnages and mixed shipments, (c) doesn't require special handling equipment, (d) no physical breakdown during augering, (e) less segregation in blends, (f) no corrosion of handling equipment used for handling other materials, (g) bags provide an accurate measure of fertilizer applied, and (h) less difficulty in breaking up lumps if fertilizer sets up in storage.

Bulk handling has a number of advantages over bags and these are (a) less expensive - approximately $5.00 per ton saved by avoiding costs of fertilizer bags, bagging and freight on bags (about 20 lb of paper in one ton of bagged fertilizer), (b) less manual handling and more machine handling, (c) more rapid handling, (d) better suited to meeting specific needs of soils based on soil tests, and (e) no bags to dispose of.

With the foregoing background information on important trends in the fertilizer industry, we are in a better position to consider new concepts in fertilizers. My discussion of this subject has been organized into the following topics: (1) high analysis and new forms of fertilizer, (2) new sulphur fertilizers, (3) micro-nutrient fertilizers, (4) more effective fertilizers, (5) combination of fertilizers with other crop management chemicals, such as herbicides and insecticides, and (6) more convenient methods of fertilizer application.

1. Higher Analysis and New Forms of Fertilizer

The fertilizer industry is constantly searching for new high-analysis fertilizer materials. Inert materials or fillers have already been eliminated and good progress has been made in eliminating by-product compounds such as gypsum from fertilizers. The challenge now is to select compounds high in the plant nutrients and low in oxygen. Many of these compounds in themselves are not usable directly by plants but must undergo chemical and biological transformations in the soil before their nutrients are available.

Several new products, containing more plant nutrients than the present fertilizers, show promise of becoming mainstays in the fertilizer industry.

Superphosphoric acid is the foremost of these new materials. It is made by either concentrating wet process acid to 68-72 percent or electric furnace phosphoric acid to 75-79 percent. Superphosphoric acid can be used to manufacture a number of new fertilizers including (a) granular ammonium polyphosphate with nitrogen levels between 10-16 percent and phosphorus concentrations ranging from 58-61 percent, (b) granular superphosphate containing 54 percent P_2O_5, (c) higher analysis liquid fertilizers with analyses of 11-37-0 or 10-34-0 instead of 8-24-0 produced from wet process acid, and (d) micronutrients can be carried in superphosphoric acid because of its sequestering properties.

Potassium metaphosphate is being investigated in Scotland and Israel and by TVA in the United States. It is a high-analysis material containing up to 60 percent P_2O_5 and 40 percent K_2O. The advantages which can be gained from the use of this fertilizer include its lack of phytotoxicity, non-burning characteristics, and non-retardation of germination. Moreover, the material is non-hygroscopic and is free from settling problems.

Urea containing 45-46 percent nitrogen is the highest analysis solid nitrogen fertilizer now available. It can be expected to replace ammonium nitrate and other lower analysis products, since distribution and handling costs are a major part of the total cost of fertilizers. In addition, cost of production of urea may be less than for ammonium nitrate.

Urea-ammonium phosphate is another multinutrient fertilizer material that may contribute toward high analysis. In addition to the high nutrient content of this fertilizer, certain process improvements reduce manufacturing costs and allow urea and diammonium phosphate to be combined into one homogeneous product. A variety of high-analysis grades can be made such as 35-18-0, 25-35-0, 29-29-0, 38-13-0, 25-15-15, and 16-22-22.

Potassium nitrate is another relatively new high analysis fertilizer containing 13 percent N and 44 percent K_2O. The nitrate form of nitrogen produces a quick response and the almost complete absence of sodium and chloride is advantageous because these elements are deleterious to some crops. It is an aid to granulation and can be added to stabilize ammonium nitrate. Potassium nitrate can be used to advantage in mixed liquid fertilizers with high N to K_2O ratios and it can be a component of prilled complex fertilizers.

There will be other new high analysis products. For example, research workers have found long chain, slowly soluble pentammonium tripolyphosphate containing 90 percent plant nutrients. Experimental high-analysis fertilizers with grades as high as 44-75-0 and 36-91-0 have been synthesized by reacting ammonia (NH_3) with elemental phosphorus and oxygen under high pressure. Other potential fertilizer materials have been made by reacting NH_3 with P_4S_{10} over a range of high temperatures. Phosphoryl triamide ($PO(NH_2)_3$) containing (44.2% N and 75.9% P_2O_5) was patented in 1965 by an Italian chemical company. Red phosphorus, the safer form of elementary phosphorus, oxidizes slowly in soils to form plant available phosphorus compounds and it can be useful where long term P supply is needed with less risk of phosphorus loss through soil fixation. Other forms of phosphorus such as phosphine (PH_3 containing 209.5% P_2O_5) and phosphorus nitride (P_3N_5 containing 43% N and 131% P_2O_5) have been considered as possible high analysis fertilizers.

2. New Sulphur Fertilizers

Numerous accounts of the increasing frequency of sulphur deficiency and the importance of this element in plant growth have served to focus the attention of the fertilizer industry on means of introducing this nutrient into their fertilizer products. One of the principal reasons for the problem of crop deficiencies of sulphur is the trend to higher analysis fertilizers containing very low amounts of sulphur. Thus, one of the obvious means of correcting sulphur deficiencies is to add this element to high-analysis fertilizers or to develop new suitable sulphur-bearing fertilizer products. A number of alternatives for accomplishing this have been developed and these products are in various stages of being tested. These are (a) granular high-analysis sulphur assemblages suitable for bulk blending and for direct application. Grades as high as 70-80 percent sulphur have been produced using various binders such as gypsum, ammonium sulphate, urea, bentonite, and goulac (calcium lignosulphonate) to promote the formation of hard granules, (b) ammonium phosphate-elemental sulphur assemblages containing 8-10 percent sulphur, (c) triple superphosphate-elemental sulphur assemblages containing approximately 10 percent sulphur. Up to 20 percent sulphur has been added to concentrated superphosphate (0-54-0) made from superphosphoric acid, (d) anhydrous ammonia-sulphur solutions containing 10-15 percent sulphur, (e) complete high analysis granular and pulverulent or dry mix goods with elemental sulphur, (f) solution and slurry fertilizers containing polysulphides or suspended elemental sulphur, (g) nitric phosphates containing elemental sulphur, and (h) sulphur-micronutrient assemblages.

Several new or different sulphur-bearing fertilizers have been developed or are about to be manufactured. Urea-sulphur with about 8-10 percent sulphur is a relatively new material that was introduced during the past few years into markets in the western United States. Methods have been developed for producing a granular ammonium nitrate-sulphate which contains 30 percent N and 5 percent S. A mechanical mixture of approximately equal portions of urea and ammonium sulphate, referred to as Nitro-plus is becoming popular in western Canada.

Sulphur can be introduced into liquid fertilizers through the use of such inorganic salts as ammonium sulphate, ammonium sulphite, ammonium bisulphite, and ammonium thiosulphate. A solution of ammonium bisulphite and aqua ammonia containing 8 percent N and 17 percent S is marketed in the United States for blending with solutions for making clear liquids. Also, ammonium thiosulphate solution containing 12 percent N and 26 percent S is marketed for the same purpose. An even more concentrated solution for addition of sulphur to liquid fertilizers is made by addition of hydrogen sulphide to aqua ammonia. The resulting ammonium polysulphide solution contains up to 20 percent N and 45 percent S.

While not compatible with liquid fertilizers, liquid sulphur dioxide (SO_2 contains 50 percent sulphur) has been found to be agronomically suitable as a source of sulphur. Like anhydrous ammonia, liquid sulphur dioxide must be kept under pressure and injected into the soil with equipment of the type used for anhydrous ammonia.

3. Micronutrient Fertilizers

Micronutrient use has increased considerably in recent years in the United States and certain other countries. There are three main reasons for this increased use (a) greater awareness of possible deficiencies, (b) higher crop yields placing a greater demand on plant nutrient supplies in the soil, and (c) high-analysis fertilizers containing few impurities has reduced the amount of micronutrients added to soil from these sources.

The various forms of micronutrient fertilizers are outlined below:

water-soluble inorganic salts eg, borax, borate granular, boric acid, copper sulphate, ferrous sulphate, manganese sulphate, zinc sulphate, zinc nitrate, zinc chloride, and sodium molybdate.

water-insoluble inorganic salts eg, metal ammonium phosphates such as iron, zinc, manganese, copper and cobalt having the general formula $MeNH_4PO_4.XH_2O$. Insoluble inorganic salts, including carbonates and oxides of copper, manganese, and zinc are also used.

synthetic chelating agents i.e. certain organic chemicals known as chelating agents, form ring compounds in which a polyvalent metal is held between two or more atoms. Such rings are chelates. Among the best known chelating agents are ethylenediaminotetraacetic acid (EDTA), hydroxyethlenediaminetriacetic acid (HEDTA) and diethylenetriaminepentaacetic acid (DTPA).

silvichemical chelating agents et, ammonium lignin sulphonate plus wood sugars (Greenz 26 and Super Greenz 26) and polyflavonoid chemically extrated from western hemlock bark (Rayplex zinc, iron, manganese and copper).

frits i.e. silicate glasses or "frits" in which the water-soluble micronutrient carriers are fused with a silicate and the product pulverized.

Two approaches are followed in supplying micronutrients in solid fertilizers. One consists of adding small amounts of several nicronutrient elements, usually B, Cu, Fe, Mn, Mo and Zn as insurance against mild deficiencies. Claims may also be made by the manufacturer that micronutrients in premium fertilizers are needed as a maintenance fertility program. However, the problem is often not so much of maintenance level as it is keeping the nutrients in an available form. Further, "shotgun" doses of micronutrients do not correct nutrient imbalances already existing in the soil. The second method involves adding substantial proportions of one or more micronutrient elements that are known or suspected to be needed.

Several methods are used to incorporate micronutrients into mixed fertilizer. The simplest involves mixing at the time of shipment while bringing the fertilizer to guaranteed analysis. This permits formulations made in response to the farmer's request. Because of the problem of segregation, this practice is limited to non-granulated fertilizers. Incorporating micronutrients as granules equal in size to those in a granulated fertilizer is undesirable because of the small amount of micronutrients added. For example, in one typical case, use of a micronutrient as 8-mesh granules at the rate of one pound per acre would result in the application of less than one granule per square foot of field area. In granulated fertilizers, addition may be made before granulation at some point in the preparation of the base fertilizer. The disadvantage of incorporating micronutrients in granules is that it is uneconomical for manufacturers to make and store small lots of special products.

