In general, the hardy mid-sized rhododendrons available for planting throughout the Northeast or northern Midwest usually have Catawbiense as one of the parents.

Fortune Rhododendron *(Rhododendron fortunei)* is the outstanding introduction of China. This 10 to 15 foot upright shrub has long, large leaves with scarlet bracts which accompany the new growth below the bud (another desirable as well as identifying characteristic). The pink to white blossoms are in full bloom during the end of May. *R. fortunei* is not only a good compatible plant for many of the narrow-leaf evergreens, such as pine, but is an outstanding understory with Scarlet or Bur Oak.

Fortune Rhododendron *(Rhododendron fortunei)*, introduced from China, has long, large leaves with scarlet bracts which accompany the new growth below the bud.

Wilson Rhododendron (X *Rhododendron laetivirens)* is a hybrid of *R. carolinianum*. It is perfectly hardy through the Boston area and in protected sites as far north as Midland, Michigan. It is a small rhododendron, growing 2 to 4 feet in height, being broader than tall. Its glossy, sharp evergreen leaf is similar to the foliage of Mountain Laurel. The flower of this outstanding evergreen shrub is pink to magenta but is not dependable in more northern latitudes. The plant integrates well in rock gardens, foundation plantings, or mass plantings under oak and pine.

Rosebay Rhododendron *(Rhododendron maximum)*, the giant of the native North American rhododendrons, reaches an average height of 10 to 15 feet in the Northeast, but ranges in height from 4 feet in Canada to an ultimate of 40 feet in North Carolina. Its leaves are large (4 to 8 inches in length) and 2 to 2½ inches in width. Rosebay Rhododendron requires deep shade and fertile, well-drained soil, often thriving in bogs. Its pale pink to white flowers appear in July but are not as effective as *R. catawbiense* since the new growth often surrounds these late-appearing flowers. *R. maximum* is an outstanding woodsy species which naturalizes well. Its flower buds are perfectly hardy to -25° F.

Korean Rhododendron *(Rhododendron mucronulatum)*, a deciduous rhododendron from China, is 6 to 8 feet in height, being rather an erect shrub. It is one of the earliest of the rhododendrons to flower, usually being quite showy in late April, or about the same time as Magnolia stellata flowers. Its flower buds are perfectly hardy to -25° F. The flower color is normally a magenta, but a clear pink variety is available. These flowers are somewhat trumpet-shaped, being 1 to 1¾ inches in length. The flowers themselves resist frost extremely well, extending their life even if temperatures as low as -27° F. are encountered. Korean Rhododendron requires some sunlight; therefore, west to north exposure with less than 50 percent shade is most desirable. This plant adapts well in woodsy, naturalized plantings and fits foundation plantings.

Smirnow Rhododendron *(Rhododendron smirnowii)* is an outstanding evergreen shrub, growing 6 to 8 feet in height with a 10 to 12 foot spread. The dark green leaves often reach 3 to 7 inches in length with a light brown tomentose on the underside. This outstanding rhododendron is noted for its bright green foliage. Its late flowering which peaks during late May or early June is extremely showy. This annual flowering shrub integrates well into woodsy settings. The flower color is a magenta to rosy-pink, depending upon the seed source.

The real key to growing rhododendrons is to understand their requirements. These requirements include: protection from sun and wind, high humidity, acid soil pH (below pH 7.0), and high organic soils.

The soil pH should range from 4.5 to 5.5. The best additives to lower the soil pH include sulfur or iron sulfate. Aluminum sulfate will adjust the soil pH down but can cause phosphorus and other elements to be chemically unavailable. In soils where iron chlorosis continues to be a problem, EDTA chelated iron is best to correct this problem.

Organic matter is important to provide moisture and nutrients to this shallow-rooted shrub. This organic matter can be composted oak leaves, pine needles, pine bark, or animal manure.

Fertilizing should be kept to a minimum or not applied at all. If one is considering annual fertilizer, then a 0-20-20 or low nitrogen organic fertilizer would be best, e.g., cottonseed meal, fish meal, or tankage. The application of nitrogen can reduce or limit flowering while resulting in leggy plants.

