



IDEAS OF THE FUTURE AT WORK TODAY

IN THE 1990s: MORE PEOPLE... MORE WORK... MORE MONEY...

If you work in one of the green industries and thought you had it good in the 1980s, you ain't seen nothin' yet. Read on.

by Jerry Roche, executive editor

The green industry continues to expand at an amazing rate, according to statistics obtained for this LANDSCAPE MANAGEMENT "State of the Green Industry" report.

For instance, a survey conducted just three years ago indicated that 41 percent of LM's readers were involved in ornamental installation and care. In an exclusive survey conducted this fall, that number zooms to 69 percent as operations have sought provide clients with more services and more diverse and beautiful landscapes.

In the 1986 survey, 49 percent of our readers indicated they purchased fungicides for turf disease control; this year, 73 percent said that they offer disease control.

Though most landscape operations are still small (fewer than five employees), the industry is attracting more workers. In 1988, the survey notes, the average staff was 20.8; in 1988, the average staff was 21.8. Projected to the magazine's full read-

ership, employment rolls totalled 982,231 in 1988 and 1,040,927 in 1989. That, nationally, means at least 60,000 new workers in the industry.

Managerial wages have not changed much. The average LM reader makes \$32,117.24 per year with the bulk of those (64 percent) in the \$20,000 to \$40,000 range.

Despite many concerns (see related article), most landscape managers remain optimistic about the green industry as they head into the 1990s. Almost 20 percent of our readers who took time to return questionnaires rated their outlook perfect 10s on a scale of 1-10. Sixty-five percent gave the industry at least an 8, and the survey average was 7.99.

Here is a quick summary of our findings in the three main segments of the green industry.

Golf: more public?

The golf industry's response to an increased need for more holes has been

good. Yet the average golfer will face long lines by 2000 if private courses continue to proliferate.

Developers see residential/member courses as the quickest way to make money—by selling the course to members as soon as possible. But the "equity" course is not without its disadvantages. Members descend upon the superintendent; everyone's a boss. Policital, stressful situations can follow in this scenario.

Profit, however, can be made from a long-term commitment to public courses. Industry experts see a need for more investor groups interested in one public course for a long time.

Landscaping: more companies

The landscape industry in 1990, according to projections, will be a phenomenal 25 to 40 percent larger than in 1989. Why? Because both homeowners and business owners are putting increased emphasis on good-looking lawns and landscapes.

This virtually uncontrolled growth will probably result in new landscaping contracting companies coming into the market, experts say. As a matter of fact, if 1989 is an indicator of the potential quantity of new companies in the industry, most markets will see the number of companies double.

Government: negativism

There exists among landscape managers in the government sector a degree of pessimism as the 1990s approach. Tax cuts mean cuts in the budgets of governmental institutions. And history has proved that landscaping is the first thing to go.

There is also a need to look at the government landscape manager as environmentalist. Most agree that they must do a better job of communicating. For the public to insist that government institutions abandon pesticides in the landscape borders on the ridiculous, some say.

Summary

The 1990s promise to be different in many ways for the landscape manager, depending on his or her individual field of expertise. But all indications are that the green industry as a whole will continue to grow at a healthy pace—healthy for the industry, healthy for society and, especially, healthy for the environment.

890

WHAT READERS SAY

When asked what factors would have a financial impact on their operation in 1990, an overwhelming number of LM readers (60 percent) indicated liability insurance. Also high on the list of concerns were equipment maintenance (54 percent) and insurance other than liability (49 percent).

LANDSCAPE MANAGEMENT readers voiced a number of concerns in their open-ended responses to the survey questions. Here are some of their comments:

- "Problem number one is labor; problem number two is insurance."

- "You should send the results of this survey to the heads of government so they can read about the importance of training and proper equipment in this industry."

- "I think golf course construction and multi-family homes around golf courses will continue to increase in the '90s."

- "We are in desperate need of upgrading our status as professionals in this industry. 'Landscapers,' 'arborists,' 'grounds maintenance personnel' and others representative of this field should have accrued a minimum requirement of educational credit or certification in order to get a dealer's license. \$50 is still a small fee to pay to receive all the advantages of established, legitimate businesses trying to pay technical personnel and remain competitive with seasonal operations."

- "Expansion begins in 1990 for our course. We're revamping the back nine and adding nine more holes with a new clubhouse at a cost of \$2.5 million."

- "We need an active organization to control various aspects of the industry, not only for the people in the industry, but for the consumer as well. Public opinion must be improved!"

- "The green industry has hopefully hit bottom in Texas and will have moderate construction growth going into the 1990s."

- "Overall, this industry is overworked and underpaid."

- "Being a golf course superintendent is a thankless job. Most people or owners don't realize the amount of variables involved that affect providing a quality facility. As prepared as you might seem, Mother Nature is always throwing you curves."

- "Operating budgets are becoming tighter as enrollments start to drop because of student age population decrease. We need ideas and help to be able to do more with less."