Although solubilities of the micronutrient salts in mixed fertilizer may be affected depending on the type of process used, the chief concern is not in the chemical reactions that occur, but instead in getting uniform distribution when small amounts of finely divided micronutrients are added to the large mass of mixed fertilizer base. Use of adhesives to uniformly coat granular fertilizers with micronutrients shows great promise in overcoming segregation. Some of the materials that have been used for this purpose are spent motor oil (1 to 3% by weight used), molasses and water.

The use of chelating agents for supplying micronutrients such as iron, zinc and manganese has been increasing. Even though chelated micronutrients are believed to be about 5-10 times more effective than inorganic salts, their use has been limited because of high costs. Consequently, their use has been restricted mainly to high-value crops, ornamentals, lawns and gardens. Chelated micronutrients can be mixed with fertilizers and applied directly to the soil or they can be introduced into foliar sprays.

Problems concerning segregation and poor uniformity of application of micronutrients are absent with liquid fertilizers. With liquid fertilizers there is the problem of limited solubility of many of the micronutrient sources. The solubility problem is especially acute when the phosphate is of the orthophosphate type. Liquid fertilizers made from polyphosphate base solution will dissolve from 10 to 60 times more zinc, copper and iron than solutions made from orthophosphate base solution. Chelated forms of the micronutrients are more soluble and are used to some extent even though the cost is higher. Polyphosphate gives a higher micronutrient solubility through sequestration. For example, a stable solution containing 1.0% each of boron, copper, and zinc and 0.2% manganese and molybdenum can be made by dissolving micronutrient compounds in 11-37-0 ammonium polyphosphate solution, giving a total micronutrient content of 3.4%.

4. More Effective Fertilizers

There is considerable interest in developing new fertilizer materials that will give more crop response per pound of nutrient than conventional materials. Activity in developing more effective fertilizers seems to be warranted because crops recover only 50 to 75 percent of the nitrogen applied, only about 20-30 percent of the phosphorus in the year applied and usually between

50 to 60 percent of the potassium used. Further, serious imbalance of plant nutrients can occur as a result of luxury consumption of nitrogen and potassium supplied in conventional water soluble fertilizers.

Another problem related to luxury consumption of nitrogen from water soluble sources in the early part of the season is the resulting inadequate supply of the nutrient for subsequent growth. To provide sufficient N during a growing season, more than one application of fertilizer is often required, which is an inconvenience and an added expense.

Upon application of the common nitrogen fertilizers to soil, they may be subject to: (a) leaching and runoff losses, (b) denitrification losses through biological and chemical mechanisms, (c) NH_3 volatilization losses during or shortly after application - or after hydrolysis of ammonium-forming compounds, (d) dissolution rates too slow to keep pace with daily and seasonal crop requirements, (e) immobilization through microbiological transformations, (f) immobilization through chemical reactions with soil organic matter components, and (g) inter-lattice fixation of NH_4^+ by clay minerals.

Recognition of these problems has recently stimulated the interest of the fertilizer industry in chemical and/or physical modification of conventional N fertilizers to produce nitrogen fertilizers with controlled availability. Fertilizers with controlled release should supply N continuously over an extended period, thus avoiding the need for repeated applications of conventional water soluble fertilizers. They also promise to minimize luxury consumption of nitrogen (and other nutrients such as potassium) and upset of nutrient balance, as well as reduce N losses by leaching, to decrease gaseous losses of N, and to reduce the hazard of over-application.

To achieve the objectives of the controlled release concept, attempts have been made to cover granules of water soluble nitrogen fertilizers such as urea and ammonium nitrate with rather inert, water-resistant coatings or membranes. Coating agents investigated have included various plastics, resins, waxes, paraffins, asphaltic compounds and elemental sulphur. Coatings can be of three types (a) the semi-permeable membrane where fertilizer N is released when the membrane is ruptured following the increase in osmotic pressure which results from water moving through the membrane into the granule, (b) the perforated impermeable mem- ~~brane~~ brane - pinholes through the membrane coating provide the route of release for fertilizer nitrogen, and (c) the solid impermeable membrane - the chemical nature of the membrane is such that it must be degraded by soil microorganisms prior to release of the N.

Although coating adds to the cost of a fertilizer, considerable progress has been made toward achieving the objective of the controlled release of plant nutrients. In the United States coated fertilizers are currently recommended and sold for use on ornamentals and turf. For example, the Sierra Chemical Company, Neward, California manufactures and distributes "Osmocote" 14-14-14 and 18-9-9 resin coated granular fertilizers said to provide a metered release of plant nutrients over a 4-month period.

A number of variations of the controlled release concept are possible through chemical and physical modifications of conventional N fertilizers. Brief comments on these possibilities are given below:

a) Varied coating thickness on granules of conventional N fertilizers to give different dissolution rates. Granules then could be selected and mixed for balanced dissolution and whatever nutrient release rate was necessary to meet the daily and seasonal requirements of a particular crop under specific environmental conditions.

b) Balanced dissolution through selection and mixing of different sized granules of fertilizers of limited water solubility such as oxamide or metal ammonium phosphates. Rate of dissolution of sparingly soluble fertilizers varies according to granule size.

c) Balanced dissolution by selection and mixing of fertilizers of varying water solubility to provide a range of dissolution rates.

d) The inhibitor approach involves the use of certain chemicals to repress or inhibit specific soil microbial groups which perform various biochemical transformations. Dow Chemical Company's N-Serve, 2-chloro-6-(trichloromethyl) pyridine is used to maintain ammoniacal N fertilizers in the ammonium form for an extended period thereby increasing the efficiency of these fertilizers because ammonium is not subject to loss through leaching and denitrification. Other chemicals such as thiourea, methionine, dicyandiamide and many of the urethanes are partially effective as nitrification inhibitors.

e) In the coated granule-inhibitor approach, the dissolution and release of an ammoniacal fertilizer would be controlled by use of one of the coatings discussed previously, while a nitrification inhibitor would either be added as part of the coating material or mixed with the fertilizer itself to maintain N in the ammonium form.

Several inhibitors might be incorporated into the granule or granule coating of organic nitrogen fertilizers. While one inhibitor slowed the rate of ammonification another would block the first step of the nitrification sequence. Controlled release of N would also be possible if inhibitors form part of the molecule of the organic nitrogen fertilizer compound. The inhibition could result through properties such as isomerism, chain length, asymmetry, steric hindrance and resonance.

f) The molecular-microbiological approach involves use of organic nitrogen fertilizer compounds with specific structural characteristics such that only very few groups of soil microorganisms would be capable of decomposing the fertilizer into plant available forms.

g) The whole or intact molecule approach is based on supplying inorganic and organic nitrogen containing molecules that are readily absorbed intact by both roots and foliage of crop plants.

h) In the energy-rich molecule approach, nitrogen fertilizers containing energy-rich molecules or potentially energy-rich molecules are absorbed intact by roots or leaves to increase the level of chemical energy within the plant. Except, for the energy aspects, this approach is similar to the foregoing whole or intact molecule approach. Urea might be transformed directly into an energy-rich molecule and the new polyphosphate fertilizers should also be considered as potential energy-rich structures.

i) The stimulated uptake approach is based on evidence that certain organic ompounds, after application to the plant root environment, are capable of causing a stimulated absorption of specific plant nutrients. Uptake of P and K has been shown to be stimulated in this way. A variation of the stimulated uptake approach would be the use of different nonionic surfactants to enhance the growth of plants. The intended result in this case would be a larger root system and thus a greater root absorbing surface.

j) The principal objective of the controlled rhizosphere approach would be to develop new nitrogen fertilizers that can be applied to soil or leaves to change the chemical nature of plant root exudates so that the population of soil microorganisms in the region of contact between root and soil can be controlled to the advantage of the host plant. A controlled rhizosphere would be very useful where fertilizer nitrogen is being immobilized by the rhizosphere microflora. The chemical nature of plant-root exudates can be markedly changed through foliar application of different chemical compounds, including fertilizers such as urea. Such treatments have caused significant changes in the root surface-rhizosphere population.

Of the various approaches to the development of more effective nitrogen fertilizers, the greatest progress made to date has been with compounds that release nitrogen slowly because of their limited water solubility or slow rate of degradation. Magnesium ammonium phosphate, crotonylidenediurea (Floranid), isobutyridenediurea (I.B.D.U.), glycoluril and oxamide all release their nitrogen more slowly as the particle size increases. The first three compounds are produced commercially. The slow release of ureaforms (produced commercially) and the triazines depend upon their resistance to microbial decomposition. All are costly to produce, which has limited their use largely to turfs, gardens and speciality crops.

Mention has already been made of the commercial production of a slow release fertilizer based on the semi-permeable membrane principle. Although coatings can be effective, they are costly to apply and lower the nutrient content of the product. It is extremely difficult to coat fertilizer particles uniformly in large-scale plant operations and, unless this is achieved, coatings are of little value.

Natural organic materials which are resistant to rapid microbial decomposition also exhibit slow release properties. A number of organic products are on the market, such as processed sewage and garbage and ammoniated brown coal and lignite. The N content of such products is low and costs per pound of N are high, especially when the products are transported any distance.

Laboratory studies of polyphosphates in soils generally indicate that they form insoluble compounds more slowly than do orthophosphates. However, field studies, except in a few instances, have failed to show a consistent advantage of polyphosphates over orthophosphates.

Silicate supplement applied with phosphorus fertilizers will often increase the efficiency of the fertilizer by preventing fixation of the fertilizer phosphorus in the soil. The silicate anion will also release soil phosphorus for crop growth.

Organic phosphorus sources, such as nucleic acid, have been found to be superior to conventional phosphorus sources including ammonium phosphate, monocalcium phosphate, dicalcium phosphate and tricalcium phosphate. Slow mineralization of organic phosphorus is likely to ensure a long-term supply of phosphorus to plants.