Rhododendrons are one of the lowest maintenance plants available for Northeast and Midwestern sites. They flourish when grown in companion plantings which include pine *(Pinus)*, Scarlet and Bur Oak *(Quercus)*, crab apple *(Malus)*, dogwood *(Cornus)*, redbud *(Cercis)*, Mountain Silverbell *(Halesia)*, Japanese Katsuratree *(Cercidiphyllum)*, Black Gum *(Nyssa)*, and Sweet Gum *(Liquidambar)*. Rhododendrons are not companions with maple *(Acer)*, serviceberry *(Amelanchier)*, spruce *(Picea)*, or juniper *(Juniperus)*. Rhododendrons will flourish in the Midwest if planted as understories in well-drained sites. The only maintenance that need be done, after initially acidifying the soil, is the annual application of organic matter, e.g., leaf mold, pine needles, or peat moss. Artificial irrigation with alkaline Midwest water can cause a problem; therefore, in Wisconsin, Michigan, and the Great Lakes States artificial irrigation is not desirable or needed. Rainfall is generally high enough to preclude irrigation. Companion plantings make rhododendrons work! Rhododendron is truly the aristocrat of broad-leaved evergreens which requires little or no maintenance. **WTT**

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TURF MANAGEMENT ENERGY USE IS REEVALUATED IN FLORIDA

As energy becomes more precious, many uses of it will be scrutinized. Energy consumed in the management of turf is high, higher than agricultural production. Philip Busey and Evert Burt of the University of Florida Agricultural Research Center have studied energy use for turf and have drawn some conclusions.

1. Turf energy use is high.
2. Considerable savings in energy use can be obtained through better management and better grasses.
3. The energy use question is inseparable from other aspects of turf culture. In many ways the energy question translates into a vehicle for studying better management, and getting that point across to turf managers.

Beside the reevaluation of turf maintenance practices and turfgrass selection, Busey and Burt analyze individual turf systems. "It appeared to me that in order to do an energy budget, or to have any meaningful way of looking at possible savings, it would be necessary to do an analysis of existing practices and/or design efficient turf systems ahead of time," Busey says. He designed a Turfgrass Management Audit/Maintenance Plan. "For larger areas, a similar analysis could be done with greater emphasis on detailing existing vegetation, soils and seasonal variations."

Busey and Burt have revealed basic energy use relationships which can be applied to other areas. Their findings were reported in the Proceedings of the Florida State Horticultural Society. Excerpts from this publication follow.

Turfgrass maintenance costs were 27.5 trillion BTU in Florida in 1974. This value was equal to approximately 1.5% of Florida's fuel expenditures, and 28% of the total energy used in agricultural production in Florida, in 1974. Turf energy costs were calculated based on all expenditures in the maintenance of established plantings, primarily fuel, equipment, fertilizer, water, labor, and pesticides, in that order. Benefits to Florida from turf include a landscape surface compatible with high density activity, erosion control, groundwater replenishment, and possibly reduced heat load in and around buildings. These benefits can be achieved through the use of lower maintenance species, proper management, and the tailoring of new varieties that are better adapted. Extension of present and future turfgrass technology can contribute to the savings in energy and other environmental costs.

Utility Analysis and the Choice of Species

Grasses vary in both the costs of upkeep and in the level of use that they can withstand. Current Florida fertilizer recommendations range from a low of 15g N/m^2/year (3 lb/1000 ft^2/year) for centipedegrass, *Eremochloa ophiuroides* (12) to a high of 60g N/m^2/year (12 lb/1000 ft^2/year) for hybrid bermudagrass, *Cynodon X magenissii* (13). Rates of mowing and irrigation also vary and it has been customary to ascribe a generalized cultural intensity to various species (1). Cultural intensity differences among species, which can also be equated with energy costs, are closely related to different relative growth rates among species (Table 1).

Bermudagrass, which grows rapidly and has a high maintenance cost, is the only species capable of withstanding both very heavy traffic from sports activities, and very close mowing. These features, combined with a rich green color and fine texture, make bermudagrass the most attractive turf to many. In contrast, bahiagrass grows slowly and also has relatively low requirements for fertilizer, mowing, and water. At the same time bahiagrass is generally regarded as the least attractive species. Its tall, open habit of growth, and its slow recovery from damage, makes it relatively unsuited for use in high traffic areas. The biological characteristics of grasses are closely related to their maintenance requirements and their usefulness.

