



Golf Course 2030

Grass Selection Guide

Handbook for Sustainable Golf Courses



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The R&A facilitates and funds an international research programme, Golf Course 2030, over a three-year cycle. It focuses on key sustainability priorities including – sustainable agronomy; resource management; biodiversity; and climate – to create evidence-based best practices and solutions within the golf industry.

Project conducted by:



Introduction to using this guide.

- Why is grass selection important?
- Who is this guide for?
- How to use this guide
- Should you change your current sward composition?

There are over 11,000 known grasses of which 20 may have a role to play in golf around the world.

Why is grass selection important?

All grasses are not the same. Some are better suited for the purpose of preparing surfaces for playing golf than others. There are over 11,000 known grasses of which 20 may have a role to play in golf around the world. Choosing the right ones for a range of situations is critical for success. Grass breeding programmes have developed excellent grasses for use on golf courses. The selection and appropriate management of the right grasses is an essential part of the creation, preparation and renovation of a sustainable golf course that is fit for purpose.

Whilst there are many different grass species to choose from, there are many more cultivated varieties (cultivars) for each species. Individual cultivars within each species provide additional options for effectively matching grasses with growing conditions, management level and desired performance. The selection of a species and cultivars for the golf course should be based on its distinctive climatic, site-specific requirements, the performance of grasses in comparative testing and species or cultivar characteristics.

As highlighted by the Golf Course 2030 initiative, for the sport to thrive for the next 50 years it is going to be essential to use the right grasses to meet the challenges of climate change, resource constraints and chemical regulation. Possibly the

biggest challenge for golf will be to deliver playing surfaces in better condition and with improved playability whilst using less water, fertiliser and pesticides. Grass selection will play an important role in achieving this goal.

Aims of this guide

This guide will provide you with information to decide which are the most sustainable grasses for the greens, tees, fairways and semi-rough (first cut) on your course.

The interaction of the golf ball with the playing surface, whether it is a tee, fairway, rough or green is critical to how the sport is played. It is, therefore, not surprising that the composition and characteristics of the grass species found in playing surfaces go a long way towards shaping their performance. This guide will help you make the right choices when it comes to the grasses for your course.

A one-size-fits-all approach to grass selection is not possible. Golf courses vary greatly around the world in terms of their soils, climates and available resources. There will also be variability within a site. The intention of this guide is not to replace localised agronomic advice, but rather to help inform the decision-making process when it comes to selecting the most appropriate grasses for your golf course.

The main aims of the guide are to:

- Outline the importance of grass selection and getting the best option for your course.
- Provide an overview of the factors that should be considered when selecting grasses.
- Assess the characteristics of grasses that relate to grass selection.
- Outline the decision-making process for choosing the right grasses.
- Identify the key strategic objectives behind grass selection.
- Allow critical evaluation of which grasses would be most appropriate for your course.
- Provide guidance that is accessible to technical and non-technical individuals involved with, or interested in, golf course management.

Who is this guide for?

This grass selection guide is for anyone looking to gain an understanding of grass selection and the process of how to choose the most appropriate grasses for their golf course. The information presented in the guide caters for non-technical individuals who are looking to understand grasses and their selection a little better, through to turf managers and other key decision-makers who may want reassurance in their selection and the process that has gone into making their decision.

The guide has been written to be as accessible as possible, whilst still covering the core technical detail needed to be able to:

- Understand the factors that underpin grass selection, including the challenges of climate change, resource constraints and regulation.
- Follow the critical thought process needed whilst planning for success.
- Guide users through the process of choosing which grasses might be the best options for their course.

How to use this guide

The guide has been structured to allow readers to follow each chapter in a stepwise fashion, with each section building on the previous one. For those with a good knowledge of the subject, the links in the table of contents at the start of the guide make it possible to go directly to specific sections for quick referencing purposes.

Navigate through this guide by using the Table of Contents or the links within the cool-season, warm-season and transition zone chapters.

If you are managing existing turf surfaces there will be times when you need to consider if you:

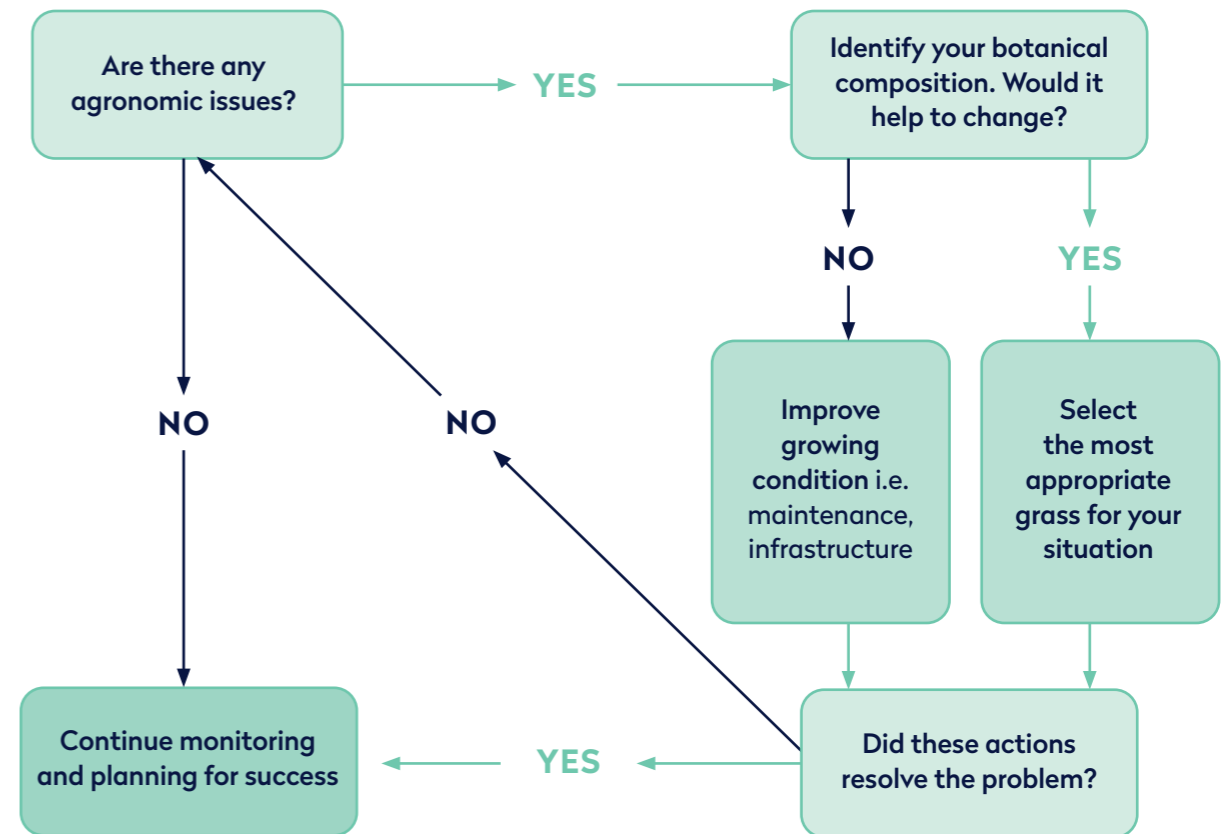
- Should work with your current species composition allowing it to evolve naturally over time.
- Consider actively embarking on sward composition change.
- Understand if you have created the conditions for success for whatever path is chosen.

To change or not to change?

This might seem like a strange topic for discussion in a document dealing with grass selection. However, it is always enlightening to look at what grasses are already in a playing surface, how can they be optimised in terms of health and performance and can they, through modifications

to maintenance programmes, fulfil the required role. The reason for this, especially on older greens, is that the grasses present will have adapted, and the population will reflect the local conditions. If feasible, one option is to manage the grasses already present to achieve the desired objectives – new is not always better.

Figure 1. Change of sward composition decision making flowchart



However, it is vital to be honest about the objectives for grass selection, review all of the criteria for and against change, i.e. cost of the change, cost of maintenance, resource availability, playing surface quality, etc, in order to make the right call, not only for the short-term,

but also for the longer-term. The decision-making flowchart in Figure 1 can help guide you through the key stages to assess if managing what you have maybe the optimal option, or would changing the botanical composition help address any agronomic issues present on

the playing surfaces. Grass selection varies according to site specific objectives, whether sowing a new facility, re-grassing an area with more modern cultivars, overseeding to maintain current composition, or overseeding to change species composition. After reviewing the

existing condition and playability of the surfaces on the course, there are a number of reasons why the answer to a change this might be 'yes', and these would include:

- Unacceptable performance of the existing grasses for golf, which may relate to issues with the growing environment, i.e. excessive accumulation of organic matter (thatch) at the turf base which creates soft surfaces prone to waterlogging and disease.
- Maintenance of existing grasses is proving to be too intensive and expensive.
- Existing grasses are too prone to disease and stress-related damage.
- Existing grasses will not cope well with changes related to climate change, limitations on resources or regulation.
- Introducing "better" grasses will resolve any agronomic issues and

prove to be a good return on the investment of making the change.

- Not achieving optimum playing quality with existing sward composition.

There are a number of key agronomic factors that will inform the decision as to whether a change of composition will provide benefit. Figure 2 highlights six of the key agronomic factors that contribute to challenges faced by course managers on their playing surfaces. The grass selection flowcharts for cool-season species in Chapter 2 and warm-season species in Chapter 3 are based on these factors.

They should be considered as part of the decision-making process as to whether changing sward composition to one that thrives under these conditions will provide the optimal solution. Background information on these agronomic factors is given in Chapter 5.

Once this decision has been made, then the contents of this guide should provide help in following through on this agreed course of action.

Whether you are establishing a new sward or introducing grass into an existing surface, it is important that the grasses used are:

- Adapted for the local environment.
- Have characteristics that are well matched for golf.
- Will persist under the maintenance practices employed on an individual golf course (with those practices suited to the grasses of choice).
- Sustainable in relation to the maintenance budget available. Some grasses require more

intensive maintenance than others and are, therefore, more costly to keep in good condition.

- Meet the requirements for the individual surface and match the style and playing characteristics of the individual golf course.

Getting it right from the start

When designing and building a new golf course, grass species selection is a vital part of the design process:

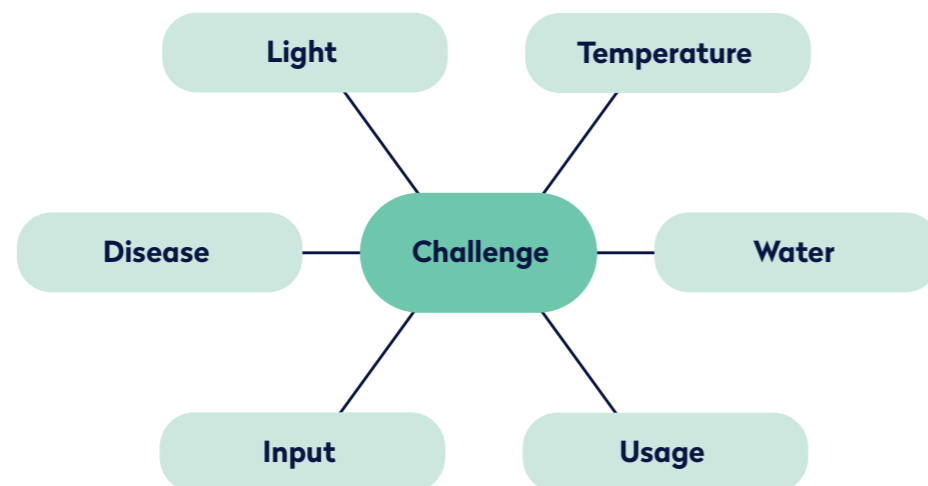
- The interaction between the designed surfaces and the species of grass that could be grown is an essential consideration.
- Marrying the designed surfaces with well-adapted grass species for that growing environment will result in a more sustainable golf

course, with surfaces that perform to their full potential.

- It is important to consider the growing environment, not just at the start of the golf course's life, but also 50 - 100 years later.

All of the above will help to ensure better harmony between the physical environment and the grass that will thrive there.