5. Combination of Fertilizers with Other Crop Management Chemicals Such as Herbicides and Insecticides

With the increasing and often acute shortage of labor and rising costs greater consideration is being given to labor saving methods of applying fertilizers, herbicides and insecticides. Fertilizer-herbicide and/or insecticide combinations have considerable labor saving appeal by permitting the application of all the chemicals in one operation. The combinations that are now being used are listed below:

Crop Management Chemical		Fertilizer
Herbicides		
Atrazine	in	Nitrogen Solutions
CIPC	in	Alfalfa Fertilizers
Dacamine (2 lb)	in	Urea Solutions
2,4-D	in	Nitrogen Solutions
Eptam	in	Dry Fertilizers
Knoxweed	in	Urea Solutions
Lorox	in	Liquid Mixed Fertilizers
Paraquat	in	Nitrogen Solutions
Treflan	in	Nitrogen Solutions
DSMA plus Karmex	in	Nitrogen Solutions
Insecticides		
Aldrin	in	Liquid Mixed Fertilizers and Nitrogen Solutions
Chlordane	in	Dry Fertilizers, Liquid Mixed Fertilizers, and Nitrogen Solutions
Diazinon	in	Liquid Mixed Fertilizers and Nitrogen Solutions
Dieldrin	in	Liquid Mixed Fertilizers and Nitrogen Solutions
Di-Syston	in	Liquid Mixed Fertilizers and Dry Fertilizers
Endrin	in	Liquid Mixed Fertilizers and Nitrogen Solutions

Heptachlor	in	Liquid Mixed Fertilizers and Nitrogen Solutions
Malathion	in	Liquid Mixed Fertilizers and Nitrogen Solutions
Parathion	in	Liquid Mixed Fertilizers and Nitrogen Solutions
Trithion	in	Dry Fertilizers
Herbicides Plus Insecticides		
2,4-D plus Parathion	in	Dry Fertilizers

Although these combinations are growing in popularity, they present problems of compatibility, segregation, cross-contamination, over application and hazards to personnel.

6. <u>More Convenient Methods of Application</u>

With a properly designed system, sprinklers can distribute fertilizers at lower cost than broadcasting. Application of fertilizer through sprinklers is especially advantageous with turfgrass which usually requires split applications of fertilizer, particularly nitrogen. Split applications can be applied through sprinklers at very little increase in cost over a single application.

Many kinds of fertilizer can be applied through sprinkler systems. The principal requirements, other than crop needs are that the fertilizers be fully soluble, and that they do not cause serious corrosion of the metals used in the sprinkler system.

Aqua and anhydrous ammonia forms of nitrogen, which are widely used with furrow and flood irrigation, are not recommended for use with sprinkler irrigation because of excessive volatilization losses into the air.

Fertilizers used successfully with sprinklers include the solid forms of ammonium sulphate, ammonium nitrate, and calcium nitrate soluble in water; and the liquid forms of ammonium nitrate, urea and ammonium nitrate-urea. Fish meal, muriate of potash, diammonium phosphate, wettable sulphur, etc. have also been applied successfully through sprinkler systems.

Compatible mixtures of herbicides, insecticides, and fungicides may also be applied with fertilizers through sprinkler systems.

There are two general types of injector equipment. The batch method with Venturi or Pitot injectors is most frequently used with agricultural crops. These injectors circulate water through a fertilizer tank by creating a differential pressure in the pipeline. Alternatively, the solution can be fed in at the suction side of a booster pump. The second method, which is frequently used in irrigating nurseries and turf areas, utilizes proportioning injectors to meter the fertilizer solution from a supply tank into the irrigation water at a known concentration.

It should be noted that injection of fertilizers into irrigation systems may be a potential source of pollution to waters used for human consumption. Drinking fountains placed in parks or on golf courses should be supplied with water entirely separated from the pipelines used for conveying fertilizer solutions.

Stolons and Vegetative Reproduction of Turfgrass [1]

Tobias Grether[2]

To preface the necessity for growing grasses by asexual means we should understand the basic genetic need for this procedure.

With asexual reproduction we have the capability of reproducing the exact physiologic characteristics of a given grass plant without worrying about the inherent difficulties of a long-term

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[1]Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2]President, Cal-Turf Nurseries, Camarillo, California.

breeding program in seed production.

To appreciate the methods used in the production of stolons one must be fully conscious of the variations caused by accidental seed born on the plants intended for asexual reproduction. This accidental seed has sounded the death call of many a would be nurseryman. Seed, born by a strain that can only be perpetuated in its unique identical physiological exactness by asexual reproduction will usually provide rather wild variations of growth. Where very specific growth characteristics are desired these variations are usually detrimental. Only by the recognition of a multitude of desirable factors in one strain is it possible for such a strain to become of commercial value.

Most of the bentgrasses used in the U. S. that are produced from stolons are used for golf greens and bowling greens. The most common varieties of these bents are Congressional, Old Orchard, Toronto, Cohansey, Evansville, Arlington, plus a host of others that never came into more popular use.

To produce stolons of any variety of bentgrass is not particularly difficult. To produce pure stock of known parentage that will root and grow into a vigorous turf is somewhat more difficult.

Our operation starts with pure strain selections of known parentage that are planted on fumigated soil in rows. The fumigation technique used is similar to that developed by the strawberry industry in California. Chemicals that are effective for this type of work are methyl bromide, chloropicrin, vorlex, and combinations thereof.

Both dosage rate, soil temperature, tilth, and moisture level are extremely important to the successful eradication of weed seed and pests. Dosage rates are approximately 1# per 100 sq. ft. of methyl bromide. Applied at soil temperatures of 60 degrees when the soil is in good tilth and at approximately field capacity. The sandy soils are more easily fumigated than the heavier soils due to the fact that the gas will more easily penetrate into large pores.

Planting pure strains in rows can be accomplished by sprigging stolons and irrigating immediately after planting. While the bentgrass will withstand much more desiccation than the bermudas, they must still be handled with great care.

After the stolons have grown into dense matted rows, they are cut with a sod cutter and chopped and shredded with a special piece of equipment. They are bagged or boxed and transported to the site where they are to be planted.

Upon arrival at the planting site bent stolons may be kept for several days. To assure their continued good growing qualities, they can be kept up to six days by occasionally wetting the burlap bags and keeping them in a shaded place. If longer storage periods are desired, they can be held for periods up to four weeks at 34 degrees F.; if they are not packed tight and air circulation is maintained.

Sufficient stolons should be ordered to plant at a rate of 8 to 10 bushels per 1,000 sq. ft.--or at higher rates if extremely fast coverage is desired. The stolons should be scattered evenly and rolled. One eighth inch of the soil mix topdressing should be applied and rolled. About 1/3 to 1/2 of the stolons will be showing above the ground.

Water should be applied immediately and the stolons kept moist continuously until they germinate, which takes several days. It is most important to keep the stolons moist; otherwise, they can lose their germinative capability, reducing the percentage of stolons that actually grow.

If hybrid bermudas are used they should be planted during the warm season. For normal establishment, the temperature should be 72 degrees or more. Below this temperature the growth rate slows. Tifgreen should not be planted after October nor before April for greens use.

After planting, the stolons must be kept continuously moist until the grass germinates. It is not the amount of water applied that makes the difference, but the frequency of application. In a few days new growth will be seen, and the watering can be gradually reduced as the stolons show stronger growth.

Stolon plantings differ from seed plantings in some very important ways. The most important of these is the fact that as soon as a stolon roots it represents a much more mature plant than an original seedling. Through its capability of vigorously producing, both runners and rhizomes stolonized bents not only establish faster but can be mowed sooner and played earlier due to the above characteristic.

Upon stolonizing with bents it is not unusual that complaints are made about the density of the stand. This is due to the fact that even at a 10 bushel per 1,000 sq. ft. rate of planting, there are probably less than 1/10 as many plants per sq. ft. compared to seeding. It is nevertheless not unusual that a stolonized green can be played 8 to 10 weeks after planting.

In conclusion I would like to make a point or two for future research and development of asexually propogated varieties of bentgrass, of all the bents now in commercial use, only Old Orchard was systematically selected. The balance were found by chance and upon use as commercial varieties showed some good characteristics.

I would suggest that based on the rather wide growth variations obtainable in all the bents, a number of strains could be developed that would considerably broaden their usefulness in general.

As an instance, the so-called "desert golf courses" that have bermudas on their fairways could make good use of a vigorous more salt tolerant bent to compete with the bermudas and produce winter color. If this were possible, overseeding would be eliminated.

In your own Washington and Oregon area, where many climatic conditions actually render the bents dominant over most other species, it might be interesting to look for variations that are coarse and tough for playing field use. If any comparison between the bents and bermudas is permissable, we can certainly show that asexual breeding and selection have greatly extended the usage of bermuda--why not bents? Zoysia is going through rather extensive breeding in the Eastern United States and it is likely that great progress can be expected of this species in the future.

Preventative Maintenance of Grass-Cutting Machinery[1]

W. H. Brinkworth[2]

1. Title Slide.

2. Highways, Parks, Institutions, Golf Courses.

   America's beautification program is grass, more grass, and still more grass. The lawn areas with eye appeal are the ones that are well groomed. To get this high degree of grooming, we have to have the correct equipment, properly maintained; and properly trained operators to get the job done.

3. Parts, Manpower, Dollars.

   In order to get the right mowers, and have them maintained properly, we must have a properly trained man and the budget to do the job.

[1]Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2]Toro Manufacturing Corporation, Cupertino, California.

4. Question.

And this question, "Is the mower properly maintained?" . . . What do we mean by properly maintained?

5. Mowers of All Types.

Today's maintenance department -- whether it be in a park, golf course, cemetery, school or other major institutions with turfgrass areas -- requires a variety of lawn mowers. The different sizes of grass areas, the kind of grass established and the use of the areas, all affect the type of mowers needed.

6. Storage Building.

For, in order to get properly maintained equipment, we must have the right facilities and the right tools and knowledgeable people to train the man who is actually going to do the cutting.

7. Inside Shop.

The average shop today in order to speed up repair and maintenance, should be well provided with the proper tools.

8. Proper Tools.

Not all shops need expensive tools like these shown, but I use this slide to illustrate a way to departmentalize certain types of tools, and a very neat and orderly way of storing them.

9. Cleaning.

Adequate cleaning facilities are necessary so that closer inspection can be made of equipment after a day's operation. Today's maintenance compound, where equipment is stored, should have an adequate wash rack.

10. Cleaning, Cont'd.

Air is a wonderful thing for blowing out the bearing areas and taking off excess water used in washing.

11. Cleaning, Cont'd.

Today's institutions use larger equipment to reduce mowing time of large areas. These machines need periodic cleanings. Daily checks should be made by the operator, under close supervision by the golf course superintendent or mechanic, to ensure that correct adjustments are made.

12. Cleaning, Cont'd.

Steaming, I feel, of any of the grass-cutting equipment, is a periodic necessity to keep the machines good looking and clean, to make it easy to inspect wearing parts, and to give the machines that new look that operators respect.

13. The New Look.

Operations such as these keep costly equipment in the field years longer. Clean, well-kept machines build a personal pride in the operator. And with personal pride, you have gained something that is very rare in today's market place.

14. The New Look, Cont'd.

You can see here what a coat of paint will do for a piece of equipment that is properly maintained.

15. Grass De Luxe.

And, of course, with the preventive maintenance, proper storage, thorough cleaning of the equipment, and the operator's personal pride in his work, your grass areas can look like this.

