

Edinburgh Technology Fund

APPLICATION FOR FUNDING

Section 1 - Applicant Details

Lead Institution/Organisation : Greenshields' Greenfields Ltd

Type of Award *(mark box on right as appropriate)*

Technology & Business Assessment
Technology & Business Development X
Commercialisation & Partnering

Total Project Cost (£) : £2.7 million

Total Funding Sought from ETF (£) £2.7 million

Section 2 - Project Title & Executive Summary

Project Title: Development of a genetically modified hybrid grass to be used as a playing surface in sports venues in the British Isles.

Executive Summary: The recent exponential growth of sports is placing new demands on the standards expected in all areas of the sporting world. In Britain, two of the fastest growing sports, in terms of participation and wealth, are golf and association football. Clubs within these sports will be more than willing to embrace any new technology that may improve the standards of the services they provide. Greenshields' Greenfields Ltd. aims to develop and produce a genetically modified hybrid grass strain that will be ideal for use on golf fairways and football pitches in Britain. The strain will have advantageous characteristics, such as improved damage resistance and suppressed growth, which will elevate it above its rivals, and establish it as the best grass for use in the sports venues concerned in Britain.

Note that you should not exceed the space shown in this proformn. If you complete th-sform electron-cally and you lose the paginatio~,) ou should reformat, or cut down on, your text, to bnng the application back to its page limits. It is permissible to add copies of important information as appendices. However, the application should be capable of standing on its own.

Section 3 -Project Description :

Describe the project for which you are seeking funding from ETF, giving an indication of the technical or business background against which the project is based, also indicating why you think there is commercial potential for the ideas you propose to test or develop. A description of the work to be carried out should be given and the milestones along the way to successful completion of the project should be identified. While this section should primarily address the immediate project, some indication of the next steps to be pursued should be given.

=> Greenshields' Greenfields Ltd. sets out to develop and produce a genetically modified hybrid strain of grass, which will be used in sports venues on the British Isles. In particular, we will be targeting the needs of golf and football clubs, who require a certain quality of grass for their fairways and pitches, respectively. The choice of hybrid strain to be modified is very important, as it is imperative that it has wide range appeal, and that it encompasses as much of the British Isles as possible in its ability to adapt to environmental differences. The hybrid we are proposing to use will consist of two-thirds fescue species (chewings and creeping red), one-quarter meadows grass, and one-twelfth bent grass. This combination of cold season grass species should be amenable to the vast majority of inland Britain, with only the coastal regions being particularly unresponsive to the constituents of the hybrid.

The core of the project, and the technology it offers, lies in the genetic modification of the grass strain and the resulting advantageous characteristics. The techniques behind the genetic modification are now relatively straight forward as a result of their extensive development in *Arabidopsis thaliana* and maize over the last few years. The relevant DNA can be inserted into the grass in the form of a gene construct via *Agrobacterium tumefaciens* transformation (for detail of the methods, refer to Doerner *et al.*, 1996. Nature 380: 520-523), and the transformants will be screened to detect those in which the DNA has integrated into the relevant part of the genome (~20% of cases).

We aim to genetically modify the grass in three separate ways to produce beneficial effects with respect to sports playing surfaces. The first, and most important, is the targeting of damage resistance. One of the biggest problems that greenkeepers and groundsmen face is the inevitable 'wear and tear' that their venues suffer, predominantly from divots and studs, respectively. The most obvious way to resolve this is by having a grass strain that regenerates quickly and is deep-rooted to prevent the problem in the first place. The grass strain will be genetically modified to achieve this by ectopic expression of cyclin-dependent protein kinases that control progression through the cell cycle. A similar principal has already been accomplished in *Arabidopsis*, where expression of a *cdc2aAt::cyclAt* gene fusion has resulted in significant increases in root growth rates (Doerner *et al.*, 1996). The second objective will be to convey some degree of inhibition of shoot growth in the strain, which would be extremely beneficial to golf courses by reducing the amount of grass cutting required. This could feasibly be achieved by manipulation of *BRI 1*, a gene in the Brassinosteroid pathway, the potential of which has also already been demonstrated in *Arabidopsis* (Li and Chory.1997. Cell 90: 929-938). Thirdly the modification could include the expression of a dark green colour in the grass, which would be both desirable for golf courses in maintaining fairway colour throughout the year, and also enable containment of the product, as the pigment could be used to identify areas that the strain had spread to.