Figure 2. Key challenges facing golf course management



Before considering which grasses would be the most sustainable choices for your course, you must identify in which of the grass climate zones your course is sited. The world of grass can be divided into different climate zones; cool-season, warm-season and the Transition Zone. Climate plays a major role in determining the typical grass species that can grow in particular regions of the world. This is due to grass species being adapted to live in particular climates and temperature ranges. Grass species are classified as to where geographically they will grow based on their climatic adaptation and temperature range required for optimum growth:

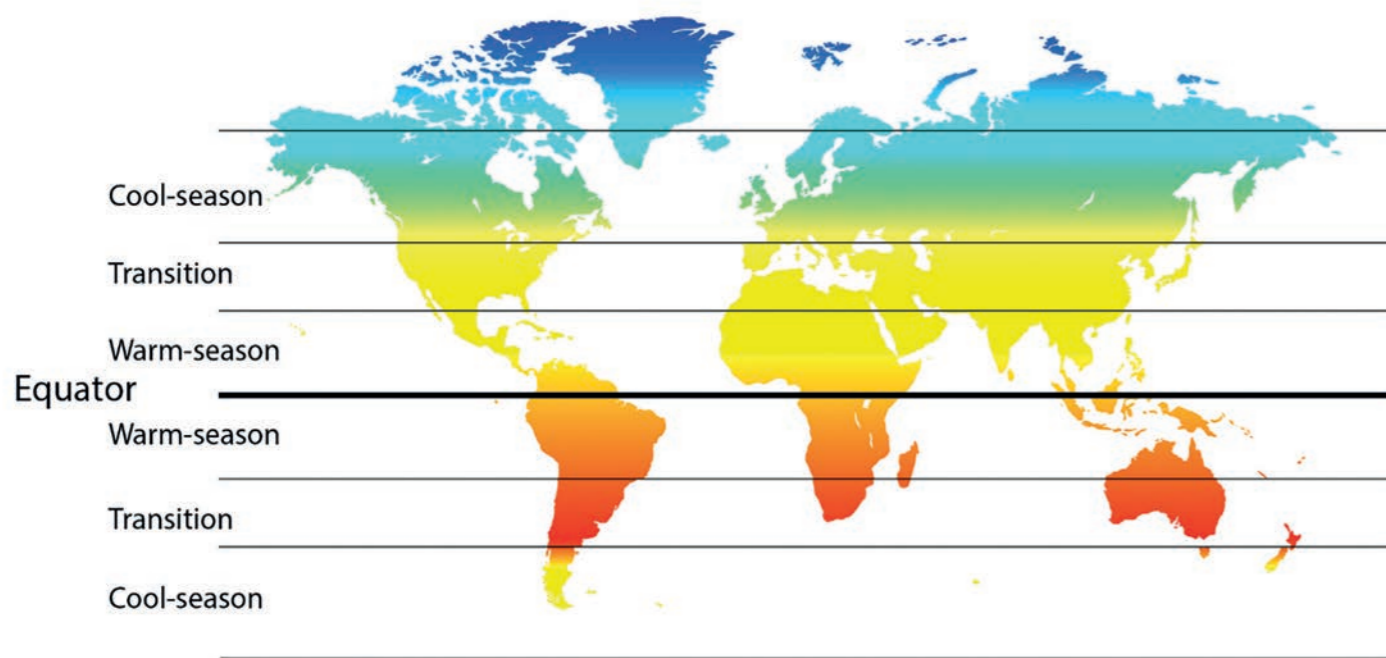
- A. Cool-season grasses** – grasses adapted to cool humid, sub-humid, and semi-arid areas.
- B. Warm-season grasses** – grasses grow best close to the equator and at latitudes between 35° North and 35° South (Figure 1). If temperatures become too cold warm-season grasses become dormant, i.e. little to no growth with turf discolouring.
- C. Transition zone** – In the Transition Zone the weather is too cool in the winter to maintain warm-season grasses, yet warmer summer temperatures make growing cool-season grasses difficult, i.e. neither is ideally suited to grow in this region.

The next sections of this guide look in more detail at these zones and the grasses typically grown in each. You can go direct to the one most relevant to you be that cool-season, warm-season or transition zone. These chapters are arranged to provide some background about the

growing environment at each climate zone and which grasses are best adapted. The key decision-making tools in each chapter are flowcharts which outline specific and dominant challenges to be overcome on a golf course and the main species which could be considered.



Figure 3. World map displaying turf grass growth zones



Take-home message

- As a one-size-fits-all approach to grass selection is not possible, the intention of this guide is not to replace localised agronomic advice, but rather to help inform the decision-making process when it comes to selecting the most appropriate grasses for your golf course.

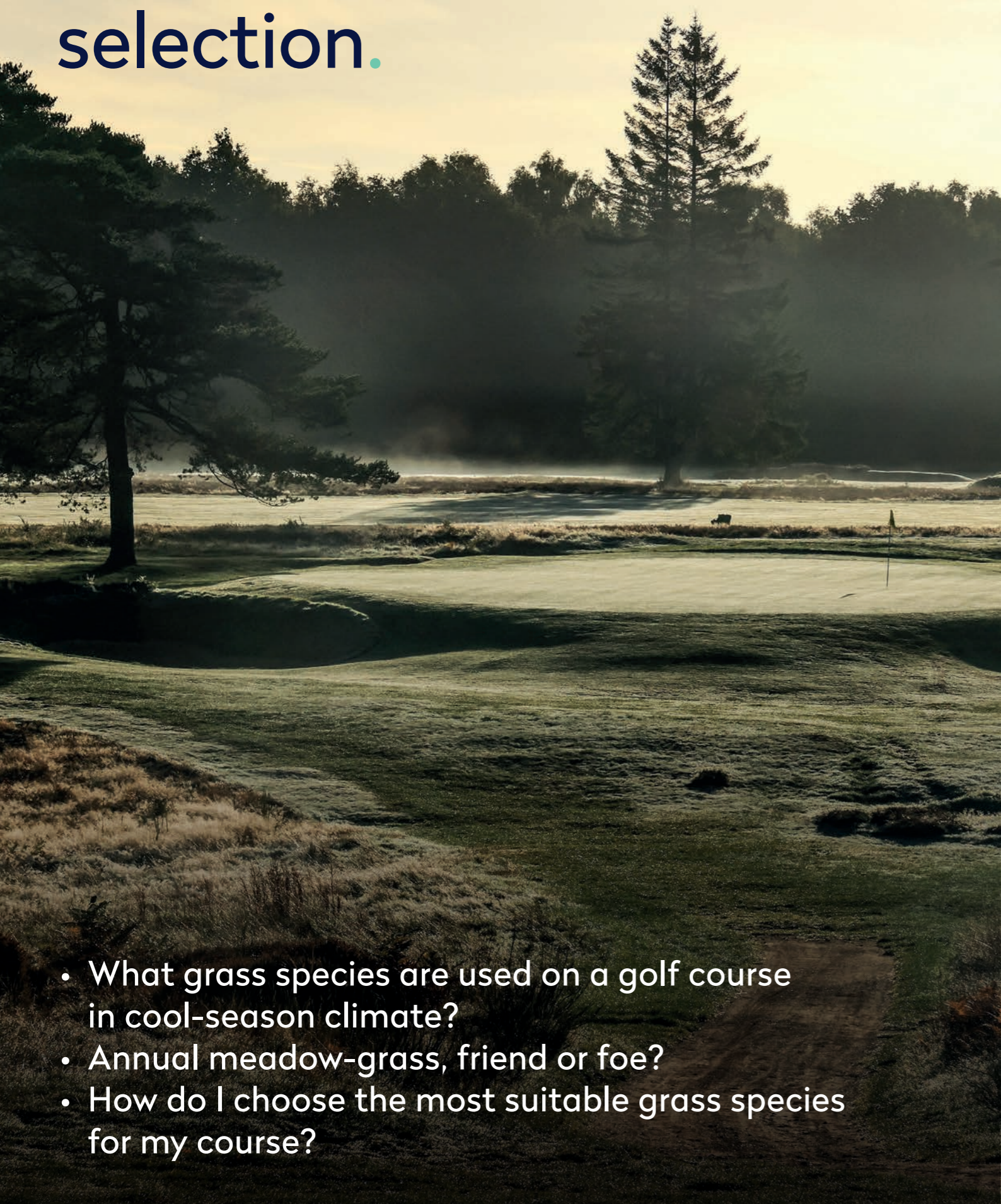
- The guide has been structured to allow readers to either follow each chapter in a stepwise fashion or go directly to specific sections for quick referencing purposes.
- Grass species are classified as to where geographically they will grow based on their climatic adaptation and temperature range required for optimum growth.

- Identifying the climate zones your course is sited is the first step in selecting the most adapted species.
- Use the decision-making flow-chart in following chapters to determine if changing the sward composition is necessary.

Please remember, this is only a guide. Whilst it contains a great deal of valuable information, the specific circumstances at your site must be taken into consideration. This may require some adaptation of the guidance.

If you are unsure of the best selection for your course, or how to manage the most sustainable options, after consulting this guide then do seek assistance using the sources of support listed in Chapter 8.

Cool-season grass selection.



- What grass species are used on a golf course in cool-season climate?
- Annual meadow-grass, friend or foe?
- How do I choose the most suitable grass species for my course?

In most parts of northern and central Europe, and similar climates around the world, cool-season grasses are often the better option.

Cool-season grasses are adapted to cool humid, sub-humid, and semi-arid areas and they are most competitive between 15 to 25°C. In most parts of northern and central

Europe, and similar climates around the world, cool-season grasses are often the better option. Cool-season grasses are normally established by seed or turf.

These are the main grass species that are commonly found on golf courses:

All Areas	Greens Only	Non-Greens
Red fescue (Festuca spp.)	Creeping bentgrass (Agrostis stolonifera)	Perennial ryegrass (Lolium perenne)
Browntop bentgrass (Agrostis capillaris)	Velvet bentgrass (Agrostis canina)	Smooth stalked meadow-grass (Poa pratensis)
		Tall fescue (Festuca arundinacea)

For putting greens, traditional red fescue/bentgrass mixtures and bentgrass blends are still the choice of many golf managers, either for establishing a new facility or overseeding an existing surface. Perennial ryegrass can also be used for overseeding golf greens on parkland courses, though this is a relatively new innovation enabled by plant breeding. These species can also be used on fairways and tees either seeded as a monostand

or used in blends and mixtures. Tall fescues and smooth-stalked meadow-grass can be used in rough areas as they perform well at higher cutting heights, with the latter also used in mixes for tees due to its wear tolerance and recuperative capabilities.

Although often considered a weed, annual meadow-grass can provide a decent playing surface given more intensive maintenance

and, generally, higher inputs. If the decision is made to manage this grass, the implications on disease management and sustainability must be understood. Annual meadow-grass, it is not an easy species to manage to provide good year-round playability, as it is prone to stress in the summer heat and is the grass most susceptible to common and disfiguring diseases.

Note on annual meadow-grass

There is no viable commercial source of annual meadow-grass seed or other vegetative material. Annual meadow-grass is the only species that can produce seed at the very close cutting heights employed on golf greens, which builds up a seed bank in the soil. This species takes advantage of situations where sown grasses are weakened because growing conditions are not in their favour or because the maintenance employed is not suitable for them to persist, i.e. cutting too close, applying too much water or fertiliser. Such maintenance

regimes are often the result of extreme pressure being put on greenkeepers to produce faster and faster putting surfaces, and the easiest way to do this is to cut closer and closer, to the detriment of the grasses used to establish the playing area. This puts additional pressure on the surviving grasses, even the annual meadow-grass, which then requires much higher inputs of water, fertiliser and pesticide to present a playable surface.

The annual meadow-grass seed bank enables this grass to invade weakened swards and once this process has begun it is very difficult to stop,

without a total adjustment to the environment and maintenance which instigated it in the first place. This is not a new phenomenon but has become increasingly common over time as expectations for faster greens and a verdant aesthetic have become more prevalent. Reversing this process is a significant challenge, one that demands commitment to the cause and support from everyone in the golf club as the presentation of putting surfaces can suffer through the early years of the programme as mowing heights are lifted and aggressive refinement scaled back.