16. Poor Storage.

Let's look at the other side of the picture. We have poor storage quarters, improperly kept, usually a gravel or dirt-floor corporation yard cluttered and untidy, with an air of "let's do it tomorrow" or "I don't give a damn." Of course your crew, in surrounding such as these, take on the same attitude . . . hence, neglected equipment.

17. Sloppy Maintenance.

Usually, as depicted in the previous slide, when a storage area has a maintenance overhaul base, it looks like this.

18. Sloppy Maintenance, Cont'd.

This man's wages are the same as those of the man with good quarters. We know that the parts and materials that he is replacing cost the same, but the chances of him doing good work in such surroundings are slim, for it is easy here for dirt and other foreign matter to get into gear cases and bearing housings. In my travels, overhaul bases such as these outnumber the clean and orderly maintenance shops.

19. Poor Storage.

It is evident that this machine has been stored where a lot of moisture was able to reach it and we can readily see the dollars that it would cost for this machine to be put back in working order. Bearing surfaces, ignition systems, belt pulleys, chains and sprockets, inside carburetors, gas tank -- all are rusted yet you can see by the tread on the tires that this machine is not more than a few years old. Properly cared for and maintained, it would have had many many years of work left in it.

20. Dirt.

We are seeing more and more hydraulic systems in mowing equipment. We know that they are dirt-proof up to a certain point, and we know that dirt in hydraulic systems can cause failure very quickly. Yet customers run equipment when it is filthy dirty, as you see here, with much of the dirt around the filler cap. Replacement of seals and overhaul to a unit such as this could cost well over $100. A few minutes with a steam hose, or warm water once a week, could keep this system in tiptop condition.

Mowing is a dirty job and time should be allowed for operators to clean and maintain their equipment.

21. Dirt, Cont'd.

Dirt is something that goes with mowing. And the type of dirt that accumulates on lawn mowers in some areas can become abrasive if the machines are improperly stored in locations that may be flooded. This equipment was dug out of a storage shed after the spring thaws, requiring many dollars for overhaul and repair.

22. Dirt, Cont'd.

It is evident that this operator ran and stored his equipment, day in and day out, with no thought of cleaning and maintaining it. There are many places I could point out on this piece of equipment that are due to fail and will be ignored by this customer until they do fail.

23. More Dirt, More Carelessness.

(Slide Shown)

24. Dirt, Cont'd.

This is an $8900-dollar piece of equipment in the spring of the year. This machine has been taken from the storage area and the people hope that it will work. It is less than two years old. At the time this slide was taken, it had been stored in this condition all winter long. Here is a case where something bad is bound to happen.

25. Dirt, Cont'd.

Lawn mowers are primarily engineered and designed with considerable backup in strength to cut and maintain grass. From the condition of this reel we are convinced that more than grass was encountered and that there was a great deal of neglect simply because this operator did not know what he was doing.

26. Summary.

Now, you have seen what careless maintenance can do to equipment. Here is what improperly maintained machines can do to turf. This picture would indicate to me an improperly adjusted mower, an operator who is not careful about height of cut, who did not have a mowing plan for his area. And the end result, I think we all agree, is a terrible mess.

27. Summary, Cont'd.

The time spent in properly planting and landscaping the area; the dollars spent in materials, design and preparation; and the man hours used add up to the task cost. Are we getting our money's worth with improperly adjusted equipment, careless operators and the boo-boos that I mentioned?

28. Good Turf.

Let's look at a perfectionist in growing and grooming grass and see the beauty that can be achieved with planning, training and proper equipment.

29. Grass.

Grass like this is arrived at only after a great deal of supervision.

30. Training.

The right machine, a trained operator, maintenance and, of course, the very important factor of safe operation.

31. Training, Cont'd.

Is the operator properly trained and how do we get proper training on specific types of equipment? There are many ways.

Number 1. When the equipment is first acquired, the supplier should give you a complete check-out on its operation. With the machine comes an owner-operator manual.

32. Training, Cont'd.

This should be studied. I might mention here that no one piece of equipment does all jobs. Select the correct unit, put your own ingenuity to work on the operating techniques required to make the area look as decorative as possible. Then, make sure that all of this is passed along to the operator.

33. Training, Cont'd.

I think these four items are the responsibility of a good operator: To tighten nuts and bolts, to lubricate, to inspect wearing parts, and -- where his knowledge is limited -- to ask either you or the mechanic to check malfunctions that are recurring.

34. Owner Manual.

Every manufacturer of equipment tries to accompany every piece of equipment with a descriptive owner manual. If adjustments, recommended in this manual, are followed, many hours of good mowing will result.

35. Owner Manual, Cont'd.

In these same owner manuals, there are suggested techniques recommended for specific turf areas. They may be something you are already doing. But, in most cases, they prove to be valuable tips that can be applied while you are training the operator.

36. Training.

Little tricks, such as this one where the operator leaves his seat when a side bank may cause the machine either to spin out or to tip . . . he steers the equipment across the area, eliminating burned tire marks or the interruption of his swath where hiw mower might have stuck.

37. Training, Cont'd.

The operator moving around in the seat can make a world of difference in the traction on this mower.

38. Training, Cont'd.

You will note that by transferring his weight forward he gives the added traction to the unit needed to climb the hill without spinning out.

39. Mower Records.

I have inspected many, many different types of mower records, from a school-scribbler cost-of-hours method to a very exact card file on each piece of equipment with an operating number to a very simple paper pad on which a problem is noted and passed on to either the mechanic or the superintendent. I feel that it is highly important to record oil changes, greasing, and major overhauls to major components. It is very important to note the date the new piece of equipment is put into service and, also, to note the cost of this equipment. When a running tabulation is kept, it is easy to see when the replacement parts reach 60% of the cost of the unit. A survey can be made of the general condition of the machine, compared to the record, and it then can be determined whether it is more economical to continue servicing and repairing the unit or to replace it with a new piece of equipment.

Most manufacturers can give you an accurate life expectancy of a piece of equipment. Most fleet owners retire a portion of their equipment line annually, replacing it with new equipment. Denver Park Department, for instance, replaced 8 professionals out of their fleet of 40, starting the 5th year; so that every 5 years they have replaced their entire fleet. They do likewise with the tractors on a 10-year basis, retiring the 5 oldest tractors and replacing them with new ones. Every 10 years they have an entirely new fleet. Golf courses, on the other hand, usually work on a 3-year program with greens mowers, a 10-year program on fairway mowers and tractors. The smaller hand rotaries, if they are the consumer type, may have to be obsoleted once a season. Only well kept records will tell you when it is economically sound to make these changes. They give you the ammunition to take to your greens committees, or park boards, or to whoever authorizes budgets for replacement of equipment. Please keep records.

40. I include this slide to talk briefly on the selection of proper tools. They seem to be the hardest things to hang on to, where maintenance of grass cutting is concerned. But there is only one answer--closer supervision and make sure you have adequate storage for costly tools.

41. Maintenance Record.

In laying out your maintenance record for grass cutting equipment, it is important to follow the owner manual for procedures in greasing, oil changes, periodic adjustments, etc. The question I ask most operators at the operators schools is "How many grease fittings are there on the piece of equipment you are operating?" You would be surprised at how many wrong answers I receive. Of course, if the location of some grease fittings is unknown, some part of your machine is not being greased and you can then expect a failure.

42. Adjustments.

Every manual for owners has valuable information regarding adjustments. Not only to the cutting unit, but to your belt pulleys, chain sprockets, clutches, etc. Let's review one sprocket adjustment and see where this operator made his mistakes. Had he known his correct adjustments, he could have saved X number of dollars. You will note the adjustment on this chain has been extended to the fullest. But still the chain is loose and has been let run in this condition until the sprocket shaft and bearing have been worn badly. Had the operator known, when he came to the end of the adjustment, to take a half link from the chain, back the adjustment to the beginning and start over, money could have been saved in parts and material. Ignorance of this adjustment cost the owner a sprocket, sprocket shaft, a bearing and a new chain.

43. Adjustment, Cont'd

Here is a similar condition involving bushing wear. Had this bushing been properly greased and close attention paid to the bushing wear, the following replacements would not have been necessary: The roller end shaft, the roller bracket and the roller bushing. If the bushing had been replaced when it showed normal wear, the job could have been done for 60 cents. Failing this, the replacement of all these other parts ran close to $10. Now on a 7-gang mower, we have 14 such places where the height of cut is set. You can imagine, with this much slop on the bushing surface, what uneven cutting would be obtained.

44. Adjustments, Cont'd.

The picture you see here depicts the correct balance of a rotary blade. This is a department I cannot stress too heavily. Many rotaries have failed because this was neglected.

45. Adjustments, Cont'd.

Let's look at what can happen when a blade is unbalanced. A heavy vibration is set up, vibrating so badly that the engine can be shaken right through the deck in as short a time as 15 minutes.

46. Adjustments, Cont'd.

You will see here what has happened. In the previous picture you saw a piece missing from the blade, causing heavy vibration and the need to replace a complete deck. Balance your rotary blades. If you feel a vibration, it is time to inspect and sharpen off the excess weight to make sure the blade is evenly balanced.

A good balance is obtainable and is absolutely necessary for rotaries used in your grass cutting operation.

47. Adjustment, Cont'd.

Let's review some belt pulley adjustments. This new V-belt has been ruptured. The rupture was caused by a misalignment of the pulleys. To replace a belt without realignment of the pulley would be a gross waste of time, parts and effort. Know how to recognize the difference between a misaligned pulley break . . .

48. Adjustment, Cont'd.

. . . . and a belt damaged by slipping. The pulleys here could be in correct alignment but the tension on the belt pulleys is out of adjustment.

49. Adjustment, Cont'd.

Here is what a belt looks like that has had normal wear. The uniform cracking is due to the many thousands of flexings that this belt has had entering and leaving the pulley. However, the cords are intact and the belt is capable of many more working hours.

50. Lubrication.

We now come to the most important parts of the grass cutting unit, the gasoline engines. The majority being 4-cycle, the oil is in the crankcase, the gas in the tank. And it is the crankcase, in most cases, that is the sorely neglected area. What are ideal time periods for oil changes on 4-cycle air cooled engines? Believe me, there are no set hourly times. Only the condition will determine the frequency with which the oil should be changed. How often should this reservoir be checked? The age of the engine and its condition would certainly determine the frequency of inspections. If the oil is replenished, if the condition of the remaining oil warrants it, sometimes it is cheaper to change the oil than to add new oil to dirty oil.