There will obviously need to be extensive research to achieve the desired characteristics of the strain, but since the fundamentals of the techniques and their applications are already understood, it is probable that the development process should only take a year. The strain will be grown in tissue culture until this point, and then large-scale production can commence. Land will have to be purchased for this purpose, and containment measures to prevent the spread of seed will need to be implemented. The first harvest of seed and turf should be produced about three years after the initiation of the project, after which there will be a harvest each year.

The primary goal of the project is the full development of this modified hybrid strain, and the bringing of the grass to market. In the future, however, it is our intention to apply the technology to many other hybrid strains, which may lead the company into being international. The potential of Europe and the U.S. as prospective markets is enormous.

Section 4 - Technology Status and Competing Technologies

Summarise the current state of technological development and the significance ETF could make to demonstrating the technology and bringing it closer to commercialisation. Amongst other things, this section should aim to highlight:

- what competing technologies there are and the weaknesses in them that the new technology would address*
- the extent of any existing patent coverage and details of any patent searches for prior art and an indication of the intellectual property which might arise during the development programme*
- any technical barriers which competitors would need to overcome in order to catch up with your technology*
- the rights (if any) of any third parties in the background to be used in pursuing the technology development.*

The competing technologies are other hybrid strains that are used in golf fairways and football pitches in Britain. Some of these are better suited to certain soil types and weather conditions, particularly those employed on links golf courses in coastal regions, but the vast majority are inferior as they do not offer the advantageous characteristics resulting from the genetic modifications in our strain. The accelerated root regeneration and suppressed shoot growth promised by our strain would lift it above our competitors, and ensure that our customers would be prepared to pay more for it, as they would more than recover their outlay in reduced maintenance costs. The strain would obviously also produce a better, and more attractive, playing surface for the sporting venue.

The strain requires full research and development before large -scale production can commence. The first year of the project will largely consist of laboratory experimentation, until the characteristics of the grass are perfected. Intellectual property would arise in the developmental process, as there are patents for the use of the cell cycle and brassinosteroid genes concerned. Antoni Rafalski (patent no. W09953069) has the patent for the use of *cdc2* in "the production of a chimaeric gene, wherein expression results in altered levels of the protein in a transformed host cell", and Ulrich Eder (patent no. GB2127021) has patented "the use and manufacture of brassinosteroids as growth regulators". Negotiations would have to take place to allow the required genetic modifications to be undertaken.

Greenshields' Greenfields Ltd. would patent the commercial use of the genetically modified grass strain to prevent competitors using the technology for similar means. This would enable us to apply the technology to other hybrid strains in the future, or sell the rights for such projects to other companies.

Section 5 - The Market

Give an indication of the potential applications and markets for your technology. Who do you believe your customers would be and what justification can you give for believing that there would be a demand for a product or service based on your idea(s)? This section should include any market data you have available, including indication of the relative sizes of the markets, where they are located and how these would be prioritised in terms of their commercial importance and the ease with which they could be addressed. Are there any market-dictated barriers to entry either for your own technology or preventing others from competing?

Golf courses and football clubs, and their need for good quality, hard-wearing, and consistent surfaces, represent the majority of the market for the grass strain in Britain.

Golf Courses

Almost all the golf courses that will be using our grass will be new golf courses, as there is little point in clubs replacing established fairways with new seed, which will be both costly and time-consuming. Nevertheless, the size of this market is likely to be substantial. Golf is the fastest growing participation sport in the UK today, and this statistic is supported by the fact that around 40 golf courses open in Britain each year (based on the last 2 years). This trend is predicted to continue, as the profile of the sport, its wide-range appeal, and the money within it, are all increasing rapidly, thanks in no small part to the phenomenon of Tiger Woods, who is arguably the biggest personality in the world of sport today. Of the 40 golf courses opening each year, around 20 should be both suitable for the grass strain, and have the financial backing and ambition of becoming a recognised venue, and hence wish to employ the grass for their fairways. These golf courses should be more than willing to adopt the strain, as the promise of a better playing surface, together with reduced maintenance costs, will be difficult to resist. New golf courses often have to limit the numbers of golfers playing in the first few years, as damage to fragile fairways can be costly, but our strain's deep rooting and fast regeneration should eliminate this problem, saving the club even more money.