- "We dropped all maintenance in the spring of 1989 due to insurance and vehicle costs and employee turnovers. We are concentrating on installation and having a great year."

- "Quality-minded individuals in the mowing end of the business are very hard to find and keep."

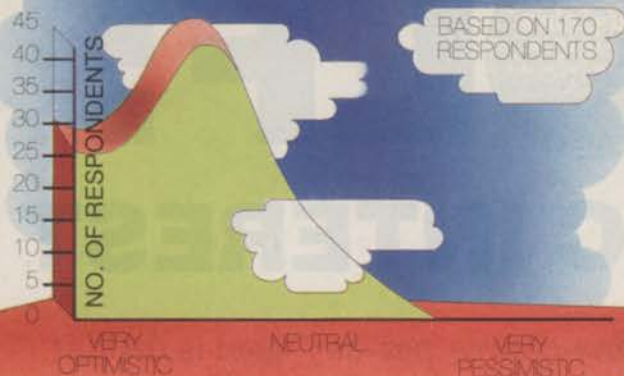
- "Water and governmental regulations could affect the whole industry."

- "As the population increases, the need for open/green spaces increases. Desire for athletic fields, recreation areas and hiking trails is on the increase."

- "One of my main objectives is providing chemical awareness to my customers, so that they know that I am applying the safest and most effective controls."

- "There's a tremendous golf boom in Hawaii. There's a landscape material shortage with all the construction projects, but it's a great time to be in the industry."

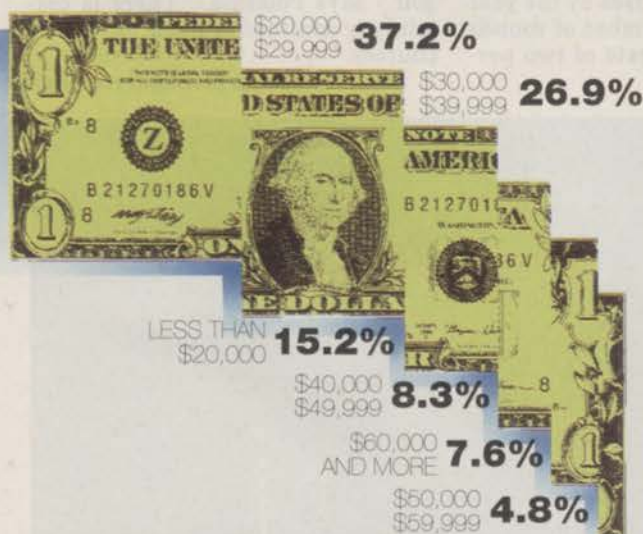
—Jerry Roche □



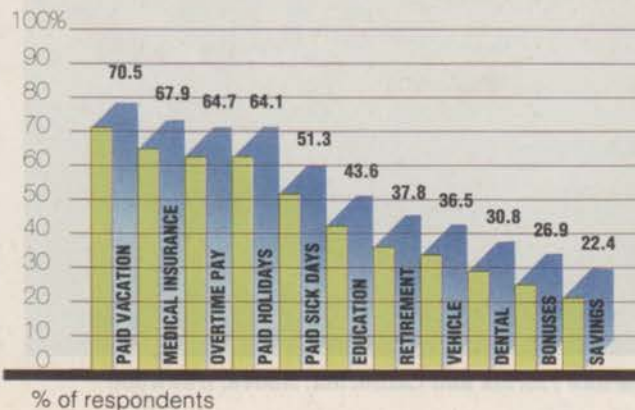
OUTLOOK

FOR THE GREEN INDUSTRY IN THE 1990s

WAGES ANNUAL WAGES REPORTED BY LM READERS



BENEFITS PROVIDED BY LM READER COMPANIES



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90 GOLF: IN THE PUBLIC INTEREST

The golf boom rolls along, though the 'one-course-per-day' goal is distant. More public links are needed, or Joe Golfer faces longer lines.

by Terry McIver, associate editor

Golf course developers in the 1980s harkened to the call for more and better golf courses. But as the industry enters the '90s, development of more public-access courses must quicken to match the demand expected by the year 2000.

Ribbon-cutting continues at courses across the nation. Regionally, the Southeast is most active in new project development. Florida leads

the region, with 39 courses planned. Angelo Polermo, vice president of golf course development for the National Golf Foundation (NGF), says construction nationwide continues at a good clip, based on annual NGF surveys, but still warns of a "capacity gap" of 4,000 golf courses by the year 2000, "even if the number of rounds played grows at the rate of two percent each year."

NGF expects 315 new courses to be opened nationwide by 1990. At least 138 of those, according to Polermo, will be resort/residential courses out of reach for the public golfer. "We (the United States) have 24 million golfers playing 487 million rounds of golf," says Polermo. "There is certainly a continuing need for public courses."

Still, Polermo is justifiably excited



Great scenery and year-round sun are big draws for golf states like Florida and California. Above, Ironwood Country Club in Palm Desert, Calif.

when he sees the golf construction industry harken to the call for more courses.

