

Project number: 4758

Funding source: Teagasc and the seed industry

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Project dates: Jan 2001 – Dec 2008

Breeding improved varieties of perennial ryegrass



Key external stakeholders:

Grassland farmers, seed industry, advisors, agricultural consultants and researchers.

Practical implications for stakeholders:

The programme focussed on breeding improved varieties of perennial ryegrass for Irish farm systems. The main emphasis was on improving variety performance under grazing. The primary traits for improvement were seasonal yield distribution, nutritional value, ground cover, persistency and disease resistance. Key results were:

- Five new perennial ryegrass varieties with greater genetic merit and improved agronomic characteristics over existing varieties were commercialised and released.
- The new varieties were: January (early diploid), Shandon (intermediate diploid), Glenstal (intermediate tetraploid), Tyrconnell (late diploid) and Glencar (late tetraploid).
- Eleven other perennial ryegrass varieties, newly bred by Teagasc, displayed exceptional performance in the Teagasc trials and were submitted to the Department of Agriculture, Food and Marine for consideration for addition to the Recommended List of Grass and Clover Varieties for Ireland.
- Research conducted indicated that variety performance varied substantially from year to year and that the level of variation from year to year was unpredictable. Only varieties included on the Recommended List of Grass and Clover Varieties for Ireland, that have a strong history of high performance in Ireland, should be used by Irish farmers.
- Research into breeding methodology to improve the genetic gain per unit time and cost determined the optimum allocation of field resources for breeding for increased forage yield in perennial ryegrass.
- Breeding offers a low cost and successful means to improve the productivity and profitability of perennial ryegrass based swards.

Main results:

Five new perennial ryegrass varieties were awarded Recommended Listing in Ireland and/or UK, and commercialised and released. Summary characteristics of the new varieties are presented in below in Table 1. Full variety results from the Ireland Recommended List are available at www.agriculture.gov.ie and the Northern Ireland Recommended List at www.afbini.gov.uk

Commercial seed of Teagasc bred cultivars are produced and distributed worldwide by DLF-Trifolium.

Research into the optimum testing methodology for perennial ryegrass yield trials indicated that fresh weight yield could be successfully used as a proxy for dry matter yield in breeding yields. This would facilitate the evaluation of a greater number of plots for the same level of resources thereby increasing genetic gain by on average 11%.

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The optimum allocation of resources for a perennial ryegrass variety testing programme was estimated at four replicates per location, and either two locations and 3 sowing years or three locations and 2 sowing years with 2 harvest years for each sowing year.

Research conducted on variety trials across Ireland indicated that variety performance varied substantially from year to year and that the level of variation from year to year was unpredictable. Only perennial ryegrass varieties included on the Recommended List of Grass and Clover Varieties for Ireland, that have a strong history of high performance in Ireland, should be used by Irish farmers.

Table 1: New Teagasc bred varieties

Variety	Key characteristics	Recommended List
January	<ul style="list-style-type: none"> • Early maturing • Diploid • Exceptionally high spring growth • Very high silage yields 	Ireland, Northern Ireland, England, Wales and Scotland
Shandon	<ul style="list-style-type: none"> • Intermediate maturity • Diploid • High total yield • Excellent spring growth 	Ireland
Glenstal	<ul style="list-style-type: none"> • Intermediate maturity • Tetraploid • Excellent total yield • Outstanding spring yield • Very good sward density 	Northern Ireland, England, Wales and Scotland
Tyrconnell	<ul style="list-style-type: none"> • Late maturity • Diploid • Exceptionally late season growth • Outstanding ground cover 	England, Wales and Scotland
Glencar	<ul style="list-style-type: none"> • Late maturity • Tetraploid • Excellent total yield • Very good spring growth • Exceptionally high 1st cut silage yield 	Ireland, Northern Ireland, England, Wales and Scotland

Opportunity / Benefit:

This project offers farmers new improved perennial ryegrass varieties of greater genetic merit and improved agronomic characteristics that when sown may increase the productivity, profitability and sustainability of Irish farm systems. A commercial agreement between Teagasc and the seed industry ensures the production and availability of seed for farmers. The research findings on the optimum methodology for the evaluation of perennial ryegrass yield will increase the efficiency and reduce the cost of the breeding and cultivar trials in Teagasc and the Department of Agriculture, Food and the Marine.

Collaborating Institutions:

DLF-Trifolium
University of Wisconsin-Madison
Department of Agriculture, Food and the Marine, Ireland
Agri-Food and Biosciences Institute in Northern Ireland

Teagasc project team: Patrick Conaghan
External collaborators: Prof. Michael Casler (University of Wisconsin-Madison), Dr. Klaus Nielsen (DLF-Trifolium), Dr. Trevor Gilliland and Dr. Brian Waters (AFBI) and, John Claffey and Dermot Grogan (DAFM)

1. Project background:

Over 90% of the agricultural area in Ireland is devoted to grassland which provides the main feed for our ruminant livestock. While sward composition, especially for old pastures, is often complex, perennial ryegrass (*Lolium perenne*) is the most desirable species and the key component of the most productive pastures. Almost all forage grass seed sown in Ireland is perennial ryegrass. Consequently any improvement in this species has large potential benefit to the Irish agricultural economy.

Forage breeding is a technology that harnesses the creative power of selection. It is powerful, precise and predictable. Forage grass has been subjected to very little formal breeding. Genetic variation within and among populations is still extremely high, showing no signs of decreasing. Breeding offers a low cost means of improving the profitability and productivity of perennial ryegrass.