51. Lubrication Cont'd.

To cite an example: This particular engine, a 9-horse Wisconsin . . . remove the filler plug, make sure the unit is on level ground and look into the crankcase and make sure that the oil is well up in the threads of the hole. The normal capacity of this crankcase is a full Canadian quart. If it is down about a cupful of oil, it is dangerously low.

I would like to recommend this procedure for checking oil. Make sure there is oil in the crankcase through a visual inspection but return the plug to the filler hole. Start up the motor and let run till the engine is thoroughly warm. Shut the engine down. Again remove the filler plug and dip a clean screwdriver, stick, or metal object into the hole to draw out some of the oil in the crankcase. Let this oil run down a clean white paper; hold the paper up to the light. If carbon particles, dust and dirt are visible, a change is required. The reason for starting the motor prior to the inspection is to stir up any settled dirt particles that have accumulated in the bottom of the crankcase. Do not drain cold oil from a cold motor, because all these particles will settle out in the bottom of the crankcase. When the new oil is added, they will be stirred into the new oil and, of course, you will not have a complete oil change.

Use a good quality of 30 weight oil, a non-detergent if possible. No oil should run longer than 24 hours' running time under ideal conditions, and the ideal condition would be a stationary engine running out of dust or where no dust particles can be taken through the air intake cleaner.

52. Lubrication, Cont'd.

This picture illustrates the carboned oil found in the crankcase of a 4-cycle engine. The greens mower, I would say, is one instance where from 18 to 20 hours would be a good running time, as they do operate usually in dust-free surroundings. Make sure the warm oil is completely drained. As illustrated here, lubricate the rest of the machine while the oil is being drained.

53. Lubrication, Cont'd.

If filter elements are accessories on your equipment, make sure they are changed often; every second oil change is not too frequent.

The owner of this tractor did not know that there was a filter element on his equipment. He changed oil frequently but complained that even after one hour of operation, his oil was black. Upon inspection, we found this element wedged solidly in a cake of carbon. It had been on the equipment for a little over three years. The engine showed many signs of premature wear and we almost had to use stumping powder to remove this element from the cylinder. Know where you filter elements are . . . either on the engine's hydraulic equipment or wherever oil is filtered. All filter elements should be changed frequently.

54. Lubrication, Cont'd.

Greasing is another important factor. Know where your grease fittings are. Know how frequently they should be greased; know how much grease to apply to the different components on your equipment; and clean up after the greasing job has been done.

55. Lubrication, Cont'd.

Usually the easy-to-get-at grease fittings are the ones that receive the most attention.

56. Lubrication, Cont'd.

An owner's manual or inspection sheet should be used when the operator is unfamiliar with the equipment. Make sure he gets the manual that belongs to the specific equipment he is working on.

57. Lubrication, Cont'd.

Caution! in the use of oil and grease around clutch surfaces. Know how frequently they should be greased. Just because there is a grease fitting visible here doesn't mean it should get the same greasing as a roller bearing. In too many cases clutch surfaces are rendered useless because of grease. Can you imagine the condition of an operator's clothes after working on a unit with this much excessive grease, holding dirt right at the bearing surface? This man was instructed to clean the zerk fitting before greasing the equipment. You can see that he did just that. So be specific with your instructions. Make sure he understands to clean up excessive oil that works out of the bearing surfaces.

58. Engine Service.

We see here, I think, one of the greatest causes of burned-out engines: Stopping the air-through intake, closing off the coolant air and making the engine run very hot. Usually, the air-cooled engine runs between 360 degrees to 400 degrees under normal conditions. This is the heat temperature at the spark plug. Now, close off the coolant air with dehydrated grass straws, fluff from poplar trees, seeds from dandelions, or just plain dirt which accumulates either in the plug house screen or between the fins around the cylinder and over the head. The temperature can rise to over 560 degrees and seize the motor very quickly. These extreme temperatures cause premature wear to all moving parts of the engine.

Again, the question is asked how often should service be given to this part of the engine; and again I say, whenever conditions demand it. Frequent visual inspections should tell you when the blower housing should be cleaned on this particular engine.

I asked the operator how he gauged the frequency of cleaning. He replied, "When I see the straws and grass working out around the spark plug."

This is too long a period. Too much damage had been done through high temperatures causing premature wear, valve burning and other things, and there was the danger of fire. The recommended procedure for cleaning the blower housing is to remove it or, if air is available, reverse the flow of air. Make sure you have done a thorough cleaning job in all the fins. The engine manufacturer has worked diligently to design this blower housing. To put the maximum amount of air through the blower housing up and over the head. If there is a dent, a tear, or an obstruction in the housing unit, your engine is going to over-heat.

60. Engine Service, Cont'd.

In this slide, we see evidence of overheating and the burning of the part around the head bolts. This operator bragged about how clean his machine was and was convinced that the overheating of the engine was caused by some malfunction . . .

61. Engine Service, Cont'd.

. . . upon removing the blower housing, the evidence of why the engine was overheating was right there. His fins were plugged with dirt, stopping the air flow over the cylinder head. We arrived too late to save him major overhauls to this engine.

62. Engine Service, Cont'd.

There is no excuse for dirt accumulating inside the blower housing, as we see here. This operator was mulching leaves and, as you can see, a great deal of leaf mulch dirt accumulated inside the blower housing. It wasn't until the engine seized that the operator realized what had caused the damage.

63. Engine Service, Cont'd.

Here is the inside of the blower housing. You can readily see the debris and dirt caked inside, shutting off all possible supply of air.

64. Engine Service, Cont'd.

Spilling oil and letting dust and dirt accumulate on the engine are other causes of overheating. You can see all the fins are caked completely closed and the ignition is fouled. I wish I had a sample of what the oil in the crankcase looked like.

65. Engine Service, Cont'd.

This engine was running a compost mixer, and every second or third shovelful of compost was hitting close to where the engine was running. The results were disastrous.

66. Engine Service, Cont'd.

Here you see a machine in our shop with a specifically designed breather protector. And, I might add, this engine was in for an overhaul due to overheating. I am sure a device like this would have been thought of by the original manufacturer and used, had it been any good. Please stay away from homemade gimmicks. There is no better service that you can render than to just plain clean it out.

67. Engine Service, Cont'd.

Here's more of the same. We usually find this condition on poorly maintained equipment where there is a sloppy operator who takes the "I don't give a damn attitude."

68. Air Cleaner Service.

And you will find that, where one department is neglected, there will be other departments just as badly neglected.

That brings us to a major item that requires daily service and frequent inspections -- the air cleaner. On this particular machine, it is the oil bath type. There are also the dry cartridge type and the polyurethane sponge type. They all provide an adequate way of cleaning the air that goes into the manifold. If neglected, this is one sure route that dirt has to get into the oil crankcase.

And when air cleaners get into a condition such as we see here, you know that a large amount of this dirt is being sucked into the crankcase and is contaminating the oil. Here is a prime contributor to engine wear and to shortened engine life.

69. <u>Air Cleaner Service, Cont'd.</u>

This picture shows an oil bath air cleaner. It looks as if the operator had a barbeque in the lower one-half of this element. It was taken from an engine brought into the shop for an overhaul to the main bearings, piston assembly, wrist pin and crankshaft. All bearing surfaces showed premature wear caused by dirty oil.

70. <u>Air Cleaner Service, Cont'd.</u>

While cleaning this air cleaner, it is not recommended that it be placed on the head of the machine where oil can be spilled over the rest of the motor. You will also note the oil filler plug at the base of this engine. If this were removed with that dirt in place, there is a good chance that the crankcase would get a large portion of this dirt, and an oil overcoat -- as we see here -- certainly would raise the engine's temperature.

71. <u>Trained Operators.</u>

I think the best investment that any of us can make in our grass-cutting operation today is to take the time to train our operators on the equipment they are going to run. Close supervision should be made to make sure they can run the mower, service it, check it out, and recognize malfunctions before they happen. They should be taught to plan how an area will be cut and to make it look its professional best.

72. Trained Operators, Cont'd.

Make sure the operator knows the limitations of the piece of equipment he is running. Know when rotary mowers should be used, and know their limitations, because they, too, have their limitations, both in types of material they will cut, hills they will climb and traverse, and the hours they can be continuously run without inspection.

73. Trained Operators, Cont'd.

The proper selection of equipment by the operator for a specific mowing area is very important. You see here a group of young fellows who are cutting a wide open space. The choice made here, either by the superintendent or the operators, is a wrong one, in my opinion. Either the superintendent is running for an election or he is uninformed and has not heard of gang mowers. Each one of these mowers cuts differently, depending upon the life of the machine, its state of repair, and the operator handling it. Consequently, we get these different mowing patterns. We are running the cost of labor very high, and there is the added danger that one of these men may be hurt.

74. Trained Operators, Cont'd.

A superintendent should certainly go over the adjustments with his operator; but in doing so, he should not get too many fingers in the pie. We see a dangerous operation here. The operator testing the mower has his hands very close to the cutting end of the blades, and the superintendent is turning the reel. Close inspection of this particular setting is good but caution should also be used. Only one man should be adjusting and turning the reel.

75. Trained Operators, Cont'd.

On the other hand, to save time, the foreman is checking the reel-to-bed-knife adjustment for the operator while the operator sits in the seat with his foot on the clutch and the motor running. One slip of the operator's foot and the foreman is in danger of serious injury.

76. Turf Accidents.

Now, gentlemen, we have talked a lot of preventive maintenance, care of machines, training of operator, and safe operation. But even the best of us has those little amazing accidents caused when an operator, in his haste to get a job done and preoccupied, overlooks some important facet of servicing. In this particular case, just before a very important tournament, the operator forgot to tighten the oil filler plug. He started his initial cut across the center of the green, noticed what was happening, panicked and went clear across the green, fearful of stopping and letting a puddle of oil build on the green . . .

77. Turf Accidents, Cont'd.

. . . The superintendent decided to try and hide the operator's mistake. And, as Jim Watson would put it, you sometimes compound the condition.

78. Turf Accidents, Cont'd.

This is turf dye and you can see, that in trying to cover up the operator's mistake . . .

79. Turf Accidents, Cont'd.

. . . the problem was compounded. My point here, gentlemen, is do not experiment, especially with your equipment. This will also apply to your turf and grass areas. Experimentation can be costly.

80. Conclusion.

I hope that I have left a suggestion or two with you that will help make your job an easier one. I am sure convinced, and I hope we have proven it, that if you get the right machine, with the right man, on the right turf, you will get a right smart-looking job.