Thus, it is possible to simultaneously evaluate the maintenance costs and the usefulness of different species in the landscape, and thereby analyze which kind of grass is best suited for particular use requirements. Based on estimated costs, we would not recommend

Continues on page 40

Table 1. Management costs for various turf species, arranged from the most intensive in cultural requirements (bermudagrass) to the least intensive (centipedegrass). Fertilizer, mowing, and water requirements have been modified from Florida recommendations, according to the authors' preferences for southern Florida, in order to achieve dependable high utility. Some rates can be reduced substantially.

Species	Fertilization	Mowing	Irrigation	Estimated cost[z]	Growth rate[y]
	g N/m^2/yr	times/yr	cm/yr	$/1000 sq ft/yr	%/day
Hybrid bermudagrass, *Cynodon X magenissii*	60	50-300	200	70	7.9
Zoysiagrass, *Zoysia japonica*	30	30	130	35	5.0
St. Augustinegrass, *Stenotaphrum secundatum*	30	35	130	35	4.8
Bahiagrass, *Paspalum notatum*	15	12[x]	60	15[w]	2.1
Centipedegrass, *Eremochloa ophiuroides*	10[v]	20	60	15	1.8

[z]Maintenance costs have been estimated on the basis of all expenditures, including labor, for medium-sized turf areas (100-10,000 m^2). These figures are minimal costs, and can be increased by two to four times to include costs of edging, cleanup, routine spraying whether required or not, and managerial costs of supervision.

[y]Adapted from Busey and Myers (4). Growth rate is the relative fresh weight gain of a grass under ideal conditions. Values should be directly related to clippings produced, fertilizer and water requirements for replenishment of leaf tissue, and attendant energy costs.

[x]For most home lawns and especially in south Florida, the number of mowings may increase to about 25 per year.

[w]Maintenance costs of bahiagrass vary from less than $2 per thousand square feet per year (along Florida highways) to as high as the cost of maintaining St. Augustinegrass. Excessive costs for maintaining bahiagrass may result from failure to correct mole cricket infestation, excessive irrigation and fertilization, and close mowing.

[v]A fertilization rate is proposed here which is less than current Florida recommendations (12).

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When a turfman tries to skimp along with a narrow-spectrum herbicide on the theory that it will control the major eyesores like dandelions and chickweed, and will cost less per gallon than Trimec — he opens the door to an endless chain of problems and expenses.

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Of course, you know where they came from and why they came. They're the natural consequence of using a narrow-spectrum herbicide in an area that is fertilized and watered.

The hardy weeds (which were not controlled by the narrow-spectrum herbicide) are nourished by the fertilizer and water, and fight with the grass to fill the vacancy left by the demise of the sensitive weeds. Some of them win, and weeds that were once obscure become prominent.

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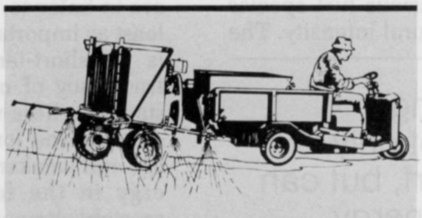

How many species of broadleaf weeds will Trimec control?

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Energy *from page 37*

that a manager with a budget of only $15 per year per one thousand square feet grow hybrid bermudagrass. Conversely, a turf manager with as much as $30/1000 ft^2/year should not exclude the possibility of growing bahiagrass; perhaps a lower traffic tolerance would be adequate and the maintenance budget could be reduced by using a species such as bahiagrass.