The objective of this project was to develop and use methods that effectively select for the best phenotypes leading to the breeding of improved varieties of perennial ryegrass for Irish farm systems. The main emphasis was on improving variety performance under grazing. The primary traits for improvement were seasonal yield distribution, nutritional value, ground cover, persistency and disease resistance. World-wide propagation and marketing rights on all new cultivars will be offered to a commercial company ensuring the availability of new cultivars to Irish farmers. This project continues, with modifications, the successful commercial white clover breeding programme established at Teagasc, Oak Park, Carlow in the 1960s.

2. Questions addressed by the project:

- Can forage breeding produce improved cultivars of perennial ryegrass?
- What level of genetic improvement in perennial ryegrass can be achieved with forage breeding?
- What is the optimum allocation of replicates, locations and years for a perennial ryegrass variety evaluation programme in Ireland?
- Can fresh matter yield be used as a proxy for dry matter yield in breeding for increased dry matter yield in perennial ryegrass?

3. The experimental studies:

The breeding programme was based on (i) recurrent phenotypic selection involving the evaluation of individual plants, (ii) recurrent genotypic selection involving the evaluation of the progeny of different crosses and (iii) the production of synthetic varieties constructed by intercrossing a number of selected genotypes. The main emphasis was on improving variety performance under grazing. The primary traits for improvement were seasonal yield distribution, nutritional value, ground cover, persistency and disease resistance. The best varieties were submitted to the official Recommended/National List trials in Ireland, UK and other countries for independent evaluation. World-wide propagation and marketing rights on all new cultivars were offered to a commercial company ensuring the availability of new cultivars to Irish farmers.

An extensive data set of historical perennial ryegrass yield trials in Ireland from the Teagasc Oak Park breeding and Department of Agriculture, Fisheries and the Marine variety evaluation programmes was mined and re-analysed. The information provided by these past experiments was used to make recommendations on the optimal allocation of resources and methodology for future perennial ryegrass trials.

4. Main results:

Twenty four new perennial ryegrass varieties bred by Teagasc displayed exceptional performance

in the Teagasc breeder's trials and were submitted to the official Recommended/National List trials in Ireland, UK and other countries for independent evaluation and consideration for addition to the Recommended List of Grass and Clover Varieties in the respective countries.

Five new perennial ryegrass varieties were awarded Recommended Listing in Ireland and/or UK, and commercialised and released. The new perennial ryegrass varieties are: January (early diploid), Shandon (intermediate diploid), Glenstal (intermediate tetraploid), Tyrconnell (late diploid) and Glencar (late tetraploid). The varieties were shown to offer improved yield, quality and persistence characteristics for grass-based production systems with on average 2.2 percentage units higher annual yield at time of release than comparable existing varieties of similar ploidy and maturity group.

Research into the optimum testing methodology for perennial ryegrass yield trials indicated that fresh weight yield could be successfully used as a proxy for dry matter yield in breeding yields. This would facilitate the evaluation of a greater number of plots for the same level of resources thereby increasing genetic gain by on average 11%.

The optimum allocation of resources for a perennial ryegrass variety testing programme was estimated at four replicates per location, and either two locations and 3 sowing years or three locations and 2 sowing years with 2 harvest years for each sowing year.

Research conducted on variety trials across Ireland indicated that variety performance varied substantially from year to year and that the level of variation from year to year was unpredictable. Only perennial ryegrass varieties included on the Recommended List of Grass and Clover Varieties for Ireland, that have a strong history of high performance in Ireland, should be used by Irish farmers.

In conclusion, the Teagasc grass breeding programme continues to improve the methodology for breeding and evaluating perennial ryegrass, and develop new improved varieties of perennial ryegrass with greater genetic merit and improved agronomic characteristics than existing commercial varieties.

5. Opportunity/Benefit:

This project highlights the benefit of perennial ryegrass breeding to grassland agriculture and the large improvements in white clover productivity that may be achieved through breeding. This project offers farmers new improved perennial ryegrass varieties of greater genetic merit that when sown may increase the productivity, profitability and sustainability of Irish farm systems.

Research conducted offers improved testing methodology for grass breeding and evaluation that may increase the rate and reduce the cost of the genetic gain in perennial ryegrass breeding and variety evaluation programmes by improving the precision and accuracy of the yield estimates, and optimising the use of the available resources.

6. Dissemination:

This information has been widely disseminated to grassland farmers via discussion groups, open days, farm walks, popular press and Teagasc publications.

Main publications:

- Conaghan, P., O'Kiely, P., Howard, H., O'Mara, F.P. and Halling, M.A. 2008. Evaluation of *Lolium perenne* L. cv. AberDart and AberDove for silage production. *Irish Journal of Agricultural and Food Research* 47:119-134.
- Conaghan, P., Casler, M.D., McGilloway, D.A., O'Kiely, P. and Dowley, L.J. 2008. Genotype × environment interactions for forage yield of perennial ryegrass sward plots in Ireland. *Grass and Forage Science* 63:107-120.
- Conaghan, P., Casler, M.D., O'Kiely, P. and Dowley, L.J. 2008. Efficiency of indirect selection for dry matter yield based on fresh matter yield in perennial ryegrass sward plots. *Crop Science* 48:127-133.

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