"The industry recognizes the validity of the NGF's research, which indicates that there are some very strong golf markets out there," he notes, "and this is demonstrated by the number (of golf courses) under construction and recently opened."

Financially speaking

California's Palm Springs area, long a premier golf mecca, has a thirst for more public courses that won't take a divot out of middle-income pocket-books. Bob Stucynski, superintendent at Ironwood Country Club in Palm Desert, notes that the surrounding Coachella Valley has only six or seven public/semi-public courses that charge from \$25 to \$50 a round. The yen for private, residential courses seems to be driven by developers' desires for quicker investment returns. Much of the thinking, according to Stucynski and other supers, is that with high land prices and no housing developments to provide extra income, the lag time before a public course can be successful is a million yards long. A public course built for \$2-4 million would take 10-15 years before becoming profitable, especially with low green fees.

"Even if you run 380 rounds through each day," reasons Stucynski, "you still have operational budgets (which will vary), depending on what condition you want the course to be in. Let's say your maintenance and pro shop operation costs \$2 million per year, with salaries. You've got to generate \$2 million worth of outside play. Where are you going to get the money to pay off the initial premium?"

Public courses work

Funding is the biggest bunker to clear when it comes to development, and the combined resources of multi-investors can make it easier.

More private investors have to become aware of the money-making potential for new courses.

"No question about it," says Tom Haugen, of Stonebrook Golf Course in Shakopee, Minn. when asked if a public course can be a more profitable venture.

"You've got so many more people to draw from," states Haugen. "People don't like to play 20 rounds of golf at one place (as do members of a private club). It's an easy way to set up a golf course, with virtually no advertising other than to announce that you're open."

Jerry Lemons, superintendent at Tennessee's Old Hickory Country Club: "The business has been looked at by owners as an 'ego-driven' enterprise rather than one by which owners can profit."

How much money can a public golf course make? "If you can keep land

hire a lot of lawyers and environmental engineers, and face a two- to three-year permit process before you can even break ground. In many cases the privates have access to more financing, but that's a generalization."

But to some experts, the "members only" golf course is not an absolutely more profitable way to play the game. Golf course architect Michael Hurdzan serves as president of the American Society of Golf Course Architects. Hurdzan believes there is a mistaken belief that a golf course developed in tandem with housing must someday become a private course in



Florida golf course designers Lloyd (left) and George Clifton believe in an "absolute need" for more public access courses in the state, just as in the U.S.



Bob Stucynski says that, for quicker investment returns, developers build residential courses. Wholly public courses don't prove as profitable as soon.

and construction under \$2 million," insists Lemons, "you can pay for that course in five years."

But is it indeed that quick a return? According to Pat Jones, director of communications for GCSAA, a public course can be a hard row to hoe.

"It takes quite a bit of capital to work for two or three years in advance of construction," reminds Jones. "To go through the permit process, to complete environmental audits, and deal with the government, you've got to

order to exist profitably.

"Primarily," states Hurdzan, "golf development is in the golf resort and second home market. That doesn't mean the most demand is there; that simply means that that's the easiest way to develop."

According to Hurdzan, "20 percent of the people who buy homes in a golf course development play golf. The other 80 percent want the amenity of not having neighbors; they just want to sit on their patio (and enjoy the view)."

"We in the golf industry can make the boom continue for a long time," Hurdzan warns, "or we can kill it by charging too much and trying to put too many people on too few courses."

The average golfer needs the help of the golf course construction industry. A developer in suburban Chicago, for instance, says golfers at courses there constantly face long lines.

More groups of private investors looking for a long-term commitment are needed. Those who will build the course and manage it for a long term. It can be done, and is in the best interest of golfers everywhere serious about the game.

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TRUTHS AND CONSEQUENCES

Chemicals were favorite targets for environmentalists during the 80s. The future holds more of the same scrutiny.

"Be prepared," says Jerry Lemons of Old Hickory Country Club. "When there's a tragedy, it jumps out at us. That's when we in the business get hurt the most. Pesticides are guilty before proven innocent."

GCSAA's Pat Jones says resistance from persons who do not want to see a golf course built in their neighborhoods is a towering hazard many developers must clear to reach the green. And the best defense is to stay one step ahead.

"GCSAA's role," explains Jones, "is to educate the public, develop factual information and data, and prove to the public and government regulators that golf courses are safe places to be, are not damaging to the environment, and—if anything—are an environmental benefit."

Remembering the drought of 1987-88, superintendents want more sensitized irrigation systems that conserve more water. Systems are now hooked into weather stations that adjust the watering cycle based on daily evaporation rates; soil sensors corroborate with weather system information.

"We're seeing the trend to double- and triple-row irrigation," says architect Michael Hurdzan. "We're going to two or three systems of sprinkler heads around a green as well."

Lemons says the cost of lightweight mowers can outweigh the gains.

"On warm-season grass courses especially," he says, "wear and tear is not as critical as on bentgrass fairways. In the South, it's been one of those fads that has pushed down our way. You can still use the tractor-type mowers, and maybe go to a 10-bladed unit rather than a seven-bladed one.