Irrigation is Your Most Costly Maintenance Practice[1]

R. H. Turley[2]

According to a recent survey in the United States, irrigation accounts for 36% of your maintenance costs (1). This is 10% more than the cost of equipment and 13% more than the cost of labor. Irrigation costs amount to over one billion dollars annually for household lawns alone and when you add to this, the cost of watering recreation turfs, parks, boulevards, and cemeteries, you have a very impressing - or depressing - figure.

Irrigation requirements are governed by a number of factors such as climate, soil and maintenance practices. Obviously, you cannot control the climate, but you can schedule your irrigations to suit climatic variation and so conserve water. Such climatic conditions as periods of high winds, intense sunshine, low

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[1]Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2]Turfgrass Research, Canada Department of Agriculture, Saanichton, B. C.

humidity and high temperature all contribute to high water use. Under these conditions the frequency of irrigation must be increased while under the reverse, irrigation water can be saved.

The main function of soil is to provide a medium for supporting the grass. Soil also serves as a storehouse for plant food, it supplies oxygen and it acts as a reservoir for water. The physical characteristics of the soil--structure, texture and porosity--control the movement of water into, through and out of the soil. Soil compaction may adversely affect growth, elongation, soil-water relationships and soil aeration.

These characteristics vary widely with different soils. Sandy soils, for example, are generally loose with little or no structure, are coarse in texture having large particles, and have low porosity or water-holding capacity. Clays, on the other hand, have distinct structure, are fine-textured with numerous small pores which contribute to a high water-holding capacity. The soil acts like a sponge. It will only hold so much water and any excess is lost through deep percolation into the sub-soil beyond the reach of the grass roots. Sands, which hold less water than clays, need more frequent irrigations.

Management plays a major role in maintaining turf and influences irrigation. On heavily used turf, such as golf and bowling greens, fertilizer and irrigation requirements are critical to maintain rapid growth to compensate for wear and frequent mowings. Compaction frequently found in the top inch or two layer of soil restricts the penetration of water, air and plant nutrients into the root feeding zone. Excessive thatch has the same effect. The above examples illustrate the important part management plays in the efficient use and conservation of water.

The main lawn species used for turf in this area have medium deep roots when allowed to grow to maturity. However, frequent mowing drastically reduces the depth of rooting. On a deep clay loam at Davis, California, Hagan (2) found that fescue, bent- and bluegrass lawns removed all available moisture to depths of 8, 12 and 30 inches, respectively. He also points out that available water for plant use varies with different soils. Sandy soils hold 1/2 to 3/4 inch available water per foot of soil; loams about 1 1/2 inches and clay, about 2 1/2 inches. In an irrigation experiment at the Research Station, Saanichton, the turfgrasses removed soil moisture only to the 1-foot depth. On golf course greens, which are more frequently mowed, the effective rooting depth would likely be even less (perhaps about 8 inches); if this assumption is reasonably true, then on a light sandy loam, there will be considerably less than 1/2 inch of moisture available for plant growth and light frequent irrigations will be required.

To illustrate some of these points we have just discussed, I would like to tell you about an irrigation experiment which was conducted at the Research Station, Saanichton, B. C. on two different soil types. One soil was a light gravelly loamy sand of low fertility and low moisture-holding capacity. The second soil was a sandy clay loam of good fertility and high moisture-holding capacity. Four irrigation treatments were applied. These applications were based on a soil moisture budget using black Bellani plate atmometers for estimating potential evapotranspiration. A black Bellani plate atmometer is an instrument which evaporates water in the same ratio as plants transpire water (3). Irrigations were applied when the soil moisture budget indicated:

1) a water deficit of 1/2 inch

2) a deficit of 3/4 inch

3) a deficit of 1 inch, and

4) a deficit of 1 1/4 inches.

All plots received the same total amount of water over the season, only the frequency and amount per application varied. The irrigation treatments were applied to pure stands of fescue, blue- and bentgrass lawn plots. The plots were mowed each week, the clippings saved and dry weight of clippings recorded. Prior to each irrigation, soil moisture was determined by drying soil samples taken at depths of 0 to 3, 3 to 6, and 6 to 12 inch depths.

Results. Soil moisture varied in direct proportion to frequency of irrigation. The frequent light irrigations maintained higher and more uniform soil moisture throughout the season than the heavier irrigations on both soil types. Average soil moisture content over both seasons on the clay loam was 17.60%, 15.73%, 13.50% and 12.88% for the 1/2, 3/4, 1 and 1 1/4 inch irrigation treatments, respectively. On the sandy loam, the average soil moisture content was 12.44%, 9.58%, 8.52% and 8.13% for the same irrigation treatments, respectively. Soil moisture was depleted in an increasing order by fescue, blue- and bentgrasses. The average moisture deficits were in ratio of Chewings fescue to Merion bluegrass to Highland bentgrass, 1200:1493:1660.

Differences in dry matter yields between the irrigation treatments on both soil types were small. The 2-year average yields per plot from both soil types were 926, 914, 858 and 827 grams from the 1/2, 3/4, 1 and 1 1/4 inch irrigation treatments, respectively. The data indicated that all irrigation treatments were sufficient to maintain vigorous grass growth except the heavy 1 1/4 inch treatment.

Visual ratings indicated relatively little difference in turf quality between the irrigation treatments and all except the 1 1/4 inch treatment supplied sufficient moisture to keep the turf growing vigorously and to maintain color on both soil types. In late July of both years, the turf on the sandy soil receiving the 1 1/4 inch irrigation treatment suffered from lack of water and turned brown. This indicated that the soil moisture was only slightly above wilting point.

Irrigation is your most costly management practice and large savings will accumulate from the efficient use of water. Scheduling water applications to suit climatic and soil conditions will contribute to its efficient use. Such management practices as verticutting and aerifying to remove thatch and compaction will improve the percolation and save water which would otherwise be lost by run-off. Frequent and close mowings, as found on golf greens, reduces the effective rooting depth of turf. Under such conditions, light but frequent applications of water are more efficient than heavy applications which would percolate below the turf roots and be lost.

1) Turf Grass Times. Vol. 1, No. 1. Oct. 1965.

2) Hagan, R. M. Know How to Water. Southern Calif. Turf Conf. p. 23, 1952.

3) Robertson, G. W. and R. M. Holmes. Estimating irrigation water requirements from meteorological data. Exp. Farms Service, Can. Dept. Agr. Ottawa. 1956.

Public Golf Courses for the Future[1]

Dick Haskell[2]

1. INTRODUCTION:

   A. Reference to several publications by National Golf Foundation, Chicago, Ill.

      1. Started in 1936 by leading manufacturers of golf playing equipment

   B. Reference to articles by O. J. Noer, Milwaukee, Wisc.

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[1] Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2] Director of Golf, City of Seattle, Seattle, Washington.

C. Reference to articles by members of American Society of Golf Course Architects

2. <u>ARCHITECT FOR GOLF COURSE:</u>

A. Most important move

1. Save money in long run
2. Get correct design
3. Use natural terrain better
4. Experience

3. <u>SELECTING GOLF COURSE SITE:</u>

A. Reasonable cost of land, $500 to $4,000/acre

B. Can be converted into golf course at minimum construction cost

C. Can be maintained at minimum cost

D. 160 acres for 18 holes, 200 for 27 plus driving range

E. Gentle rolling hills with some trees

F. Should allow room for 9-hole beginners' course and practice range (50 tees)

G. Site should be easily accessible--on main road if possible (transient play)

H. Soil should be prime consideration

1. Ideal soil is sandy loam
2. Get inexpensive soil analysis from state agricultural agency

I. Power and water must be available

J. How much clearing and dirt moving is necessary? Can be expensive!

K. What are the natural golf features?

1. Rolling terrain, creeks, wooded areas, ponds, etc.

4. DESIGN OF THE PUBLIC GOLF COURSE:

A. Ideal design would be such that major alterations would never be necessary.

1. Secure accurate map and aerial survey of area
2. Secure topographical map
   (a) on these maps the architect will make a number of preliminary layouts
3. Locate club house, parking areas, practice range, course
   (a) club house on high ground, but not necessary
      (1) last hill uphill--many don't like this
4. Length of holes (total 5,800 to 6,500 yds)
   (a) the length of the hole will be determined by the slope of the terrain and the direction of the play, the natural features from tee to green, and the desire to obtain a variety of lengths within the round.
5. Par of holes, four par 3's; four par 5's; ten par 4's (par 72)
   (a) avoid holes of 250 to 350 yards--too easy, no challenge
6. Distance from green to next tee should not exceed 75 yards (better 25)
   (a) trees should be at least 25 yards from greens and tees
7. Locate 1st and 10th tee and 9th and 18th greens near starter's office--
   (a) starter should be able to see 8th and 9th fairways for 2nd nine starting
   (b) starter should be able to see practice putting green
   (c) starter should have call system to 1st tee, 10th tee, practice green
8. Guard against east and west direction holes
   (a) sun in your eyes--unsafe
9. 1st hole should be easy par 4 or par 5
   (a) few hazards to delay play
10. Start course with easy holes, then advance

them to more difficult

11. Putting green should be visible from approaching area
    (a) sand traps should be visible too
    (b) much safer
12. No blind shots from teeing area
    (a) can be dangerous and slow play
13. Sharply sloping fairways should be avoided
    (a) puts too much luck in game
    (b) makes game fatiguing
    (c) makes turf difficult to maintain
14. To include night lighting?
    (a) how about heavy dew?
    (b) cool evenings?
    (c) resting the course?
    (d) economically feasible with high initial cost?
    (e) does public really want it?
15. Is there a place for plastic grass? (Astroturf)
    (a) for putting greens
    (b) for teeing areas
    (c) expensive? $2.50/sq. ft.
    (d) wear possibilities
    (e) playability
    (f) accepted by the public?
    (g) installation at Jackson Park in Seattle (this fall)
16. Hand carts and motorized carts
    (a) here to stay on public courses?
    (b) provide paths?
    (c) expensive? to rent? to own? owning policies? charges?
    (d) how many seats? one, two, three, four?
    (e) wear and compaction
    (f) dangerous
17. Sand traps around greens? in fairways?
18. Water hazards?
19. Safety of play
20. Speed of play
    (a) any answer to speed play?
21. Grass tees vs. mat tees
    (a) wear factors, winter golf, can you grow grass tees?

Advanced Training for Turgrass Managers[1]

Alvin G. Law[2]

Much is being said about the need for additional education in every walk of life. Low standards of living, runaway population, malnutrition and starvation in the under-developed countries of the world can be related to illiteracy and lack of education. Can we relate the lack of education at a somewhat higher level in our own country to the problems in the total turfgrass industry? Can the "apprentice system" of the past serve the future? Is the "Keeper of the Greens" of the 18th century now a modern Agronomist or Horticulturist? What is the size of the turfgrass industry? What is its scope? Let us examine a few of the factors that are involved today in the consideration of the total turfgrass industry.