Persuading golf courses to use the grass should not be difficult, as the benefits of it should be immediately apparent. A certain level of advertising would probably be sensible however, to raise awareness of the strain in greenkeeping circles, and it is therefore proposed that we affiliate to the British and International Golf and Greenkeepers Association (BIGGA), who are advocating the project. The commercial potential of the project is best highlighted by a similar scheme undertaken in the U.S., where Greg Norman (the No.1 golfer in the world for much of the period between 1986-1993), produced a new hybrid Bermuda grass (GN-1), which has made him more money in a decade than his golf career did in 20 years. The strain now serves as a selling point for new courses, due to its playability, and has been used as the surface for two of the last three Superbowls.

Football Clubs Football today is big business. At the top end of the game, there is more money than ever, with television revenues and gate receipts increasing exponentially since the early 1990s. The English Premiership exhibits this trend most vividly, with clubs receiving around £10million/year from television rights, and attendances being the highest in European football. This season the average gate at a match is well over 30000, and since the figures are increasing at the highest rate in Europe also, the situation is set to continue. Representative of this is the fact that of the 20 clubs in the league, 8 are planning to move to a larger stadium in the foreseeable future, which will obviously require a new pitch. Additionally, many clubs resurface their pitches at least once a year in an attempt to improve the playing surface, which is subject to damage from overuse and the weather. The promise of a more durable pitch would be absolutely invaluable to these clubs with respect to enhancing the quality of football, and we believe clubs like Manchester United, who have perennial problems with their pitch, and those moving to a new venue, would be prepared to pay very handsomely for the benefits offered by our turf. Advertising would probably be unnecessary for the football market, as it is common practice by clubs moving to new stadiums to test many different grass strains on the land before they lay the actual pitch. It is likely that we would provide turf for 5-10 pitches annually in Britain.

Both markets will be very important to Greenshields' Greenfields Ltd. as they should be worth about £1million each annually to us, and hence they will be prioritised equally.

Section 6 - The Proposers

Why does the prospect of setting up your own business appeal to you? What do you think will be the main challenges to be faced? Have you had any previous experience or training that you believe will equip you for the demands of a business start-up? What personal qualities do you believe you bring to the project that you think will improve the chances of success?

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The prospect of becoming involved in the world of sport is very appealing to me, and I believe my knowledge, and appreciation of what is needed in the respective sports, will stand the company in good stead for the future. I come from a farming background, and have a great deal of interest in both sports concerned, having played county golf and being a fanatical football fan.

Section 7 - Funding

The following figures are estimates for the cost of the project for the 3 year period, from initiation to sellable product.

Staff Salaries

Director £30000/year

Skilled Research Scientist £30000/year

2 Technicians £40000/year

Laboratory Rent

100 square metres @ £15/m² /month = £1500x12 = £18000/year

Advertising

£20000/year

Annual Costs of £138000. For Three Year Period ~ £400000

Equipment:

For developing, planting, harvesting, and containment measures ~ £2million

Land

To meet probable demand, 150 acres will be purchased @ £2000/acre = £300000.

Total Project Cost, from Initiation to Market ~ £2.7 million.

Profit Forecast

20 Golf Courses/ year require 20 acres of fairway each ~ 400 acres to be sown with seed each year.

250kg of seed is needed to sow 1 hectare ~ 625kg/acre

Total seed needed in a year = 400x625 = 250000kg.

Normal competitor's grass seed sold for £70/25kg

Greenshields' Greenfields Ltd. seed sold for £100/25kg. **Annual sales of £1million**

Yield of seed is 750kg/hectare/year = 1875kg/acre/year

Acres of land required for seed = 250000/1875 = ~130 acres

Approx. 5-10 football pitches a year will be turfed @ £200000/pitch. **Sales of £1-2million/ year.**

Maximum of **20 acres** needed for turf.

Total Land = 150 acres. Annual Sales of £2-3 million.