"We've got 120,000 square feet of greens," says Lemons. "And we want to maintain high stimpmeter readings. Smaller triplex mowers are used on greens and approaches. We have Bermuda fairways, and we overseed with rye in the fall. By the time we get the Bermuda pumped up to take over the rye, we're on a five-day cutting schedule."

"The competition has forced us to lightweight mowing of fairways," says Brice Gordon of the Audubon Country Club, Louisville, Ky.

"You've got tremendous-looking courses out there," says Gordon, "thanks to the new varieties of grass and new equipment. It's a positive development. We now mow fairways six times a week at 1/2-inch. People want that quality."

Hurdzan also notices greens getting flatter, but not without drawbacks. "Lower cutting heights are due to less slope. They're mowing so close that if we put very much pitch to a green, the ball starts rolling too much. So we're forced to design flatter greens.

"Consequently, the flat greens don't have surface drainage. And shots don't hold as well, so superintendents are forced to over-water. Before, we could bank them. All the water goes through the soil profile, so we have more disease problems as a result of that."

The solution then is to increase the infiltration rate of greens, to dry them down.

Rolling mounds, wrap-around bunkers and elaborate water hazards have satisfied golfers' desires for challenging (some say impossible) shots and beautiful scenery. But design often becomes a game of one-upmanship, leading to time-consuming, costly maintenance.

Jones believes that with the heavy public demand for golf there follows a demand for relatively inexpensive tracks of \$2-4 million. "Without proper maintenance and a proper superintendent, the more expensive courses can be difficult to maintain. You might spend \$1 million a year to keep the place going."

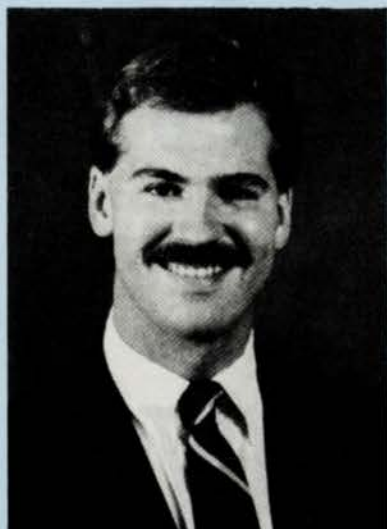
Lemons recently re-designed and rebuilt the greens and bunkers of Old Hickory Country Club in Tennessee. He believes that many current designs neglect maintenance concerns, and will frequently build huge mounds into designs "to keep up with the big boys."

Lemons asks, "How long can the course be maintained at the dollar figures that are received from public golfers? Big-name designers spend upwards of \$6 million, and often create nightmares for maintenance."

Lemons is using foresight. His concern is the capital required to maintain that look. "If the economy goes bad in the future," Lemons asks, "can we afford million dollar maintenance budgets?"

The answer: "Design for maintenance, and realize that form follows function."

—Terry McIver □



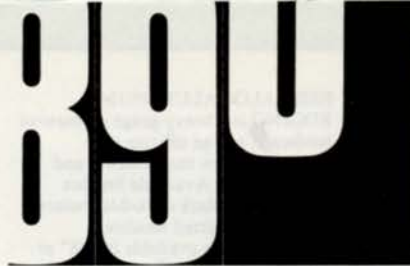
Pat Jones



Michael Hurdzan



Brice Gordon



DOUBLE YOUR MONEY:

LAND\$CAPE

Rapid growth for the landscape industry will continue into the next decade. Opportunities exist for the industry to double in the next three years or sooner. Being able to secure some of this available business will mean that you need to develop your management to take advantage of the growth.

What is the outlook for 1990? Is this an industry where diversifying companies are likely to expand? Will it be an industry where new companies can find an opportunity? What will happen to the quality of service as the industry expands?

Residential, commercial

Residential occupants are getting tired of spending time maintaining their properties externally. In addition, residential customers of chemical lawn care companies are starting to consider outside contractors to perform the rest of their landscape services. These non-commercial customers are realizing that, if they are to have multiple property services performed on their landscape, it can be cheaper and more effective to have

Our intrepid business expert peeks into his crystal ball and sees up to 40 percent—that's right, 40 percent!—growth in the landscape market within the next year.

by Ed Wandtke

only one service company.

In the commercial sector, companies that had been maintaining their own property are starting to turn to professional service companies. This is happening because of expanding pesticide regulations. Companies do not want to worry about liability issues derived from applying pesticides. Also, many businessmen believe that an outside landscape company can do the job better and cheaper.