Nutter, Vol. 1, (1), Turfgrass Times, assembled data from surveys in different areas of the country to show that the total turfgrass industry exceeds 4 billion dollars annually. This $4 billion involves the annual exchange of monies for services rendered and is not a reflection of the true value of the total real estate involved in the turfgrass industries. Some 70% of this $4 billion is involved with home and commercial lawns. Cemeteries comprise 8% of the total and golf courses only 5.5%. The estimates Nutter used were conservative and the $4 billion may easily be $6 billion today.

More specifically, what is happening presently in the area of golf course operations? The most recent estimates by the National Golf Foundation indicate that by 1970 there will be 10,000 regulation golf courses and

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[1] Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2] Professor of Agronomy, Washington State University, Pullman, Washington.

approximately 1200 par 3 golf courses in the United States. In addition, there are presently 4500 driving ranges in operation in the U. S. with an estimated increase of 10% per year in this area. There presently are approximately 600,000 acres of grass devoted to golf courses in the United States alone. One estimate is that the total annual budget for operating these golf courses is over $500 per acre. In 1967, there were 8 1/2 million people in the United States who played 15 rounds or more of golf. This is approximately 1 golf course for every 900 golfers in the United States. Compare this with New Zealand who has one course for every 180 golfers. In spite of the fact that less than 50% of the turfgrass superintendents in the United States keep adequate records of their operation, these still are truely impressive figures on the size of the industry.

The manager of a turfgrass operation, whether he be a golf course superintendent, a city park superintendent, a school playground supervisor, or the manager of a cemetery, must wear a great variety of hats in his daily operation. He must, first of all, be able to work with people, both people who are his supervisors and people who are his employees. Thus, he must be a practicing expert in public relations and personnel management. He must be able to recognize common disease and insect problems, and he must know what to do about these. He must be able to recognize serious weed problems and know what can be done. He must know what fertilizers to use, in what proportions, and how often in order to keep the turf in top condition. He must know about water use, its penetration and retention in the soil, and he may need to know about drainage and soil pH. He must understand soil compaction and its relation to texture and structure and its relation to use of the area. He must know about turfgrass species and varieties and their adaptation and special characteristics. He must understand the operation, maintenance, adjustment and repair of many different kinds of relatively expensive equipment. He must know how to keep accurate records and prepare budgets that are clear and understandable to his superiors. Dr. Paul Sartoretto, President, W. A. Cleary Corporation, in his talk, "Keeping Control" at the 38th International Turfgrass Conference, 1967, stated, "A knowledgeable golf course superintendent is self-confident.", -- "As long as he is the most knowledgeable man about grass on his golf course, he is going to be respected and gain the confidence of his entire membership." This applies, of course, to the person managing turf in general, not only to the golf course superintendent.

The person who "knows more about grass" than anyone else and who knows also from a practical standpoint of the relationships between soil and air temperature and response to pesticides of various kinds and to fertilizers, and who can relate water movement in soils to some of the basic principles of soil physics and plant growth and who can interpret this knowledge and this experience to both his superiors and to his employees will be a truely successful turf manager. As leisure time increases in this country, there will be more and more pressure on the open spaces, -- the parks, the golf courses, and the playfields that are an integral part of our Heritage. Additional education of a formal nature coupled with the continued use of the apprentice system of the past is the only way in which we can continue to provide the quality turf necessary for recreational uses.

There are currently in the United States only 4 Universities which offer a degree in turfgrass management. Therefore, we look to these universities to provide the staff and leadership that can be used in positions of training in industry and in other universities who may emphasize turf management in the regular Agronomy or Horticultural major. A listing of the courses suggested and required by one university (Purdue) is as follows:

SUGGESTED TURF MANAGEMENT COURSES

Purdue University

Those marked "R" are required.

AGRICULTURAL ENGINEERING

Elementary Drawing for Forestry Students
Farm Structures
Agricultural Tractors & Their Power Units
R Drainage, Irrigation & Erosion Control
Farm Tractors and Engines

AGRICULTURE

R Agricultural Lectures

AGRONOMY

Crop Production
Grain & Forage Crops
R Soils
R Soil Fertility
Technology of Field Crop Seeds
R Genetics
Agricultural Meteorology

ENTOMOLOGY

Introductory Entomology
R Fundamentals of Applied Entomology
Theory & Practice of Economic Entomology
Insecticides, Formulations, & Appliances

GEOLOGY

Physical Geology
Historical Geology

GOVERNMENT

Introduction to Government

Elements of Democracy
International Relations

HISTORY

Early Civilization
The United States & Its Place in World Affairs
Soil & Plant Analysis
Agronomic Phases of Water Management
R Soils and Crops Seminar
R Turf Management
Field Crops Breeding
R Crop Ecology
R Soil Physics
Soil Classification & Survey
Intermediate Soil Science
Special Problems

ART & DESIGN

Basic Design
Basic Drawing

BACTERIOLOGY

R Bacteriology

BIOCHEMISTRY

R Agricultural Chemistry
Plant & Animal Biochemistry

BOTANY & PLANT PATHOLOGY

R Introductory Plant Pathology
R Weeds and Weed Control

CHEMISTRY

R General Chemistry (two semesters)
Introduction to Qualitative Analysis
Introductory Quantitative Analysis
R Organic Chemistry

ECONOMICS

R Principles of Economics
Introduction to Accounting & Cost Accounting
Personal Finance
Legal Background for Business
Business Law
Insurance Principles
Land Economics
History of Indiana

HORTICULTURE

Introduction to Horticultural Sci.
Floriculture
Landscape Appreciation
Nursery Management
Greenhouse Management
Plant Protection

INDUSTRIAL MANAGEMENT

Industrial Sales
Small Business Management

MATHEMATICS

R Algebra
R Trigonometry
Analytic Geometry, Differential Calculus
Analytic Geometry, Integral Calculus

MILITARY SCIENCE

R Two years for able-bodied non-veterans

PHYSICS

R Outline of Physics for Agric. students

PLANT SCIENCE

R Introduction to Plant Life

Agric. Application of Plant Science
R Introductory Plant Physiology
Taxonomy of Seed Plants
R Ornamental Plants
Introduction to Plant Anatomy
R Intermediate Plant Physiology

PSYCHOLOGY

Elementary Psychology
Psychology of Sales & Advertising

SOCIOLOGY

Introductory Sociology
Urban Sociology
Marriage & Family Relationships

ENGLISH

R English Composition I
R English Composition II
Introduction to Literature
Agricultural Writing
Business Writing

SPEECH

R Principles of Speech
Business & Professional Interview

ZOOLOGY

R Biology of Animals

You will note the great diversity of courses that have been organized into the proposed curriculum. They are designed to give the student who takes a major in this area some background in the physical sciences including mathematics and chemistry. He will have even more training in the biological sciences including Agronomy, Botany, Plant Pathology, Horticulture, Entomology, and Zoology. He will have courses in the Humanities and Social Sciences which should be of considerable use in his future contacts with his supervisors and his employees. There are a number of courses in the area of economics and business management which are important in the day to day operation of any sizeable business. While there may be minor variations from school to school throughout this country, any of the land grant universities in the United States can provide the same general structure of course work for students interested in becoming turfgrass managers. They may "major" in such fields as Agronomy, Horticulture, General Agriculture, or Plant Science. The particular field listed on the diploma is not the important thing. The important thing is the course content of the course of study he pursued attaining that diploma. A specific example of the studies in Agronomy at WSU is shown in Table 2:

Table 2. STUDIES IN AGRONOMY AT WSU

A. General University Requirements
   1. English Composition - 3 hours
   2. Physical education - 4 semesters
   3. Humanities and social sciences - 12 hours. (3 hours in each area). Speech 112 (H) and Economics 201 (S) are suggested.
   4. Sciences - 12 hours. (3 hours in each area). Bacteriology 201 (B) and Geology 101 or Physics 101 (P) are suggested in addition to the other courses needed for support of major field--Biological Sciences 103, Botany 201, Chemistry 105 and 106, Mathematics 101 or 107.

B. Necessary major and supporting courses
   1. <u>All Agronomy students</u>
      a. Agronomy 201, 312, 411, plus 8 hours of electives in Crop Science
      b. Soils 201 plus Soil Fertility
      c. Chemistry 240 and/or Chemistry 217
      d. Biometrics 310 or BA 315
      e. Botany 320 (Plant Physiology)
      f. Entomology 345 and 345L

g. Plant Pathology 329
h. Genetics 362 and 345
i. Communications elective

2. Science-oriented students who intend to do graduate studies should take the following additional supporting courses:
   a. Botany 332
   b. Biochemistry 364 and 366
   c. Physics 101 and 102
   d. Mathematics electives
   e. Foreign lanquage electives
3. Students oriented toward agricultural industry and technical employment should take these supporting courses.
   a. Agricultural economics electives
   b. Business administration and economics electives
   c. Electives in other agricultural areas

Here we have listed the general university requirements, the necessary major and supporting courses separately. You will note that the student is required to take 12 hours of humanities and social sciences. These include courses in speech and economics and may include additional courses in Sociology and Psychology. In the sciences the student will take Chemistry, Mathematics, Bacteriology, Botany, and perhaps Physics.

These are background courses which permit the student then to build on this basic knowledge as he studies plant pathology, entomology, soils, agronomy, landscape design, etc. He can understand the relationships between the plant and the environment in which it is growing and the various hazards that may affect its growth. Students oriented toward industry and technical employment will be encouraged to take business and economics courses so that they will understand business procedures, budgets, and the problems associated with communications between individuals.

These two examples serve to illustrate the courses of study that are available at four year universities and colleges for persons interested in turf supervisory work. The greatest problem facing those of us working in the area of turf as well as the areas of production-agronomy and horticulture is finding enough students to satisfy the demands for these various fields. Turf management jobs, including golf course superintendents, are competing directly for graduates in agriculture with the fertilizer industries, with the seed industries, with extension services--soil conservation service, and various other agencies and the number of students is not large enough to satisfy the demands now or in the forseeable future.

At the community college and college level much interest is also being evidenced in the training of people specifically for the field of turf management. Formal courses are offered dealing with some of the fundamental or basic principles or they may be applied courses dealing with such things as turfgrass varieties, soil management and fertilization, mowing, equipment maintenance and operation, and irrigation methods, -- frequencies, and duration, and thatch control. Many of these courses carry college credit and can be entered by persons without formal advanced training but with considerable field experience. They are particularly popular in the California area of the west where many such courses are offered by the 4-year community colleges that have developed there.