For purposes of this analysis, we consider "utility" to be the usefulness of a turf in terms of traffic tolerance, coverage of the soil, and beauty (specifically, intensity of color and closeness of cut). We have applied rather arbitrary utility values to show examples of relationships of the usefulness of various turf species maintained at various levels of cultural intensity. The concept of "utility function" has been presented in management books (11)—the "utility function" is the relationship between costs and returns. When the utility function is presented graphically for a variety of circumstances (Fig. 1), a decision aid is thereby created for choosing the right grass and the right management strategy. This graph has been drawn as a series of curves, to represent a widespread economic observation of decreasing marginal returns at higher and higher levels of input (fertilizer, mowing, irrigation). Beyond a certain point, most species even do worse, and are beset by a number of pest problems. The real challenge coming to turf research is not the need to show that one management strategy provides greener grass than another, but to show how much an extra shade of green will cost the consumer and how much an extra pound of chemicals will affect the environment. A flexible concept such as the utility function should permit sound decisions in the reduction of energy and other turf costs, while at the same time provide an economical return in beauty and useability.

Too low mowing and long delayed mowing can not only damage and weaken turf, but can cause a later waste of energy.

Management Strategy

Turf maintenance primarily consists of mowing, fertilization and irrigation in order to keep the grass actively growing and continually replenished with new leaf tissue. Proper timing of these practices to satisfy plant requirements along with attention to pest problems is necessary in order to achieve a maximum possible utility at a given expenditure. In practice, the use of strict recommendations (Table 1) may not provide maximum return in quality on expenditures. When the average expected maintenance needs are programmed rigidly over a budgeting period, noticeable problems arise. For example, large amounts of water and fertilizer can be lost due to improper irrigation, as when programmed irrigation timers are used. A study of water application on urban landscapes showed that about 40% more water was used than the estimated requirement (5). Even with the adjustment of irrigation to correspond more closely with evapotranspiration, substantial N can be wasted through leaching. In studies performed on a sand soil in Fort Lauderdale, from 35% to 55% of the N from a water soluble source was lost due to leaching under conditions of high rainfall and/or excessive irrigation (14). The use of fertigation (frequent fertilizing of low rates through an irrigation system) was shown to provide a more uniform availability of N, and thereby to reduce losses due to leaching.

Considerable energy is spent to mow turf, and at first consideration this might appear to be a good opportunity to conserve energy. This kind of savings can be achieved provided that other conditions for the grass are in balance. However, regular mowing of turf is at least as important to insure freedom from weeds, as it is for short-term aesthetic reasons. Recommended frequency of mowing should not be reduced in instances where weed encroachment is active. Too low mowing and long delayed mowing can not only damage and weaken turf, but can cause a later waste of energy in the form of extra fertilizer to assist in reestablishment of bare areas.

The greatest savings of energy can be obtained through a management strategy including routine evaluation of past and present conditions. When problems arise, diagnosis of the cause for unhealthy turf is the first step, and should be followed by an analysis of available options. In the case of turf that is unsightly because of weed infestation, herbicides should not be used without considering the underlying problems (nematodes, improper irrigation, low fertility). If grass cannot be grown properly, it may be that the weeds achieve some utility in covering the soil, whereas drastic eradication of weeds without correcting the underlying conditions will only leave the manager with bare soil.

Finally, pesticides should in many cases be used primarily for curative treatments and spot treatments. A few chronic problems can be expected that virtually always require pesticide treatment—sod webworms in bermudagrass, for example. Even in these instances the pests are erratic in their behavior, and widespread use of pesticide can be replaced by prompt diagnosis and spot eradication. Few pest problems can be managed best through the use of preventive sprays. Although reliance on regularly timed preventive sprays cuts down the number of decisions required by the manager, it also cuts down on the opportunities for experimentation and greater familiarization with the turf ecosystem by the turf manager.

Low-Energy Grasses: Strategies for the Future

A breeding strategy has been presented that "places priority on genotypes requiring smaller inputs of energy, pesticides, water and fertilizer, in order to maintain an attractive and durable cover for urban areas" (2). Different adaptations among turfgrass species were related to different use characteristics. By extension of this concept to comparisons within turf species, one can conclude that there is no one "supergrass." Different turfgrass varieties are needed for different situations (3). How then can the development of new varieties be geared to reduce use of energy, pesticides, water, and fertilizer in Florida?

The goals of a breeding program might differ for each turfgrass species. An adequate consideration of various breeding strategies should consider not only