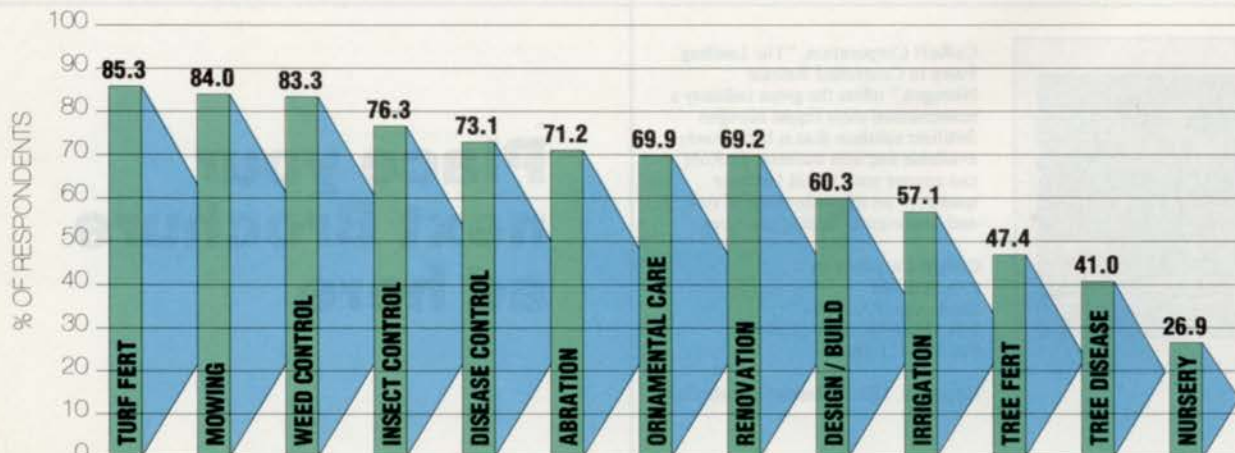
Increased growth, then, will come from first-time customers and more residential and commercial customers seeking outside professional landscape services. A 25 to 40 percent

growth in the entire landscape services market over 1989 levels is not out of the question.

New entries

With this growth will come many new companies. If 1989 is an indicator of the potential quantity of new companies in the industry, most markets could double in size. While many of these new companies often tend to lower prices for a while, most go out of business if they are not providing the service above cost. For most U.S. markets, the failure rate of these new companies is often more than 50 percent. These companies often do not fail because of under-capitalization

SERVICES PERFORMED BY LM READER COMPANIES



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Landscaping allows a company the opportunity to self-destruct because it took on more work than it could reasonably expect to service.

but rather because of management incompetence.

Seeing an opportunity in the landscape industry will not assure a start-up company that it will make it. As a matter of fact, customers will cancel landscape services because they failed to provide on a timely basis the only item they are selling—"service." Like many industries, landscaping allows a company the opportunity to self-destruct because it took on more work than it could reasonably expect to service.

Since there is no licensing requirement to provide landscape services, there is no effective method to police the industry. This may change in the future, but for now there are almost no barriers to any individual wishing to enter the landscape industry.

Many companies currently

providing some lawn care or tree services are starting to look at expanding into landscape maintenance. ChemLawn and Tru-Green, for instance, are testing the possibility of offering landscape maintenance services. And their tests will probably tell them there is an opportunity to enter this lucrative market because it is not now being fully serviced. In addition, with chemical lawn care industry's slowdown during the past three years, many companies have diversified into the landscape or tree service industries because of their larger untapped market segments.

Quality control

As the number of new service providers continues to expand, it will become important to somehow establish a determination of service qual-

ity. In professions like plumbing or electricity, there is a formal training sequence needed to acquire enough knowledge to perform the work. At the end of the formal training program, the individual is then licensed as a master electrician or plumber.

Such a system needs to be developed for the professional landscaper if there ever is to be some assurance—on a state, regional or national basis—that landscapers are truly "professional" and command the fees of a professional.

Quality control in the landscape industry is a very subjective notion. Even within a company, the level of quality provided customers differs significantly. If your company does not have written standards of appearance together with pictures of what the standards mean on a property, 1990 is definitely the year that you

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should put such a quality control system in place. If you do not, you will learn of customers' dissatisfaction with your quality when they cancel or do not renew a contract.

New offerings

For many years, landscape maintenance has meant mowing, edging and cleaning sidewalks and driveways. Today, consumers are asking their landscapers to do more:

- vacuum parking lots,

- aerate lawns,
- mulch decorative beds,
- provide vegetation control in beds,
- design and install flowering enhancement to their properties,
- prune small shrubs and trees under 20 feet,
- renovate part of a lawn that has been damaged,
- install and maintain irrigation systems, or
- re-do plant material that has become overgrown or just needs a new look.

Opportunities continuing to expand, and often are limited only by you not realizing that you could be providing the service.

So make a point of examining the opportunities and evaluating your

abilities to effectively deliver the services.

Beyond 1990

As new equipment continues to be developed, man and equipment will be more efficiently mixed to service customers. Today there is entirely too much labor needed to service landscape properties. That will need to change. In the future, property owners might ask you to design the property service, and then to provide those services. A standard of property management service for commercial sites might be developed on a national basis with individuals modifying the standard based on their budget.

Start looking at what property management associations are asking for, and work with them.



GOVERNMENT: PLAYING ENVIRONMENTALIST

Landscapers in the public sector have a lot to gain by educating the public on the importance of their work.

by Will Perry, managing editor

In many respects, landscapers in the 1980s never had it so good.