Annual turfgrass conferences are now held in every area where turf is important in the United States and Canada. Over the years these have resulted in a significant amount of very excellent training for turfgrass managers. In fact, throughout the country these conferences have provided the nucleus for the present interest in expanding the training available to turfgrass managers throughout the country. They also have resulted in the development of very extensive publications that are of considerable importance in the training schools that are now being held at the Community College or University level also.

In addition to these opportunities there presently is interest in the vocational program in the high schools in developing courses related to the training of people in applied turf areas. Here the training could be particularly valuable in developing the interest of younger persons in turfgrass work. In addition, the 4-H programs in some states are attempting to develop projects and training sessions involving the 4-H students and leading turf managers in a particular area. These training programs develop student interest in proper adjustment and use of lawn mowers, weed control, fertilizer use, irrigation practices and even public relations. They are designed to increase the effectiveness of the young people who are currently in junior high and are mowing lawns during the summer. The most valuable resource people for this sort of training are the golf course superintendents and the park supervisors in each particular community.

One other development that may have a significant influence on the interest in training in the turf area is the renewed interest in the "quick college" or two year institute. Several universities are offering this program which involves a two-year course of study plus a summer of practical experience at somewhat less expense than the four-year program. There is also less emphasis on the basic physical and biological sciences and more emphasis on some of the applied courses. Two year institutes are currently being offered at 3 universities in the U. S. Most of the students who enroll in these institutes eventually end up taking the regular four-year course.

Specifications for Turgrass Installations[1]

Roy L. Goss[2]

Specifications are prepared and used as a means to bring clarity, understanding and definition of a job to be done between an owner and contractor. A good set of specifications leaves little to the imagination of either party and, when properly written, affords a great deal of protection to all persons concerned. A poor set of specifications can lead to: (1) poor quality of work, (2) unfinished jobs; (3) loss of money, (4) loss of time, (5) lawsuits, and many more problems.

Types of Specifications

Specifications vary all the way from complicated, elaborate government (federal, state, provincial, county, and city) jobs on down to private endeavors. Regardless of who the job is for, the specifications should provide a common, unbiased basis for which all contractors can make competitive bids. It should be pointed out at this time that there is probably no better way of determining the best price to do a job than by competitive bids. Most contractors or builders make money, some break even, and some lose by becoming over-enthusiastic in their bidding or by overlooking some costly item in bidding.

Marginal Contractors

Perhaps there is no such term as a "marginal contractor", but let us use the term in reference to those with aged equipment, those slow to pay their bills, and those who take on too many jobs at once. This type of contractor will often try to find loopholes in contract

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[1]Paper presented at 21st N. W. Turfgrass Conference, Harrison Hot Springs, B. C. September 20-22, 1967.

[2]Associate Agronomist and Extension Specialist in Agronomy, W. W. Research & Extension Center, Washington State University, Puyallup.

specifications where they can save money regardless of the type of resultant job. A recent example of this occurred on a school site where a steep bank was to be seeded and jute matting placed for erosion control. The contractor placed the jute and then hydro-seeded with seed and wood cellulose fiber "over" the jute. Obviously, this is not satisfactory, but someone is to blame. He should be required to re-do the job, but how did the specifications read? Another case involves a landscaper who tried to substitute a fertilizer with only 1/2 the total plant food as specifications called for. This item would have made him several dollars, but the school concerned would not have gotten the stand of grass. Many instances occur where soils or organic material are supplied that don't resemble those specified. In these cases, the owner must have knowledge of these procedures or have a properly qualified person in their employ to check for them. If the specifications are properly written, then the contractor must comply.

Bum Specifications

Perhaps the most unpardonable deed is on the part of a specification writer or architect who prepares "specs" in ignorance of prevailing practices. For the purpose of constructing play or athletic areas, golf courses, or other lawn areas, a few suggested specifications are offered as follows:

SOIL (Top Mixture)

A. Putting greens or football fields for the Pacific Northwest: The top mixture for these areas shall consist of soil containing 90% sand and no more than 10% silt and clay. The sand particle sizes shall be as follows: no more than 15% finer than 1/2 mm (100 mesh) nor more than 20% coarser than 1 mm (25 mesh).

To a soil of this composition, add 20% organic material by volume and thoroughly mix components together off-site. Organic material must be selected from the following:

1. Fibrous sphagnum peat moss.
2. Sawdust (alder, fir, hemlock, cedar, or mixed coniferous or alder).
3. Other specially prepared wood products approved in the trade for these purposes.

B. Other Turf Areas (Lawns, Playfields, etc.): The usual material for these areas would be a sandy loam or loamy sand. A good sandy loam topsoil (containing 2% organic matter or more) would require no organic matter addition. Lighter soils such as loamy sands or sands should have as much as 20% organic matter by volume incorporated as discussed in "A" above.

In order to determine if you are specifying what you mean or if you are getting what was specified in soil, the soil textural triangle will help to determine your soil texture.

Whether you are a soil supplier or buyer, you must rely upon laboratory, mechanical and sieve analyses to prevent guessing. All owners and architects should require contractors to show proof of these tests before accepting the material.

FERTILIZERS:

All too often, poor quality fertilizers are foisted off on unsuspecting builders due to a lack of knowledge about them. Fertilizer specifications should include some of the following points:

1. Guaranteed analysis label on the bag.
2. Weight of the bag shown.

3. Specify if the material must be lump free and free flowing.

4. Specify, if the material is granular or pelleted, that it must be dust free or state percentages passing certain sieves.

If a porti on of a nutrient is to be supplied from an organic source, be sure to state the exact amount and from what source. Never say organic base, blood base, fish base, etc., etc.

It is preferable to have soil analyses available to base fertilizer specifications on, but it is not always possible, due to earth moving, unpredicatable supply sites, etc.

GRASS SEED:

Generally, when we state in the "specs" that all seed must be "certified," this is usually sufficient but there are times when we want even more rigid control of quality. For example, it is possible to specify and buy grass seed "*Poa annua* free" and, in the case of greens, nursery plantings, and good lawns, it pays.

In recent years, a term has been employed by seedsmen in describing top quality bluegrass. This term is "Sod Quality" and denotes elite or best seed.

How About the Proper Genus and Species?

All of the foregoing about quality is almost meaningless if the person writing the "specs" recommends the wrong grass. Many recommendations for turfgrass plantings in areas east of the Cascade Mountains call for bentgrass in the seed mixture. Unless this is for greens or tees, a person so recommending should be "drawn and quartered." There is hardly no worse weed in turf plantings in the area mentioned than bentgrass. It thatches, puffs, spreads, gets snow mold and other diseases, is not drought tolerant, etc.

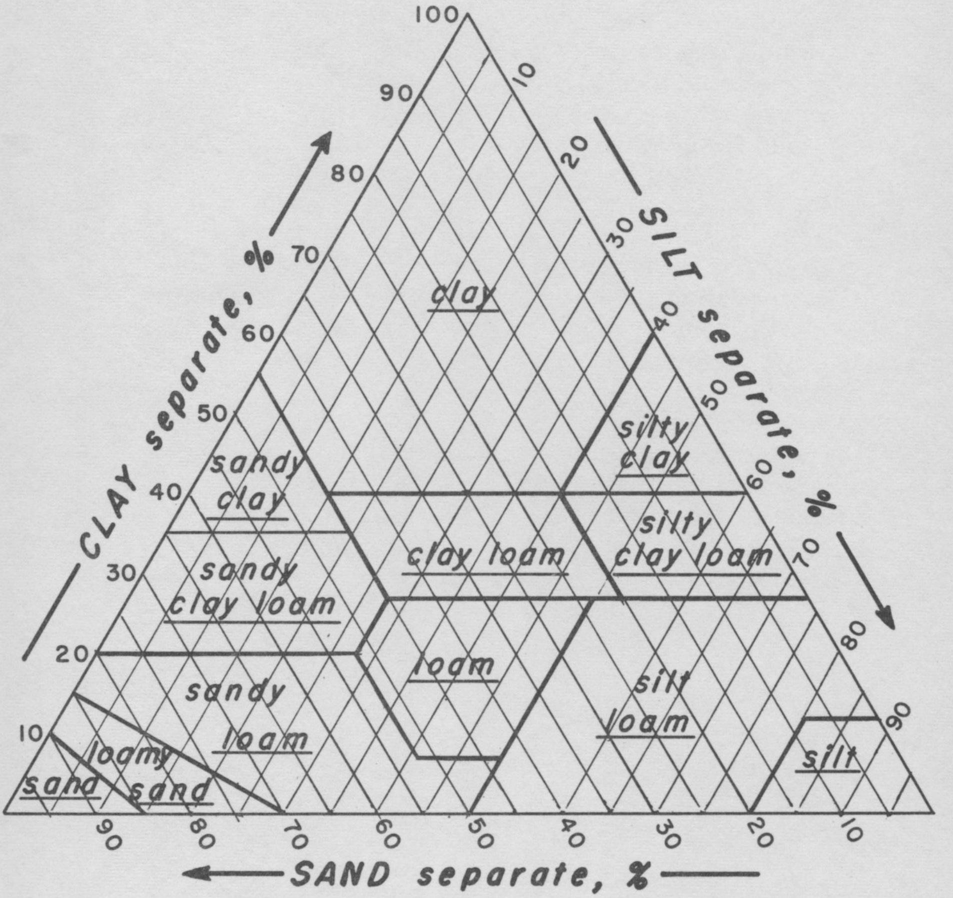
How About Non-Fumigated Soil?

How much good does it do you to call for top quality seed if you plant it on weed-infested soil? It always pays, but your purity of stand is reduced if the soil is weedy. Many times, owners end up with a weed patch instead of a lawn and want to sue the landscaper or seed dealer for selling "junky seed." If they didn't start with weed-free soil, I doubt that any court in the land would rule in favor of such an individual. If fumigants are to be used, the type, method of application, quantity, and other salient details should be carefully explained in the specifications.

SUMMARY

There are many more things that go into specifications other than the ones pointed out in this paper. However, from an Agronomist's point of view, these areas (soil, fertilizer and seed) are the most flagrantly violated specifications. There is no excuse for ignorance on the part of persons developing these specifications, because the necessary information is usually available. Likewise, there is no excuse on the part of the contractor in not carrying out the specifications to the letter if they are properly and clearly written.

The last word in specifications and in getting them properly carried out is having someone properly qualified to do the inspection. A contractor will often and knowingly substitute or do a poor job if he thinks no one will know the difference until his period of responsibility has passed and it's too late.



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