This chapter provides a series of decision-making flowcharts to assist with assessing which species would be relevant for use on a specific area of the golf course. This is based on the characteristics required of the turf and the agronomic challenges being faced. Additional information on each of the grasses is also presented.

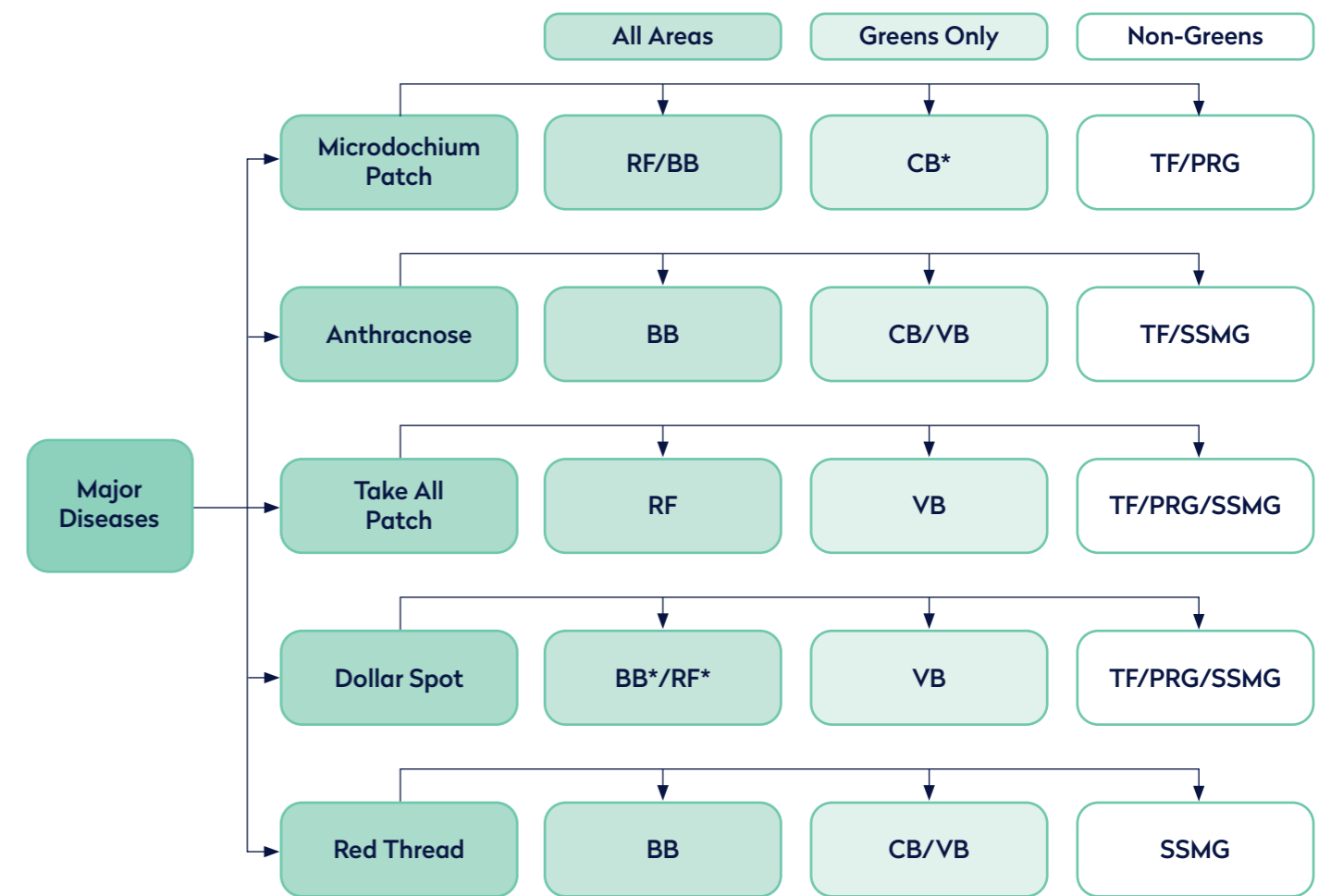
Again, it is important to note that individual cultivars within each species provide additional options for effectively matching grasses with growing conditions, management level and desired performance. The selection of species or cultivars for different regions should be based on its distinctive climatic, site-specific requirements, the performance of grasses in comparative testing and species or cultivar characteristics. Further details of where to find support on cultivar selection for your growing environment are given in Chapter 8.

Cool-season grass selection flowchart

Based on your site-specific requirements, the flowchart in Figure 4 will help you determine which grass or grasses might be more suitable for you in the context of agronomic challenges you may be looking to overcome. There are two sections to the flowchart, with the first section focusing on the main cool-season diseases and the grasses

which are most tolerant/resistant to them. The second section looks at key agronomic issues commonly encountered on golf courses, which turf managers often try to overcome. For each agronomic challenge, grasses that may be best adapted to survive under those conditions are presented.

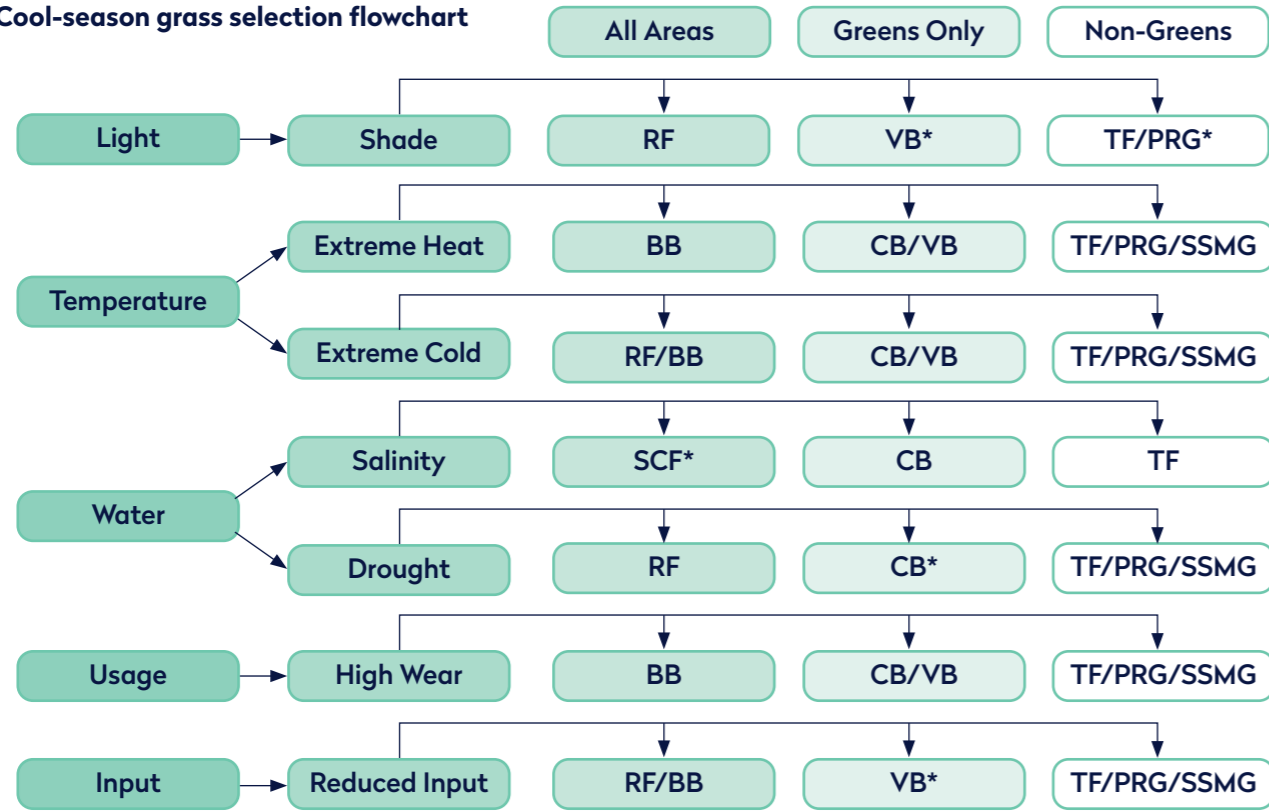
Figure 4. Cool-season grass selection flowchart



- BB = Browntop Bent
- PRG = Perennial Ryegrass
- SSMG = Smooth Stalked Meadow Grass
- CB = Creeping Bent
- RF = Red Fescue
- TF = Tall Fescue
- CF = Chewings Fescue
- SCF = Slender Creeping Fescue
- VB = Velvet Bent

*The severity of the disease on a specific turfgrass species may vary by cultivars. Please refer to the sources of support listed in Chapter 8 for more details of a specific cultivar/variety

Figure 4. Cool-season grass selection flowchart



BB = Browntop Bent
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SSMG = Smooth Stalked Meadow Grass
TF = Tall Fescue
VB = Velvet Bent

* The stress tolerance on a specific turfgrass species may vary by cultivars. Please refer to the sources of support listed in Chapter 8 for more details of a specific cultivar/variety



Velvet bentgrass

- Persist at broad range of mowing height
- Fine leaf texture
- Forms dense turf cover
- Great wear tolerance and recovery
- Tolerates drier and low input conditions



Red fescue

- Very fine leaf texture
- Great shade and drought tolerance
- Slow growth, less mowing
- Low-maintenance grass
- May struggle to persist under high wear



Tall fescue

- Very good drought and heat tolerance
- Low fertiliser requirement
- Winter hardy



Browntop bentgrass

- Persist at broad range of mowing height
- Fine leaf texture
- Forms dense turf cover
- Great wear tolerance and recovery
- Tolerates drier and low input conditions



Creeping bentgrass

- Fine leaf texture that forms dense turf cover
- Good wear tolerance and recuperative potential
- Good heat tolerance
- Winter hardy
- Can be susceptible to some damaging turf diseases



Annual meadow-grass

- Pegood shade tolerance
- Thrive in poorly drained and compacted areas
- Aggressive growth but typically needs higher level of inputs



Smooth-stalked meadow-grass

- Great wear tolerance and recovery
- Winter hardy
- Good wear tolerance and recuperative potential



Perennial ryegrass

- Rapid seed germination, best suited for overseeding
- Excellent winter colour and spring green-up
- Good wear tolerance

Warm-season grass selection.

- What grass species are used on a golf course in warm-season climate?
- How do I choose the most suitable grass species for my course?



Warm-season grasses are adapted to grow in hot climates and are usually used on golf courses located at latitudes between 35° N and 35° S.

They are found growing naturally in hot and humid and hot and arid environments. Breeding programmes have looked to harness characteristics that are favourable for use on golf courses and cultivated varieties intended for golf are well adapted for use. Most warm-season grasses are established through sprigging rather than seeding. Sprigging is the process of removing stems (stolons or rhizomes) from mature grass and replanting the vegetative cuttings in a different location. The cost and speed of establishment is highly dependent on the method.

Warm-season grasses are often ideally adapted to thrive under drought stress and high temperatures. This is made possible because warm-season grasses use a different process for photosynthesis, which is more efficient in producing their energy. Warm-season grasses can be established by seed, sprigs (creeping stems) or turf.

Warm-season grasses also have further adaptations to thrive in hotter and drier climates. They have more extensive and deeper root system than cool-season grasses. This also means that warm-season grasses can better withstand and recover from traffic stress than cool-season grasses. However, to produce a good playing surface, warm-season grasses usually

require a higher intensity of physical management than cool-season grasses.

There are three main species that are commonly used on golf courses in hot climates:

- Bermudagrass (*Cynodon* spp.)
- Zoysiagrass (*Zoysia matrella* and *Z. japonica*)
- Seashore paspalum (*Paspalum vaginatum*)

Additionally, there are some regionalised warm-season species that also perform extremely well on the golf course. They tend to be used where reduced management inputs are required and can produce very good playing surfaces in fairways and roughs.



The table below shows how grass species are used on golf course putting greens, tees, fairways and semi-rough.