In this decade, the green industry has seen an avalanche of new and improved products that kept the lid on labor costs and bolstered the bottom line.

Two-cylinder, air-cooled engines; front-deck, hydrostatic mowers and the inventive use of hydraulics has made good turf equipment even better. And that equipment now borders on greatness, as manufacturers put more emphasis on operator-friendliness. More comfortable seats, better maneuverability, and improved speed and visibility continues to have a favorable, if immeasurable, impact on employees.

Chemicals too, have allowed landscapers to manage acreage that in the past would have been too substantial for today's smaller crews. The specificity of today's herbicides and

pesticides allow landscapers to better pinpoint targets, reducing rates while improving efficacy. Biologicals and integrated pest management (IPM) are making their presence felt as well.

Chemophobia's future

So what do landscape managers in the government sector have to worry about? Well, how about "chemophobia" or today's tax rollback climate?

"To be honest I don't think the future is too bright," says Allan Shulder, executive director of the Professional Grounds Management Society. Shulder says popular citizen movements to hold the line or reduce taxes (such as Proposition 19 in California) are a threat to government sector landscapers, since landscape management is too often regarded as an expendable municipal program.

"We're usually the first to go," says

Shulder. "I can't explain why that's the case, but it is. Right now, the climate in this country is to hold the line on taxes or cut them back. I'm not opposed to that personally, but when that happens our services are cut."

Other landscapers, particularly those caring for universities or school districts, are more optimistic. Jack Coffman, of Margaretta Local Schools, Ohio, says school board members today are more aware of the importance of well-landscaped building exteriors. "I've been getting real positive feedback for what I've done here," says Coffman. "The board realizes that only about 30 percent of the voters in this town have kids in the schools. The other 70 percent make up their minds about the quality of the schools by other means. By seeing well landscaped buildings they develop positive feelings about the school system."

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Coffman also mentioned that parents and administrators are increasingly aware of the importance of quality athletic fields. "There's more of a focus on safety. Parents are going from school to school and comparing playing surfaces. If they see a better field across town, they want our field to look that good or better."

Daryl Smith, assistant grounds manager at Colorado State University, Fort Collins, couldn't agree more. He believes that as universities become more aggressive in their pursuit of shrinking student pools, more emphasis will be placed on the school's landscape.

"My feeling is that the landscape's quality has a huge impact on a person's decision to attend a particular university," says Smith. "You get mom and dad here and take in all the trees, the grass, and the pretty flowers and it's impressive."

Nearly everyone interviewed by LANDSCAPE MANAGEMENT felt that the industry needs to do a better job addressing critics of chemical use.

Shulder, who has been in the green industry for more than 40 years, says, "I've seen tremendous strides made in the green industry, but the one thing I haven't see is increased public awareness."

Shulder notes that "we need to be more positive than reactionary,"

which is a primary factor behind resurrecting the Green Industry Summit as the Landscape Environmental Resource Council in 1990.

"We're the environmentalists," exclaims Shulder. "We're the ones out there day after day taking care of the landscape. Critics don't talk about the benefits of chemicals at all. They're tremendous. We've got to turn it around, and now is a good time to make a move."

Bill Johnson, North Carolina DOT, agrees that the climate is right

to bridge the gap between the green industry and its critics. "There's some middle ground out there. The radical element is there, but reasonable people are involved as well," says Johnson. "We should do a better job of communicating, of finding that middle ground. To insist that we abandon pesticides is ridiculous."

Adds Smith: "People's attitudes have changed. They're more aware of the fact that things are building up in the environment. For right or wrong, we seem to have put that out of our minds. Now we're opening up and taking closer look at it."

Smarter chemical use

The results of this reawakening, says Smith, are improved targeting of pesticide applications, the use of bio-controls and IPM, closer monitoring of chemical applications, a concerted effort to use adaptable species, and a back-to-basics approach toward cultural practices.

Tomorrow's labor pool may be shallow, but the employees drawn from it are likely to be better trained, according to Smith, who has five degreed employees on his 17-man staff.

"The labor market will be much better, even though it may cost a little more," says Dave Nelson, roadside development specialist with the Pennsylvania Department of Transportation. "There's more training today in- and outside-house."

Government landscapers are fortunate to be outside the competitive labor pools of the open market. Allen Goldapp, Jr., manager of grounds and horticulture at Southwest Texas State University, thinks that the competitive nature of the landscape market forces company owners to rely on low-paid employees. "The landscape market in this area is very cutthroat," says Goldapp. "Business owners have to use low-priced labor rather than professionals if they're going to make a living. That's a situation that's going to have to change."

Landscapers in the government sector appear to be less affected by this competitiveness because their employees enjoy more job security and (usually) higher wage rates.

Resiliency will remain an important element for government landscapers in the 1990s. By increasing public awareness about the benefits of turf, chemicals, and well-maintained athletic fields and school grounds, landscapers will go a long way toward insulating themselves from budget fluctuations. **LM**



Allan Shulder



Bill Johnson



A major challenge for government landscapers in the 1990s will be to educate the public on the various values of well-maintained turf areas to our society.

THE STORY BEHIND BIO-CONTROLS

Today's biotechnology boom means landscapers will enjoy a wealth of bio-control agents in the near future.

by John D. Briggs, Ohio State University

Before today's wide interest in biological controls, the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Agriculture (USDA) encouraged manufacturers to develop "growth regulating chemicals" to attack vital growth activities of insects and mites. In so doing, the EPA wanted to spur development of chemicals that destroy insects yet have no effect on humans, plants or animals.

Growth regulating chemicals work two ways. Either they prevent insects from becoming adults or they interfere with the completion of the in-

sect's skeleton.

Fortunately for landscape professionals, today there is active competition in the pesticide industry for formulations of custom-designed bio-controls. The products will be useful for agriculturists and landscapers. The competition leading to the rapidly advancing technology originated with the products that are still marketed by two imaginative industrial giants who have continued the development of insecticidal toxins produced by *Bacillus thuringiensis* (BT). These are Sandoz Corporation, marketing Thuricide, registered in 1958; and Abbott Laboratories, the producer and market share leader with Dipel. Both corporations are major players among others in developing formulations of genetically engineered bio-controls.

The industry is demanding an in-

crease in the persistence and the stability of bio-controls. In addition, genetic engineering is undergoing a biotechnology boom as researchers seek to incorporate into plants the production of insecticidal toxins by bacteria.

Research goals

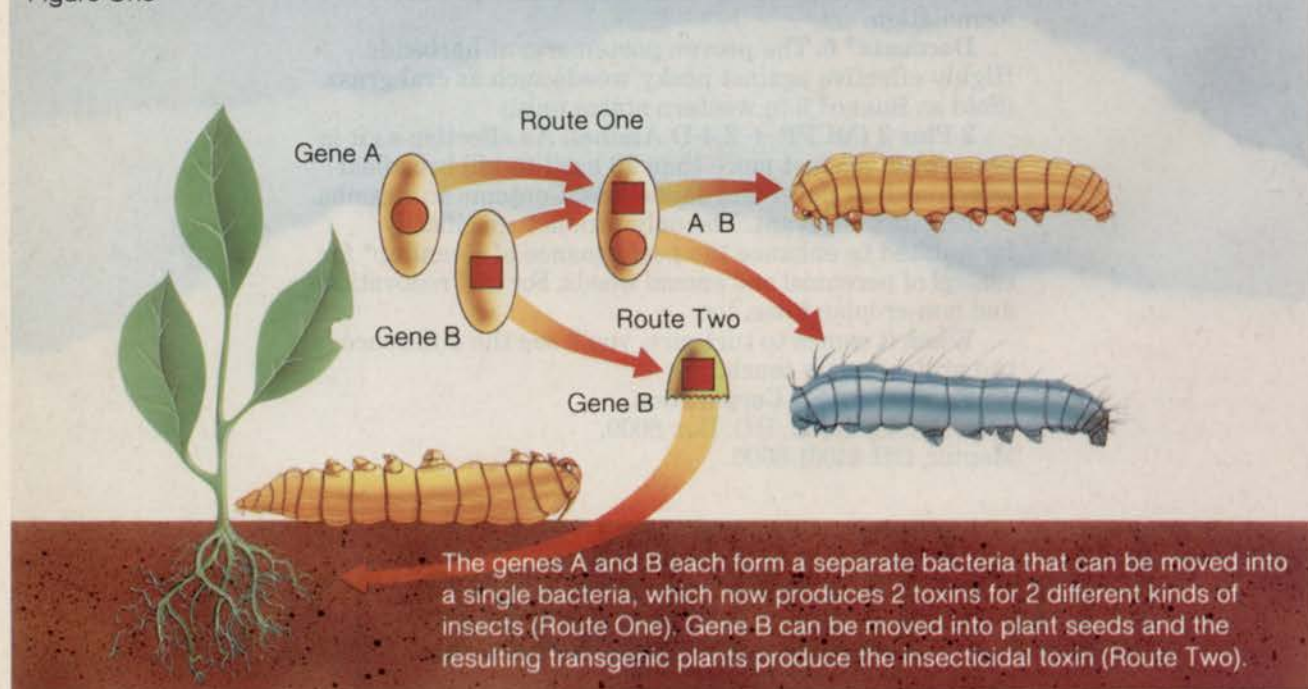
By adding insecticidal toxins from bacteria to all the other materials that plants produce, researchers may be able to create new plant varieties with built-in bio-controls.

Another objective is to develop a formulation of bacteria which inhabit plant roots, stems or leaves. The idea is to alter plant bacteria so that they have insecticidal qualities.

This procedure is like one used to change the bacteria on strawberry plants. The new bacteria lowers the freezing point of water, thereby re-

Dr. Briggs is professor of entomology at Ohio State University, Columbus. His current research includes participation in a biotechnology team researching new formulations of bacteria in bio-control agents.