All Areas	Non-Greens
Bermudagrass # (Cynodon spp.)	St. Augustine grass (Stenotaphrum secundatum)
Zoysiagrass (Zosia spp.)	Buffalograss (Buchloe dactyloides)
Paspalum (Paspalum spp.)	Kikuyugrass (Pennisetum clandestinum)

This chapter will focus on three major and three regionalised warm-season species that are often found in golf courses in the warm climates. Decision-making flowcharts are provided to assist with assessing which species would be relevant for use on each area of the golf course. This is based on the characteristics required of the turf and the conditions in which the grass will be grown. Additional information on each of the grasses is also presented.

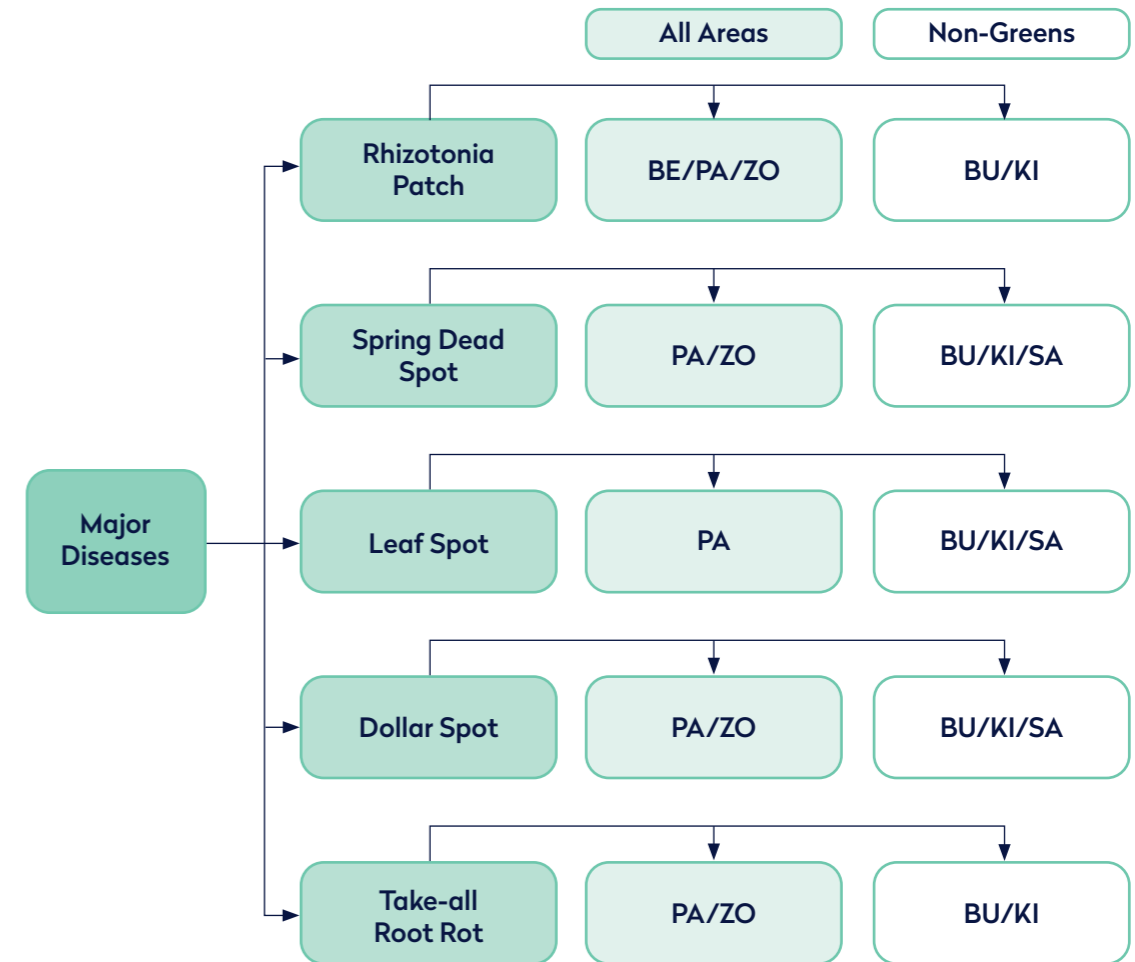
It is important to note that individual cultivars within each species provide additional options for effectively matching grasses with growing conditions, management level and desired performance. The selection of a species and cultivars for the golf course should be based on its distinctive climatic, site-specific requirements, the performance of grasses in comparative testing and species or cultivar characteristics.

Warm-season grass selection flowchart

Based on your site-specific requirements assess the grasses in the flowchart to help determine which grass or grasses might be more suitable for you. If necessary, prioritise critical characteristics that grasses must have and those which are of secondary importance in the

context of agronomic challenges that need to be tackled. As with the cool-season flowchart, it is broken down into two sections, with the first looking at a selection of common warm-season diseases and the second for typical agronomic challenges faced on golf courses.

Figure 5. Warm-season grass selection flowchart



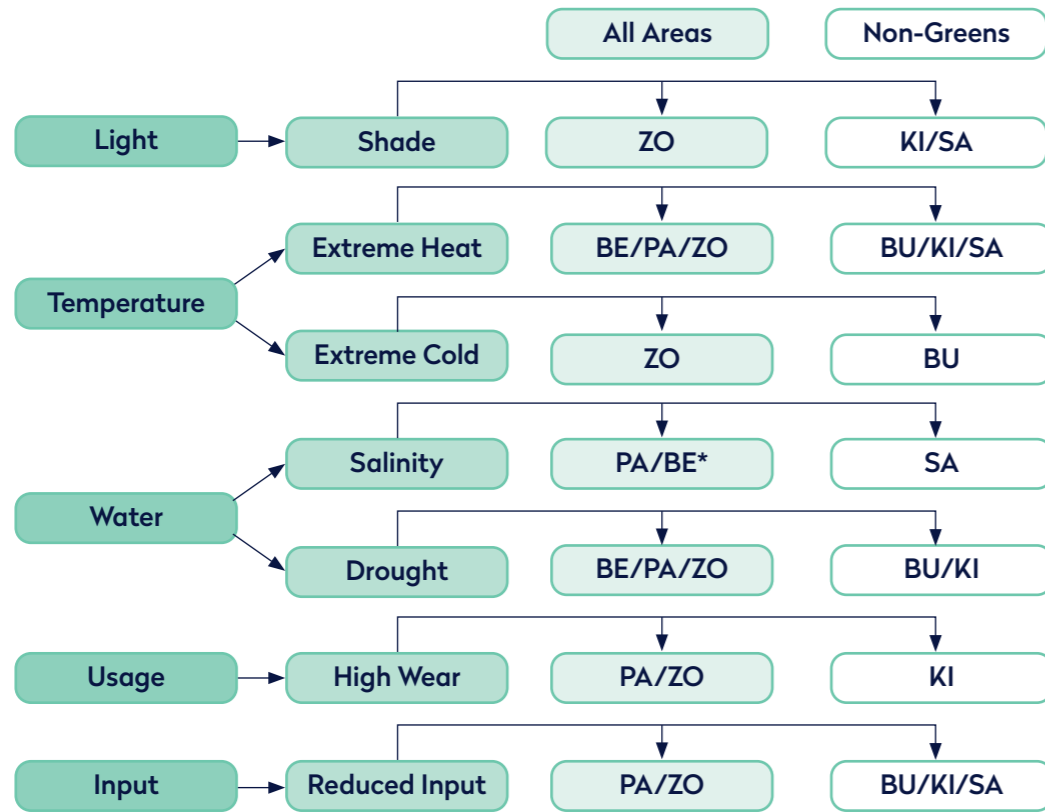
BE = Bermudagrass
BU = Buffalograss

KI = Kikuyugrass
PA = Paspalum

SA = St. Augustine
ZO = Zoysiagrass

*The severity of the disease on a specific turfgrass species may vary by cultivars. Please refer to the sources of support listed in Chapter 8 for more details of a specific cultivar/variety

Figure 5. Warm-season grass selection flowchart, Warm-season grass characteristic



BE = Bermudagrass
BU = Buffalograss

KI = Kikuyugrass
PA = Paspalum

SA = St. Augustine
ZO = Zoysiagrass

* The stress tolerance on a specific turfgrass species may vary by cultivars. Please refer to the sources of support listed in Chapter 8 for more details of a specific cultivar/variety



Bermudagrass

- Standard for greens, tees, and fairways
- Rapid establishment
- Great wear tolerance and recovery
- Great heat and drought tolerance
- Outstanding summer appearance and playability



Zoysiagrass

- Great playability even when dormant
- Slow growth rate, require less mowing
- Great wear tolerance
- High density, resistance to weed invasion
- Great heat and drought tolerance



Seashore paspalum

- Superior salt tolerance, saline water irrigation possible
- Low fertilizer requirement
- Deep and extensive root system
- Great heat and drought tolerance
- Great wear tolerance and recovery

Other regionalised species

Kikuyugrass (*Pennisetum clandestinum*) originates in East Africa. It is well adapted to Mediterranean-type climate and thrives on golf courses in a less hot, humid climate that receives regular rainfall (or irrigation). Kikuyu is very well suited to many areas in Europe and in Australia. The aggressive growth habit and competitiveness of kikuyugrass requires intensive management to control thatch accumulation.

St. Augustine grass (*Stenotaphrum secundatum*) is a rather coarse grass often used for lawns and can sometimes be found in golf course fairways and roughs in coastal or

tropical areas. This grass grows in a variety of soils and will tolerate some shade, drought, and lots of heat and salt. However, it cannot withstand cold winter temperatures. Despite its good heat tolerance, St. Augustine grass will turn brown and go into premature dormancy when water is limited.

Buffalograss (*Buchloe dactyloides*) is a low-maintenance grass with a slow growth rate and excellent drought tolerance. It requires less water and fertiliser than other grasses common to golf. Improved buffalograss cultivars have been introduced to the golf industry which provide playable roughs up to the challenge when faced with drought conditions.



Transition zone grass selection.

- What is transition zone and do I need to seasonally change my grasses?
- Cool-season or warm-season grass in the transition zone
- Grass selections for overseeding
- Overseeding or turf colourant

The transition zone is the area between the cool-season and warm-season zones with mean annual temperature ranging from 14 to 20°C.

The weather in the transition zone is too cool in the winter to maintain warm-season grasses, yet warmer summer temperatures make growing cool-season grasses difficult. Thus, it is a tough area for golf course

managers to select and grow grass. This chapter will cover the benefits and challenges of selecting different type of grass in the transition zone.