Figure One



ducing frost damage to the strawberry plant.

The genes factor

Genes are elements in the cells which are the building blocks for bodies of all organisms, including plants, animals, bacteria, fungi and nematodes. Genes carry the inherited blueprint for the characteristic shape, size and behavior of the organism. In humans, for example, genes determine physique and abilities to learn and behave.

Genes are complex chemicals that influence cells to do specific jobs. Many different genes are needed to interact in each cell to produce a whole human, animal or plant.

Manufacturers of bio-controls are moving quickly and successfully to add, remove or change certain genes in animals, plants and bacteria. For example, genes can be chemically and physically extracted from a bacteria. An attempt is then made to put them into another living organism, first in both laboratory and greenhouse experiments then in the field.

Scientists do not shift genes around in humans to change or build a better person—yet. But it is becoming big business to engineer custom-made, safe, useful bio-controls, many of which will be used in certain landscape activities.

Combining genes

Some bacteria can exchange genes with each other through their cell walls when the same kind of bacteria are mixed closely together in soil. This means that different kinds of genes responsible for different kinds of insecticidal toxins can be exchanged or combined.

For example, strains of *Bacillus thuringiensis* (BT) found in different insects around the world can have any one of 20 different types of genes. These genes influence the production of many different insecticidal toxins, some with more or less insecticidal activity than others. By either having scientists move the genes from one strain of BT to another, or allowing the natural exchange of genes between strains of bacteria, different combinations of genes can be developed into a single new strain of bacteria (Fig. 1, route 1).

Chemical alteration

In addition to moving whole genes, the genes themselves can be changed by specific chemical actions. Changing genes provides the opportunity to change toxins regulated by genes. Therefore, regular variations of toxins can help avoid the threat of insects

and mites becoming resistant to bio-controls.

Moving genes from one kind of organism to another within the same type of organism (like within bacteria), or moving genes between different organisms (like from bacteria to plants) provides the opportunity for a new patent on the genetically-engineered organism. Examples of this would be a patented beneficial insect resistant to a pesticide for release with an insecticide treatment, or a herbicide-tolerant plant to survive herbicidal treatments in a landscape.

Cotton a forerunner

In 1988 and 1989, cotton plants were field-tested to demonstrate the successful incorporation of a bio-control



These grubs were exposed to milky spore disease, a widely used bio-control in the green industry today. The grub on the left displays early growth, while the one on the right shows advanced disease.

built into plants. These plants contained genes from bacteria that regulate the production of insecticidal toxins.

Incorporating bio-control genes from BT into bacteria that normally inhabit plant roots, stems and leaves has also been successful for controlling root-feeding caterpillars. This suggests that we can expect turfgrass varieties to be developed with built-in, custom-made bio-controls for insects that attack roots, as well as those that attack the crown and stems of grass.

Herbicide resistance can also be combined with insect bio-controls in plants.

Hard at work

Industry giants are continuing their genetic engineering programs to increase the tolerance of plants to herbicides. Monsanto Corporation works with the herbicide Roundup. Ecogen Corporation continues its development of Condor, a bio-control using BT for gypsy moth. The caterpillars of gypsy moth are targeted specifically

while other collectible Lepidoptera escape injury.

Ecogen, using natural exchange of genes between bacteria, claims to have increased the insecticidal activity of Condor for gypsy moth by 7½ times. This is rearranging and concentrating the activity of a bio-control.

In a second product, Foil, the company claims to have combined the genes for production of two different toxins—one for the Colorado potato beetle and another for the European corn borer—into a single strain of bacteria. This is broadening the bio-control's range of activity.

Transgenic plants

When genes are incorporated into plants so that the plants produce an insecticidal toxin originally produced by the bacteria, the plants are called transgenic plants (Fig. 1, route 2). (Of course, a company that creates such a plant can patent it.) With transgenic plants, the genes from the bacteria are incorporated into the plant's permanent chromosomes.

Most transgenic work has begun on plants which are most easily genetically engineered: petunias, tobacco and tomatoes. Now progress is being made with plants less receptive to new genes: corn, rice and other grasses, cotton and soybeans.

There is another unique way to add the ability of a plant to produce an insecticidal toxin similar to that produced by bacteria. Genes from the bacteria are incorporated into micro-organisms that are always present in the plant's fluid transportation or vascular system. These bacteria are called endophytic bacteria. The plants that result from the gene transfer have a circulating insecticidal activity that can be described as a "systemic pesticide."

What is safe?

If we can make micro-organisms yield genes to other bacteria or plants, can the resulting bacteria or plants be safe for the landscape or for humans? Yes.

The toxins from bacteria, particularly BT, have been used for 30 years. The genes in BT which are responsible for the toxins, have been around a long time. So the use of the BT genes in another bacteria or a plant should not make any difference.

There are federal regulations for the release of genetically-engineered organisms. North Carolina has recently developed a comprehensive set of regulations that could serve as a model for other states wanting to regulate the production and use of genetically-engineered organisms. **LM**