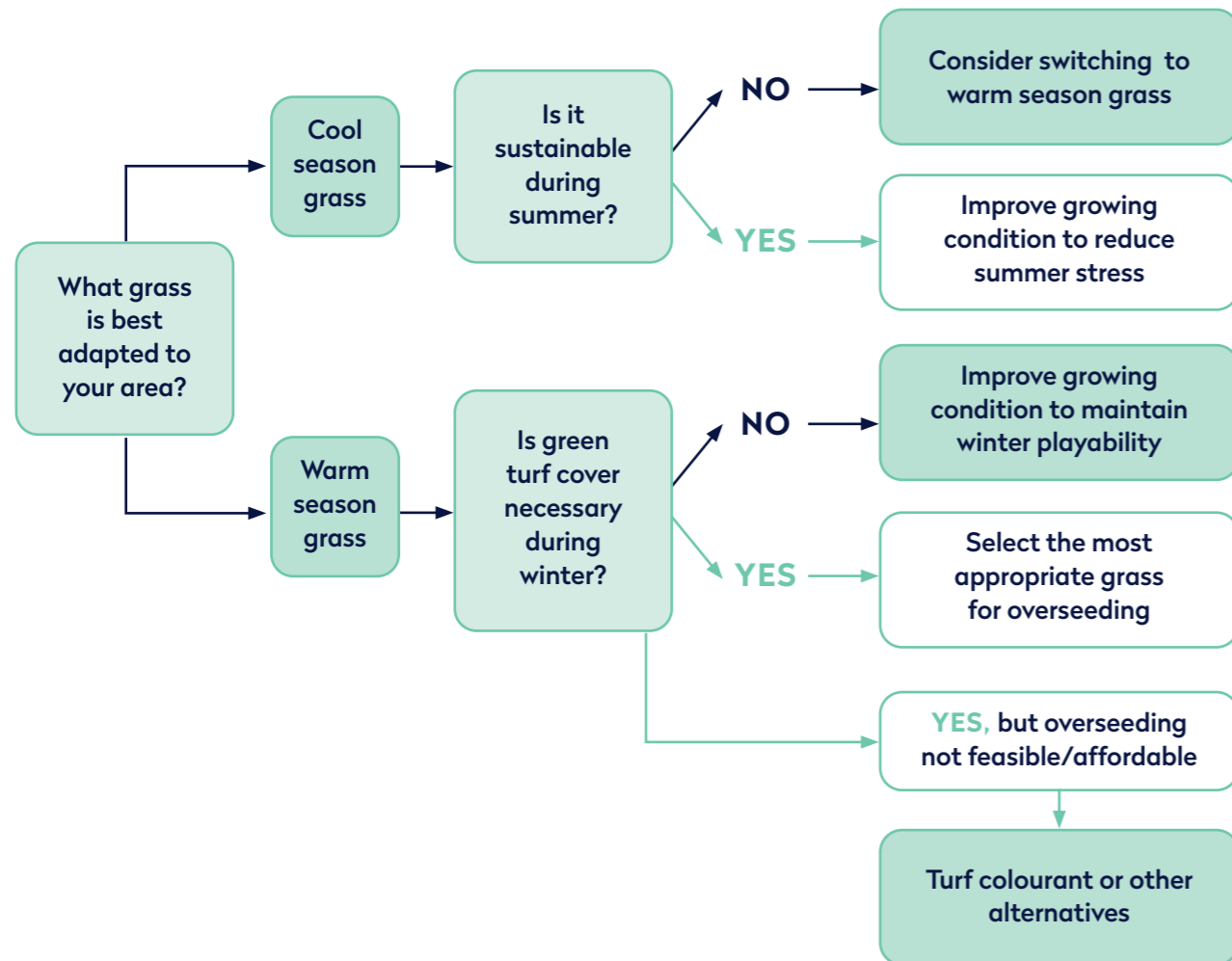


The challenge of the Transition Zone

The transition zone can be a challenging place in which to grow and maintain grasses on golf courses. This is because no one grass species can provide the optimal surface and persist throughout the year in this zone. In other words, parts of the year are too hot for cool-season grasses to provide good quality playing surfaces because the conditions are close to or beyond their climatic tolerances, whilst at other times of the year temperatures are too cold to sustain active warm-season grass growth.

So, what does this mean for my course? It means that no one grass species will thrive in that environment and that careful thought needs to be given regarding which grass or grasses might be considered for use. It is likely that compromises will have to be made and certain factors (golfing, maintenance, aesthetic or grass selection) might have to be prioritised based on course specific requirements. To aide with this process, a decision-making flowchart (Figure 6) has been created as a guide.

Figure 6. Decision making flowchart to help you choose between cool- and warm-season grass



Cool-season vs. warm-season in transition zone

With appropriate maintenance, cool-season grasses can have a longer growing season in the transition zone compared to warm-season grasses, and thus require more water and fertiliser per year. Transition zone golf courses with cool-season grasses, such as smooth-stalked meadow-grass, bentgrass, and perennial ryegrass can be more time-consuming, costly, and difficult to manage than would be the case if they grew warm-season grasses.

Due to excessive heat, irrigation requirements, disease pressure, and wear stress, cool-season grasses can decline in the summer, causing poor golfing conditions even with endless time and effort spent on maintaining an acceptable playing surface. Some golf courses have the resources to manage cool-season species to a level that meets the very high expectations of their clients. It is common to see cool-season grasses grown on smaller areas like greens and tees but rarely on fairways because they are too expensive to maintain.

For golf courses which need a reliable playing surface that is appealing, and, most importantly, more sustainable, warm-season grass is the better option. Compared to cool-season grasses, warm-season grasses require less fertiliser, irrigation, and mowing and are less susceptible to disease and insect pests. They grow actively to offer better wear tolerance and speedy recovery during the hottest of months, which may be the busiest period for the golf course.

Thanks to modern turf breeding programmes, cold-tolerant cultivars of Bermudagrass and zoysiagrass are being developed. They are increasingly being used on green, fairway, and tee areas in the transition zone. The disadvantages of warm-season grasses compared to cool-season grasses in the transition zone are winter

colour, winter hardiness, thatch accumulation and establishment costs. Despite the limitations of warm-season grasses, the reduced disease and pest pressure and lower maintenance inputs make them increasingly attractive long-term options for transition zone golf courses.

Figure 7. Pros and cons of growing cool- and warm-season grass in the transition zone

	Pros	Cons
Cool-season grass in transition zone	<ul style="list-style-type: none"> • Generally better playing quality • Excellent cold tolerance • Great winter survival rates 	<ul style="list-style-type: none"> • Higher maintenance input • Extra water needed in summer • More susceptible to diseases
Warm-season grass in transition zone	<ul style="list-style-type: none"> • Lower maintenance inputs • Fewer disease problems • Better heat/drought tolerance • Better wear tolerance 	<ul style="list-style-type: none"> • Dormant in the autumn/winter • More thatch accumulation • Winter kill

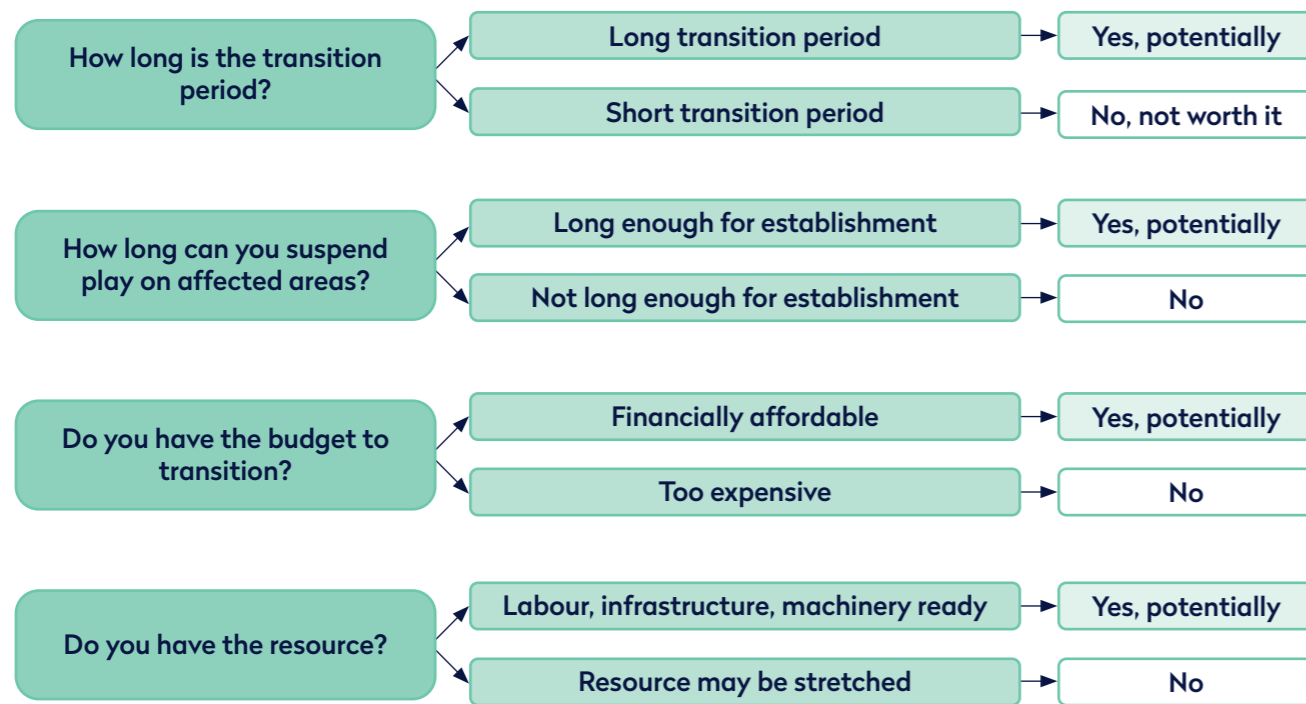


Overseeding or not overseeding?

When in dormancy, Bermudagrass loses much of its canopy during the winter and with wear damage is often worn down to bare soil by spring. In order to maintain excellent playing conditions all year, golf courses with Bermudagrass may need to be overseeded with a cool-season grass in autumn.

This is done by spreading cool-season grass seeds into the existing Bermudagrass to create a temporary green cover during the time when Bermudagrass is dormant. In spring, when temperatures start to rise, Bermudagrass will come out of dormancy, green-up and become a dominant monoculture.

Figure 8. Decision making flowchart to determine if overseeding is a viable option



Grass selection for overseeding

If you decided to overseed your golf course during winter, there are two transitional phases when issues may arise when selecting a cool-season grass for overseeding:

- 1) Autumn establishment of the overseeded grass
- 2) Spring transition back to warm-season grass

Each species of cool-season grass has both positive and negative attributes that affect its overseeding performance. Species that have been used for overseeding warm-season turf include annual ryegrass, perennial ryegrass, and rough-stalked meadow-grass (rough meadow-grass). Details of pros and cons of each species are presented in Figure 9.

Figure 9. Pros and cons of three overseeding species

	Pros	Cons
Perennial ryegrass	<ul style="list-style-type: none"> • Very quick to establish • Good wear tolerance • Used on fairways and tees 	<ul style="list-style-type: none"> • Stress at low cutting height • Poor shade tolerance
Annual ryegrass	<ul style="list-style-type: none"> • Very quick to establish 	<ul style="list-style-type: none"> • Poor cold tolerance • Poor heat tolerance
Rough-stalked meadow grass	<ul style="list-style-type: none"> • Quick to establish • Good shade tolerance 	<ul style="list-style-type: none"> • Poor colour • Poor heat and drought tolerance • Poor wear tolerance

One of the most important factors in choosing a grass for transition zone overseeding is that it must not persist and compete with the main grass species once conditions have returned which favour the warm-season grass. The sustainability of this approach also needs to be considered, against options such as painting with vegetable dyes, as overseeding is costly not only in terms of buying seed but also in the extra water, fertiliser and pesticides needed to establish the grass that is being introduced.

Turf colourant for temporary green cover

Despite its dormancy, zoysiagrass remains very playable in the winter months, with stiff leaves that produce a great ball lie all year long. Although many golfers do not like the colour of dormant grass, they are in fact perfectly playable. Painting dormant grass makes golf courses more sustainable by reducing the need of water, fertiliser, pesticides and all the time and labour spent mowing in winter.

Turf colourant has served as an alternative to overseeding warm-season grasses, especially for areas where transitioning the playing surface from a cool-season grass back to a warm-season grass is challenging due to acute, rapid fluctuations in temperature in the spring. The use of turf colourants allows for a much more predictable spring green-up because warm-season grasses do not have to compete with overseeding grasses for water, nutrients or light. This will contribute to a healthier stand of warm-season grasses going into the summer.

Like overseeding, there are a few potential drawbacks to using a colourant. The biggest issue is that colourant does not provide an active growing turf like overseeded grasses. Once the dormant warm-season grasses are worn or torn away, there is no regeneration until spring. The wear tolerance factor must be considered if the golf course receives a lot of golf play during winter months. The other drawback of using colourant is that it may need to be reapplied to maintain colour.



Photo source: <https://www.usga.org/course-care/regional-updates/southeast-region/time-to-make-plans-for-turf-colorants.html>

Figure 9. Pros and cons of overseeding and the use of turf colourant

	Pros	Cons
Overseeding	<ul style="list-style-type: none"> • Active growing surface • Better wear tolerance • Better recovery 	<ul style="list-style-type: none"> • Time and labour consuming • More maintenance input
Turf colourant	<ul style="list-style-type: none"> • Less maintenance inputs • Less expensive 	<ul style="list-style-type: none"> • No recovery during dormant • Reapplication may be required

Take-home message

- Transition zone is a tough area to select and grow grass as it is too cool in the winter to maintain warm-season grasses, yet warmer summer temperatures make growing cool-season grasses difficult.

- The key for grass selection in transition zone is to find the balance among sustainability, playability, budget, and golfer expectation.
- Overseeding is not the only choice to maintain playable surface during winter.

Turf colourant provides a more affordable solution.

- Identify the conditions you face on your course and expectations of golfers to see what might be viable options for your situation.



Key factors influencing species selection.

- What makes grass grow well?
- How do environmental factors affect your grass selection?
- How to create optimum growing condition for your grass?

Temperature is arguably the most influential variable for grass growth, with grasses being divided into cool-season and warm-season.

The influence of the growing environment

Temperature is arguably the most influential variable for grass growth, with grasses being divided into cool-season and warm-season based on their climatic adaptation and temperature range required for optimum growth. However, there are many other factors which can affect grass growth, both favourably and unfavourably. It is vital that they are considered when making the best choice of grass for particular areas of the golf course. To do that, it is important to understand how these factors influence grass growth.

In this chapter, we will discuss why it is important to understand the conditions on your course that are associated with grass growth.

Soil

Soil is the growing medium for turfgrass. The retention capacity for nutrients, water, and the efficiency of drainage systems are all dependent on the soil structure, texture, and organic matter content. The water content of the soil determines whether plants drown, thrive or wilt.

- Clay soils tend to hold more moisture, dry out very slowly and under wet conditions can become very soft and prone to wear damage.

- Sandy soils dry out quicker and hold much less moisture and nutrients, which mean greater inputs of both will be needed. Sandy soils allow more consistent play under a wide range of weather conditions. Sandy soils are generally regarded as the preferred choice for golf.

- Loamy soils are a combination of primary particles of sand, silt and clay, and are often considered the optimal texture for plant growth. However, they can result in overly wet and soft surfaces during wetter periods of the year.

Light and air

For healthy growth, grasses require sunlight for photosynthesis and good airflow for drying leaf tissue and cooling. When it comes to light and air, there are two major problems grasses can face: lack of quantity and quality of sunlight and lack of air movement.

Shade from trees, buildings or overcast weather affects grass growth and health due to lower rates of respiration and photosynthesis. Lack of air movement will extend the period of time when the grass is wet and impair the natural cooling process (transpiration), which may enhance disease development. Prolonged shade stress can significantly reduce turf quality,



with weakened turf plants being more susceptible to disturbance damage from traffic, pests, and diseases. Some golf courses are treeless, but many have several different coniferous and deciduous tree species. There can be strong competition between trees and grass for nutrient and water. The diversity of landscape and the severity of shade stress needs to be considered when selecting a grass species.

Shade tolerance

Most turfgrasses require significant quantities of light for optimum growth and development. One way to deal with shade and poor air movement is to manage the growing environment, for example, selective tree pruning and felling.

If we cannot modify the environment, we may be best considering using shade tolerance species. Please refer to Chapter 2 and Chapter 3 for further details on appropriate shade tolerant species. In areas where shade is an issue, seed mixtures containing shade tolerant

species/cultivars offer greater resilience and good performance either under full sun or in the shade compared to single species/cultivar mixes.

The built urban environment offers challenges for golf courses located in cities that are populated with tall buildings and packed tightly together. Careful consideration needs to be given to ensure playing surfaces are not negatively affected by shade, poor air movement resulting in increased humidity and higher disease pressure. A key component to meet this challenge will lie in selecting the best adapted species.

Water

In a natural setting, vegetation growth is regulated by the amount of water that is available from rainfall and that is stored in the soil. In a managed setting, as on the golf course, where growth needs to be controlled, water provision needs to be regulated to ensure the grasses are growing sufficiently for them to

be prepared as a playing surface. This is achieved through irrigation.

Conversely, the health of the grass and the quality of the playing surface can be adversely affected by there being too much water, i.e. from excessive rainfall, flooding, surface ponding. Excessive irrigation can result in similar, though less dramatic, conditions. This is addressed through drainage, which includes pipe systems, surface runoff and maintenance practices such as aeration and use of surfactants.

Getting the water balance right is a critical aspect of delivering quality playing surfaces.

A significant challenge on golf courses now and for the future is water availability and managing extremes of supply and demand. Our demand for water will not decline and new water resources will be difficult to develop. Drought tolerance is and will become even more important a characteristic of turfgrasses. Using grasses more adapted to dry environments will

be a vital component of integrated water management planning.

Dealing with excess water is already an issue for many golf courses which see periodic flooding. Integrated solutions for water management are vital and can provide wider benefits to golf course management, such as water holding lakes that can also provide biodiversity value and potential irrigation water resources.

Diseases, pests and weeds

Disease, pest and weed management is a major component of golf course maintenance. This is because they can be disfiguring to the playing surface and reduce the playability and quality of putting surfaces in particular.

Disease, pest and weed incidence is more of an issue in a managed environment because the maintenance we apply puts stress on the grass plant, making it more susceptible to attack.

Effective control of disease, pest and weed problems is important to produce and maintain top-quality playing surfaces, which are in keeping with golfer expectations. However, use of plant protection products on golf courses has and will continue to be under pressure globally because of perceived and potential impacts on the environment. This means that golf courses will have to make much greater use of integrated turf management approaches to prevent disease occurrence in the first place. Grass selection will be a key factor in keeping turf disease in check. Pesticide availability and grass selection

Availability of pesticides is under pressure in some parts of the world, this means turf managers may have few tools to help with managing pest, weed, and disease problems. Grass selection can provide a significant benefit to managing these problems, as part of an integrated pest management programme. This is because some grass species are more resistant or tolerant to some these challenges. If you know you are prone to particular problems, look for varieties that are more resistant or tolerant, this can be a significant component of ITM.

Usage and wear

Grasses used on golf courses tend to be fine-leaved species that can tolerate frequent mowing and withstand wear. They have been bred to be aesthetically attractive which, when maintained appropriately, produce high quality playing surfaces. Wear stress and damage caused by play is a key agronomic driver for plant health and grass selection. It is important to understand the intensity of usage on a golf course, as some grass perform less well under high wear. Matching the intensity of play with grass species and how the grass is managed is vital. Please refer to Chapter 2 and Chapter 3 for further details on the wear tolerance of each species.

Maintenance and turf input

The grasses used on golf courses tend to be optimised for aesthetic, playing and functional quality, without producing excessive growth, which would mean more time and cost in mowing surfaces. The goal of golf course managers is to maintain a uniform and high-quality grass

surface by maximising density and plant health, whilst reducing stress, resource use and disease pressure.

Management inputs play a critical role in the success of playing surfaces. Their interaction with the grass plant and the resultant surface has to be considered when evaluating the most appropriate grass species to be used on a particular area of the golf course. Understanding the biology and ecology of turfgrass is important to know how the plant can and should be managed. Mowing, plant nutrition, and irrigation are the primary cultural practices undertaken to maintain a high-quality turf surface. These operations, particularly mowing, tend to be the ones that are carried out most frequently on golf courses. Less frequent operations such as aeration, scarification, topdressing, overseeding and disease, pest and weed management are, however, also often vital for the long-term sustainable maintenance of high-quality playing surfaces.

A sustainable long term turf management strategy is vital to ensure that optimum grasses are maintained in playing surfaces. Species selection needs to consider long term management aims in order to be successful.

How does turf maintenance affect grass selection?

Once the list of grasses has been narrowed down to the most suitable species and cultivars for a golf courses location, the next most important factor to consider is turf maintenance. High quality golf surfaces can only persist with regular maintenance inputs. As a result, the impact and interaction of maintenance operations on grass survival and persistence is critical.

The turf maintenance regime in its current or modified form will directly affect the persistence and health of any grass species.

Therefore, the current maintenance regime needs to be assessed for its compatibility with new grasses being considered. The regime may need to be modified, but with the need to understand how this might impact the playing surfaces in the short, medium and long term.

To summarise, it is vital to consider maintenance inputs and their interactions with the grass species being considered for selection. In the following section, some of the key maintenance operations are discussed along with their impact on grasses.



Mowing

Mowing of the golf course is essential to creating playing surfaces with sufficient quality that they are suitable for their intended use. The importance of proper mowing practices and mower maintenance cannot be over emphasised. Even on the highest maintained golf courses, mowing is the largest portion of the budget because it is associated with labour provision, equipment purchases, maintenance, and storage.

Mowing height and mowing frequency are critical factors to be considered when selecting turfgrass species, as well as the type of mower to be used on a site. On a golf course, mowing heights range from 3-4 mm on putting greens to 70+ mm on maintained roughs. Some are now cutting greens at a height under 3 mm, which many grasses considered as a sustainable selection cannot tolerate. If implementing such close mowing, unless the sustainable grass of choice is well adapted to tolerate it, then conversion will fail, and you will be left with a more costly and resource dependent grass. In addition, putting greens need to be mown almost every day, while roughs

can be mown on an as-needed basis. Although low heights of cut and frequent mowing provide playability benefits, they are detrimental to the plant and can cause direct damage to the crown (growing point) of the grass. Mowing height and rooting depth are directly proportional. In other words, lower cut turf has a shallower root system that can result in less stress tolerance and a weaker plant. As a rule, it is more difficult and costly to maintain turf at lower mowing heights, which is why putting greens require the highest maintenance inputs to support plant health.

It is essential to understand that each species has its own mowing height tolerance and selected grasses may weaken, to be replaced by less desirable ones, if they are cut closer than they can tolerate. This is a key consideration when choosing a suitable grass species.

The quality of cut is also very important. Poor cut quality damages grass plant causing weakening and sward deterioration. Mowers must be well maintained, with sharp blades and correctly set to deliver a good finish.

Plant nutrition

Fertiliser application is an integral component of managing high quality turf. We need to control the growth of grasses so that they can function as playing surfaces. Managing the grasses on a golf course is all about producing quality, not quantity. The removal of nutrient containing biomass, in the form of clippings when mowing, means we often need to replace nutrients that have been removed.

The aim of nutrient inputs is to maintain plant health and root development for the least amount canopy growth required to produce the playing surface. The amount of nutrient that needs to be applied is often determined by assessing:

- Nutrient reserves in the soil
- Nutrient reserves in the grass plants
- Growing environment and growth potential
- Individual grass species requirements
- Volume of clippings removed

Different grasses require different levels of nutrition. For example, fescues require less annual fertiliser

input than most creeping bentgrass cultivars. It is important to tailor inputs to the requirements of the desirable grasses being assessed for the suitability for a playing surface.

Applying too much or too little fertiliser for an individual species' requirements will cause that grass to weaken, providing the opportunity for other, perhaps fewer desirable grasses or weeds to establish. When fertiliser is applied at rates greater than what is required for sustained growth, excessive build up of thatch can create a favourable condition for many insect pests and disease pathogens. This scenario can also lead to a softer surface with reduced playability, which subsequently requires greater levels of disturbance from cultural practices to maintain playability.

Irrigation

Irrigation is necessary on high quality turf surfaces for functional and aesthetic purposes. Irrigation provides water for turfgrass growth when there is not an adequate supply in the soil and helps transport fertilisers into soil solutions to assist plant uptake. It can also be used to cool down heat stressed turf and can be used to prevent playing surfaces from becoming overly hard. Light irrigation (syringing) is often employed during the heat of the day in summer to keep the surface cool and to prevent plant desiccation. However, syringing is not enough to replenish the amount of water needed for plant growth in hot and dry periods. Irrigation is often applied at night or in the early morning to avoid interference with play during the day and moisture loss from evapotranspiration.



The key to a successful turfgrass irrigation programme is to apply enough water to sustain plant growth while avoiding over watering. The requirement for irrigation also varies by grass species, warm season species generally need less water to thrive than cool season grasses. Knowing the water requirement and tolerance for drought is critical when thinking about grass selection. Soil moisture probes mean that making irrigation decisions can be done objectively by assessing soil water reserves available to the plant. Weather stations also provide important information on the amount of moisture lost through evapotranspiration during the day and therefore further help to inform irrigation requirements.



Aeration and sand topdressing

Producing healthy soil conditions is often a prerequisite to successful grass establishment and survival. Whilst keeping fertiliser and water inputs to the minimum required to prepare the playing surface is the best means of reducing the rate of thatch accumulation, aeration and topdressing are the most effective ways to control thatch and maintain smooth, firm putting surfaces.

Aeration is primarily performed to control thatch, relieve soil compaction, stimulate root growth, and improve drainage. Aerating might create short term disruption, but the long term benefits greatly outweigh the inconvenience. Sand topdressing is a process that spreads a thin layer of sand on top of the turf surface.

Sand topdressing applications are made to smooth the playing surface and to reduce (dilute) the build up of thatch. The sand applied to the surface can also protect the crowns of the growing grass and produce a less favourable environment for insect pests. Heavier dressings can be made following more intensive aeration operations, such as hollow tinning.



Sand is abrasive, so care needs to be taken in the timing of topdressing application to when there is adequate growth to ensure absorption and recovery of any damage to the grass leaves.

Disease, pest and weed management

A disease is caused by an infectious agent that injures the plant and diminishes its aesthetic value. Different turfgrasses are susceptible to different turfgrass diseases. It is important to know your grass and

its biology and understand what conditions give the competitive advantage to the grass plant and not the pathogen.

For a disease to occur there must be a virulent pathogen, a susceptible host, and an environment favourable to the growth and development of the pathogen. These three components make up the disease triangle. By using the disease triangle, we can more easily understand why diseases affect grasses in some situations and not others. Disease symptoms will not be expressed if any of the three components are not present and/or optimal. As golf is typically played on a grass surface, there will always be a host for pathogens to potentially attack, therefore the role of disease management is to alter and affect the environment and pathogen components of the disease triangle.



Manage diseases by not allowing conditions to favour the disease and use disease resistant species and cultivars when seeding. Disease can be controlled through appropriate and timely use of plant protection products, but these are part of the toolkit for disease management and not the sole weapon in the arsenal. Integrated turf management (combining good cultural practices, nutrition, and water management with biological and chemical control) is the only way to effectively and sustainably manage turf diseases, pests and weeds.

Insect pests can cause damage by feeding on leaf, stem, and root, or by “sucking” nutrients out of the plant. Good cultural, fertiliser and irrigation practices can help manage pest problems or mitigate plant health effects. A healthy plant will withstand pest attack better. Some grasses have a close association

with endophytic fungi (non disease causing fungi living inside the grass and they have shown high resistance to foliar feeding insects such as billbugs, chinch bugs, sod webworms, and fall armyworms.

Budget and expectation

All grasses are not the same and some grasses cost more to maintain than others. The maintenance budget golf courses can afford also varies. There can often be potential conflict between the expectations of golfers and available resources course managers have, and both factors should be considered during the grass selection process.

Those grasses that require a high level of maintenance inputs will be costly to keep, if they are to provide a good standard of playing surface. Grasses requiring a lower level of maintenance will be cheaper to

manage. As a generalisation, all of the grasses that are suitable for golf course use will deliver decent playing quality, provided they are managed properly to ensure they thrive and are persistent. The danger can be in over-managing which can incur unnecessary cost and cause grasses to under-perform, particularly those with less intensive maintenance demands.

What is certain is that grass selection must:

- Reflect available budgets for the change process and for ongoing maintenance.
- Align budget and expectation for a turf surface to be successful. This must be considered carefully when weighing up which grasses to select.



Take-home message

- Environmental factors including soil, light and air, water, disease, pest, and weeds, and usage of the course play vital roles in grass selection process.
- The conditions in which the grasses will be grown should be considered

carefully when selecting the most appropriate species for that particular location.

- Management practises including mowing, plant nutrition, irrigation, aeration and topdressing, disease, pest, and weed control will determine how well the selected grasses perform in your course.

- For grasses to persist, they must be adapted to the environment they will be grown in, if they are not, they will not survive.

Making the change and planning for success.

- Ready to change? Plan for success!
- What are the factors to consider when changing the sward composition?
- Mixture or monostand?

When selecting grasses, it is vital to have a plan and milestones for achieving that plan.

Grass selection needs to be considered as part of an integrated management process for the golf course and, as with all such processes having defined objectives of what you are trying to achieve is essential. When selecting grasses, it is vital to have a plan and milestones for achieving that plan.

The aim of this section is to help golf course managers who want to change the sward composition of an existing surface to achieve a smooth and successful transition. Turf managers must know what grasses they already have, what is their end goal, what grasses are they considering use and have they created the conditions for success. If turf managers are looking to bring about sward composition change, it will fail unless the conditions that favour the introduced grasses are created. The following steps naturally focusses on introducing new grass through overseeding, but the process is relevant for new constructions or for those able to take surfaces out of play prior to establishing a sward with seed, turf or sprigs.

Setting your goal

This is essential if you are to assess the degree of success of this process. An example of goal setting could relate to having the current composition of your greens

dominated by annual meadow-grass, with bentgrass and fescue in varying quantities. The objective is to have a surface which performs more consistently through the year and that has less reliance on water, fertiliser and chemical inputs. Your goal would be to increase the content of bent and fescue and to reduce the amount of annual meadow-grass.

Be realistic

Be realistic about why you want to achieve your objectives, what you can achieve and how quickly you can get there. Changing to a bentgrass and fescue dominated turf from an annual meadow-grass turf through overseeding into an existing sward is not an easy job and will take time. A successful transition of species composition can be achieved through sensible management practices and repeated overseeding operations over a sustained period. This conversion is relatively slow and can take a number of years to reach the desired population shift.

How to make the change and timing

There are various options for changing your grass species composition, including seeding, sprigging and turfing. There will be ideal windows of opportunity for making the change depending on

your own circumstances, location and climate. The key to timing is to ensure there is going to be a suitable period of good growing weather post change to achieve strong establishment.

Re-grassing an existing area

Although golf courses established decades ago with older species and cultivars could still provide good playability, managers some of these golf courses may notice the older grasses frequently require more inputs when compared to newer grasses. The costs to keep these older grasses alive and performing well can rapidly add up, especially when dealing with larger turf areas such as fairways. However, there are other circumstances, such as 150-year-old links greens where the native fescue/bent sward remains dominant, where the established

grasses will continue to provide excellent performance.

Over recent decades, turf species and cultivars with improved traits have become available. Despite the short-term expense and temporary closure of golf courses, converting to improved cultivars may lead to considerable long-term savings. In most cases, the initial costs of conversion can be offset by reduced maintenance costs including water, labour, plant protection products, top dressing, and fertiliser. For some, however, the indigenous grasses that are well adapted to the environment they are living in will be very low input from a maintenance perspective.

For greens, another more commonly used strategy is to overseed existing surfaces to allow the new cultivars to establish over time without taking them out of play.



Overseeding

Overseeding is the practice of spreading grass seeds over an established turf. Overseeding the same species into the established turf can help increase stand density and promote recovery from damage. Overseeding can also be used over a period of time to change the balance of species in a surface. However, this process takes time, with growing and environmental conditions optimised for the survival and persistence of the introduced species, without jeopardising the quality of the playing surfaces.

Overseeding is also a practice of temporarily introducing a second turfgrass species into a permanent sward for the purpose of winter colour or traffic tolerance. Golf courses with warm-season grasses are often overseeded with a cool-season grass in autumn to extend the playing season, making this practice common in the Transition Zone. This is done by seeding cool-season grass seeds into the existing warm-season grass to create a temporary green cover during the time when warm-season grasses would normally be dormant and brown. In spring, when temperatures start to rise, the warm-season grass will

come out of dormancy, green-up and switch the turf back to warm-season grass. Establishment of cool-season grass and transitioning back to warm-season can be challenging. Thus, selecting an appropriate cool-season species for overseeding is critical.

Overseeding can only be successful if the introduced seed is in direct contact with the soil. Seed deposited in thatch will not survive. It is, therefore, necessary to use some form of cultivation, causing as little disruption to the playing surface as possible, to introduce the seed. This can be done through aeration techniques or the use of specialist overseeding machinery.

Overseeding can only be successful when soil temperature is favourable for seed germination, the minimum soil temperature is 7 to 12 °C for cool-season grass germination and optimally 12 to 18 °C. Timing of seeding is critical to ensure the seed has time to germinate, establish and persist. It is vital to have sufficient windows of opportunity at the right time of year to carry out this overseeding. In addition, a comprehensive and efficient irrigation system will be required for rapid and successful grass establishment.

Sowing a new area: monostand or polystand

Turfgrass seeds can be sown individually, in cultivar blends of one species or in mixtures of different species. A grass seed mix is made up of two or more different species of grasses. A grass seed blend is made up of two or more cultivars of the same species of grass. Most golf courses are a mix of conditions, so a suitable grass would logically be a mix of species or blend of cultivars. A mix of species is generally more adaptable to differing site conditions (shade, full sun, dry, wet). Blends are often used in highly maintained turf where extremely uniform appearance and performance are required.

Blends and mixtures offer great benefits by combining a range of desirable characteristics, such as disease-resistance, wear tolerance, and drought tolerance. A mix will offer year-round resiliency, i.e. in a bent/fescue mix, the bent component will compensate at times when fescue lays dormant. A well-formulated blend or mixture can enhance the health, aesthetics, and performance of the sward under different types of environment. Some golf managers prefer a monoculture (also called monostands) over mixtures because grasses in the mixtures may not be aesthetically pleasing at different times of the year due to species/cultivar dissimilarities in leaf texture and colour. However, it is important to note that monocultures may be at greater risk of diseases and pest attack than mixtures, as there is no inbuilt genetic variation in tolerance with monostands.



To maintain or to change sward composition?

If the established turf performs well in the local climate, overseeding with the original mixture helps aid speedy recovery and to maintain species composition. However, depending on maintenance regimes and environmental conditions, one species from the mixture may become dominant. In such a case, the aim of overseeding is to change the blend or mixture of grasses growing in the turf. If done with less competitive species in that growing environment, this will have to be repeated regularly, and will often need to go hand in hand with modification of the growing environment to favour the less competitive species. Overseeding with a dominant species that is well adapted for the prevailing environment will slowly adjust the species composition to one that is better suited to the area it is being sown in.

Create the right conditions

Preparing the turf or soil ready for seeding and seedling establishment is essential. It is vital that the conditions into which the seed is placed favours its establishment. If conditions in the soil or the growing

environment do not favour the seed or grass species being used, then the results from overseeding will be significantly diminished. For example, sowing into thatch will result in failure. The aim is to get good seed: soil contact (not seed: thatch), so preparing the surface ready for the seeds and ensuring that maintenance practices before and after seeding are supportive to the seed and seedlings is critical to the chances of success. The following practices help to weaken the existing turf while making the overseeded cool-season grass more competitive.

- Season-long thatch management.
- Limit fertilisation near the seeding date.
- De-thatch with light aeration or vertical cutting before seeding.
- In some circumstances, reducing the mowing height can slow down the growth of the established grasses and reduce competition pressure for the emerging seedlings.
- Use of plant growth regulators prior to seeding to ensure the seedlings have space to establish before the canopy closes.

Assuming all the points above have been achieved, germination can take as little as seven days to as much as three weeks, depending on species. During this period, the surface should be kept moist. The surface should be covered with a light sprinkling of water as soon as it feels dry.

Frequency

Splitting one overseeding into two, three or multiple light overseeding applications over the growing season could be beneficial as it increases seed: soil contact. One of these treatments could be done early in the season to restore the population of desirable grasses right at the beginning of a busy playing season. The following application can be done after the playing season when soil temperature still favours seed germination.

Monitor progress

Overseeding success can be measured by species composition assessments before and after overseeding and often taking photographs before and after can help. However, making such an assessment too soon after overseeding can be misleading, as whilst the initial establishment rate might be good, a proportion of those new plants will not persist as maintenance practices intensify. So, monitor the situation over a period of months rather than weeks. Annual assessment of the species composition on your greens is also a good practice to evaluate your progress, set targets and adjust plans to.

Good communication

Communicate to the golfers, as overseeding will inconvenience them during the grow-in. Good sense normally prevails if the need

for short-term disruption to provide long-term benefits is well explained to golfers. A better performing surface and less reliance on inputs, be it labour, cultural practices, fertiliser or pesticides, will be the result. Good communication can also reduce the post-overseeding pressure to get greens straight back to a level of high performance too quickly, which would jeopardise the new grass plants.

Assess and review surface performance

Assess your achievements against your objectives. Learn from the experience and manage surfaces to avoid deteriorate in performance. Periodically review your grass selection as plant breeding brings new, better grasses and their cultivars on to the market.

Disturbance theory

For those that want to have a deeper delve into both the ecological theory of sward composition change and practical guidance on how to achieve this, it is recommended that readers peruse STRI Disturbance Theory.

This consists of a series of published articles that starts with understanding the ecological strategy of different cool-season grasses, according to the growth strategies outlined by Grime, Hodgson and Hunt. Articles then translate this ecological theory into practical guidance for those seeking to understand how best to optimise sward composition change.

A major focus of the articles relates to practical turf management strategies to achieve sward composition change. The key take home messages are:

- Understand what conditions your desirable grasses are adapted to thrive under.
- Create those conditions, as without them change will be impossible to achieve.
- Create the disturbance you need to pressurise the less desirable grasses and favour those you want.

- However, you have to know when to apply the gas and when to take your foot off it. Disturbance is a tool that needs to be used carefully and in a panned way.
- Finally, know when you have achieved your goal, but if you haven't look hard at what has limited the successful transition to the desirable grasses and adjust your approach.

Take-home message

• **Change of sward composition does not happen overnight. When you decide to change the sward composition, follow these steps to ensure success:**

1. Setting up your goal and be realistic.

2. Pick the right timing and create the right condition for change.
3. Monitor the progress and communicate to your members.
4. Assess and review the surface performance.

- **Mixtures may not be aesthetically pleasing at different times of the**

year compared to monostand due to species/cultivar dissimilarities in leaf texture and colour.

However, monocultures may be at greater risk of diseases and pest attack than mixtures, as there is no inbuilt genetic variation in tolerance with monostands.

Climate change, resource constraints and regulation.

- Sustainable, sustainable, sustainable
- How to prepare for climate change?
- How to deal with the tightening of chemical restrictions?

Golf has great potential to positively contribute towards sustainable development across emerging and established markets.

Sustainability

The R&A has defined golf course sustainability as “Optimising the playing quality of the golf course in harmony with the conservation of its natural environment under economically sound and socially responsible management” and as “Golf’s contribution to wider society and the effect the sport has on nature and resources, delivered by enduring businesses which provide a positive sporting, environmental and social legacy for future generations.” In recent years, the sustainability of the golf industry has gained a lot of attention for its impact on ecology and the environment. This is not only due to the debate on perceived negative impacts of golf courses, but also the positive benefits and opportunities golf courses provide to enhance and complement the local environment, as well as the social value these facilities provide.

Golf has great potential to positively contribute towards sustainable development across emerging and established markets. Selecting a species that is naturally well

adapted for the local environment is the essence of sustainable golf course management. Trying to grow a poorly suited grass species can lead to tremendous expense on water, fertiliser, and plant protection products. In addition to the financial issues this creates, there are also growing environmental and social cases against such intensive approaches to management. A properly selected grass species will offer numerous positive benefits including higher pest and disease resistance, greater resilience to local climatic extremes, lower requirements for fertiliser, and greater wear tolerance. As previously discussed, numerous factors require consideration during the grass selection process, including temperature, sunlight hours, water availability, and soil conditions.

Climate change

Due to changing climate patterns, careful consideration should be given to the long-term maintenance and operation of a golf facility. Understanding the implications of climate change for the region where





a golf course is located will be critical for identifying the challenges ahead. Climate change will not result in the same issues everywhere globally. Some areas will be drier and hotter, others cooler whilst some areas may become wetter, and many will experience more extreme weather events.

Maintaining turf species that are suited to the current climate and water availability will significantly reduce the requirement for additional maintenance inputs, but they may not be the most sustainable option in the future. For decades, cool-season grasses have been preferred in most parts of Europe with mild summers and winters. However, warm-season grasses have become the more suitable option for some regions where cool-season grasses used to dominate. For fairways, in general, under hot conditions where both can be used warm-season species like Bermudagrass and zoysiagrass require fewer inputs, are less expensive and more environmentally friendly to maintain than most cool-season species. It is important to make an informed and objective decision when selection is made, and to review this against the scenario of a changing environment, as the choice will potentially have

the biggest long-term influence on resource efficiency.

If predictions of long-term warming pan out, there are likely to be shifts in the climate zones for grasses. We may be looking 80 to 100 years ahead for significant changes, though more subtle ones may occur before then. The most likely scenario is that the cool-season zone will become reduced in its geographical range. There is also the advance of plant breeding, and we are already seeing more heat tolerant cool-season and more cold-tolerant warm-season grasses coming on stream. The consequence of this is a squeezing of the transition zone.

Whilst you should not be contemplating changing grasses to better suit a warmer climate that may happen in 50 years' time, you do need to be aware of the impacts of the changing climate in your location and how this affects the type of grass that will produce the best playing surfaces at a resource input level that is sustainable for you.

Weather and climate

What is the difference between weather and climate? Essentially the main difference is timescale.

Weather reflects on the conditions occurring at any given moment, typically measured in hours and days. For example, rainy, sunny, windy, hot or cold, etc.

Climate reflects on the average weather over a much longer time period, typically measured in months or years. For example, average monthly air temperatures, often based on many years of readings used to calculate the average values.

Resource constraints

Due to advancements in turfgrass breeding, within the species used on the golf course numerous new cultivars with superior traits have been developed and evaluated to fulfil the needs of consumers and to contribute to environmental sustainability. These traits include reduced water and fertiliser requirement, deeper root system, finer leaf texture, more upright growth habit, increased stress tolerance, and greater resistance to diseases. Chapter 8 provides more information on where to look for further support on identifying cultivars with specific traits.

Water availability and quality

Water availability will be a major challenge for golf courses as society's demand for water will not decline and new water resources will be difficult to develop. Grasses with improved drought tolerance have been developed to replace grasses with greater water requirements on fairways and roughs. Using grasses better adapted to dry environments is an essential part of a golf course integrated water management plan.

The use of low-quality water, such as saline affected water or reclaimed water, for irrigation can potentially increase the sustainability of a golf course by allowing clean water to be used for more sensitive applications. However, high concentration of salts in the water source can be detrimental to grasses that are sensitive to salt stress and can damage soil structure. In the warm-season regions, seashore paspalum is an extremely salt-tolerant grass, that once mature, can be irrigated with high-salt or brackish waters with little effect on turf quality. Cultivars of this species are available

for greens, tees, fairways and roughs, and some can be irrigated with water directly from the ocean. For cool-season regions, choosing the right species is vital and often end users are looking to species that occur naturally on coastal courses, as they already have a level of adaption to water salinity.

Disease tolerance

Turfgrass species vary in their tolerance to diseases, pests and weeds. Many diseases or pest problems can be anticipated and avoided by selecting the best-suited species or cultivars. Although no turf species or cultivar is immune to all diseases, some are better able to withstand disease or pests than others. The increased availability of improved turfgrass cultivars provides an excellent opportunity to select the most well-adapted turf to different environmental conditions. By incorporating disease or pest resistant species and cultivars onto the golf course, managers will increase surface sustainability through minimising the need for plant protection product applications.

Restrictions on chemicals

Chemical controls can be effective in suppressing diseases, pests and weeds by weakening or creating a less favourable condition for them. When chemical controls are subject to increasing restriction, disease, pest and weed control mainly relies on proper grass selection and cultural practices to maintain healthy grass which will be less susceptible to attack. Although cultural practices are very important in maintaining high turf quality and suppressing insects and pathogenic fungi, they often do not entirely stop diseases from developing. Using disease-resistant species or cultivars reduces the need for extra labour and resource input to manage the disease. Proper grass selection also allows golf course managers to develop environmentally compatible turf management programmes that can reduce the need for chemical controls.

Take-home message

- Maintaining turf species that are suited to the current climate and water availability will significantly reduce the requirement for additional maintenance inputs, but they may not be the most sustainable option in the future.
- Due to changing climate patterns, careful consideration should be given to the long-term maintenance and operation of a golf facility. Understanding the implications of climate change for the region where a golf course is located will be critical for identifying the challenges ahead.
- Using disease-resistant species or cultivars not only reduces the need for extra labour and resource input to manage the disease, but also ensure the turf quality under the increasing restriction on chemicals.

Getting support.



Grass selection is an important decision, involving cost and potential disruption to play whilst giving the promise of better performance.

It is vital that you get the right outcome, and it may well be extremely helpful to consult the various sources of assistance that are available. This chapter will show you how to get more support to facilitate your grass selection process.

Science-based programmes

1. British Society of Plant Breeders (BSPB) Turfgrass Seed Booklet

The BSPB Turfgrass Seed annually reports comprehensive results of available varieties in trials conducted at STRI in Bingley, West Yorkshire, U.K. Trials rate a variety of grass characteristics and cover a wide range of sporting environments including greens. Copies of the booklet are widely available in PDF format from most amenity grass seed producers' websites.

2. National Turfgrass Evaluation Program (NTEP)

The NTEP is one of the most widely known turfgrass research programmes in the US and Canada. Information such as turfgrass quality, colour, density, resistance to diseases and insects, tolerance to heat, cold, drought and traffic is collected and summarised by NTEP annually.

3. Geves Turfgrass List

Geves Turfgrass List provides a summary of the scores obtained by GEVES for each variety registered

in the official French catalogue. The website is very user friendly and provides a platform to compare the traits of turfgrass varieties, including wear tolerance, disease resistance, aesthetical quality and speed of establishment.

4. Australian National Turfgrass Evaluation Program (ANTEP)

Similar to NTEP, ANTEP is the Australian based turfgrass evaluation programme.

5. Scandinavian Turfgrass and Environment Research Foundation (STERF)

The Scandinavian Turfgrass and Environment Research Foundation (STERF) is an independent research foundation delivers 'ready-to-use' research results that benefit the golf and turfgrass sector.

Commercial/technical support

The website or brochure of seed/turf suppliers (i.e. DLF Seeds & Science, Barenbrug, Mountain View Seeds, Lawn Solutions Australia) provides information that will assist you in choosing the most suitable grass for your needs, considering all the variables along with local climate and grass availability.

Expert advice

Local agronomists and extension scientists can also assist with the grass selection process. The agronomist should have a good knowledge of the grass species and their preferred environments, cultivar performance, materials available for plant nutrition, disease, pest and weed control strategies, understanding of the importance of the soil environment and related drainage/irrigation issues.

The advantage to engaging an agronomist or extensions scientist is that you can ask questions and use their expertise to tailor an approach for the specific conditions and requirements of your golf course. They can help with the often difficult job of interpreting the complex interactions that need to be considered when selecting grasses, carrying out seeding/sprigging and subsequent turf maintenance.

Publications/social media

Traditional forms of publication such as trade and industry magazines or books (i.e. STRI Bulletin, Greenkeeping, Greenkeeper International, Golfdom etc.) provide a wealth of information that can be used to help you in your decision. Magazine articles often have the latest developments or cover the latest thinking in how to manage and select grasses.

For those that prefer a deeper scientific or technical approach can search the wealth of scientific literature that covers turfgrass science (i.e. International Turfgrass Society, European Turfgrass Society, Agronomy Journal, Crop Science, and university extension information

etc.). However, sometimes the nuggets of information you need can be hidden away in the technical information and you may need some help to translate what the findings of a particular paper are to your golf course.

Social media have drastically changed the way we receive and disseminate information on turfgrass related topics. For instance, many turf practitioners are using Twitter to provide immediate information on current topics. As with any form of communication, and it seems ever more so with social media, make sure you get a range of views to help make a balanced decision. It is easy to get lost in the politics of a debate taking place on social media. Be open minded, but also questioning and you will get the best solution for you and your course.

Direct communication

Of course, a rich source of information, especially on practical matters, can come from communicating with colleagues and peers. Utilise the knowledge and experience of local golf course mangers and greenkeepers. Someone will have been through the same process and can give tremendously valuable insight into what worked for them, how they did it and what they might do differently in the future. Learn from the experiences and mistakes of others to give your change process the best possible chance of long-term success.

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