

Technology transfer of novel ryegrass endophytes in New Zealand

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Abstract

The adoption of novel endophyte ryegrass in New Zealand has been successful and rapid, with AR1 novel endophyte seed representing 80% of the total ryegrass seed infected with endophyte within 3 years of release. Success was underpinned by a large amount of research into endophytes and the animal production benefits of novel endophytes. Awareness amongst farmers and seed retailers was created by scientists and seed company staff, often with an organised and collaborative campaign. The domination of the market with novel endophytes is likely to increase further with the on-farm success of AR1, and the recent introduction of third-generation endophytes.

Keywords: endophyte, ryegrass, technology, transfer, adoption, knowledge, awareness, benefits, validation, research

Introduction

This paper discusses outcomes of technology transfer intended to enhance the adoption of novel ryegrass endophyte in New Zealand. It addresses three questions: has the technology transfer been effective; what methods were used; and what were the key factors that influenced success?

Novel endophytes have been introduced in four stages to the New Zealand market. In the early 1990s, Endosafe was released, AR1 in 2001, NEA2 and Endo5 in 2005, and AR37 in 2007. Currently, AR1 has the largest volume of the market, and Endosafe has been phased out. AR1 is available in 17 ryegrass varieties in 2007, AR37 in four, with one variety each with Endo5 and NEA2 (CRT 2006). The characteristics of these novel endophytes have been compared by Charlton & Stewart (2006).

Methods Employed for Technology Transfer

Methods of technology transfer were similar for each of the four stages of introduction of novel endophyte. Scientists conducted a large amount of research into endophyte and the novel endophytes being developed and tested. Results and information were then transferred at conferences targeting scientists, seed retailers, consultants and farmers. There have been numerous press articles published about AR1, AR37 and endophyte in general, and these were very effective at increasing farmer awareness and knowledge because farming newspapers are the highest ranked source of information by farmers (Leggett 2006). A Google Internet search for "AR1 endophyte" in New Zealand (NZ) produced 369 results for articles published in newspapers, conferences, and web sites, and this indicates the depth of information that has been disseminated to date.

The initial companies with AR1 cultivars jointly funded a marketing/promotion campaign including brochures, press releases, retailer protocols and a nationwide road show targeting key influencers (retailers, consultants, leading farmers) (Green & McKenzie 1999). In the case of AR37, the developers (AgResearch) had a partnership with the seed companies Agricom and Wrightson Seeds, so regular meetings were held to provide technical information to company staff, who then passed this on to seed retailers and farmer meetings.

The main difference in methods used for the different endophyte releases was the level of published scientific research

and information. Relatively little published research has been able to be cited on the endophytes NEA2 and Endo 5, so the adoption of these endophytes has been based on product marketing (brochures, print advertising, seed retailer training), with the variety of ryegrass taking a higher profile than the endophyte when compared with AR1 and AR37 products. For AR1 and AR37, scientific papers have been the basis of marketing information and publicity.

A large part of the technology transfer for AR1 centred around techniques to establish pastures without contamination from resident ryegrass plants with toxic endophyte. Techniques promoted included brassica crops or spraying old pastures twice, before planting AR1 pasture. This was considered to be important for farmers to achieve the same benefits as had been measured in trials, ensure success on farms, and therefore develop a good reputation for AR1.

The involvement of Meat New Zealand (a farmer-levied organisation) has been important for the adoption of AR1. They began funding research and technology transfer into ryegrass endophyte (particularly with AgResearch and AR1) in 1992. This created a direct channel for the flow of information from researchers to farmers through the Meat New Zealand Monitor Farm programme, which has involved 125 groups since its inception in 1991, with an estimated 20,000 farmers cumulatively involved.

Resulting Uptake of Novel Endophytes

The adoption of novel endophytes in NZ has been successful and rapid, with 60% of the total proprietary market in perennial ryegrass seed being AR1 within 3 years (2001 to 2004) of release (Easton 2006). It is estimated that 25% of the total proprietary market in perennial ryegrass seed is LE, therefore AR1 seed represents 80% of the ryegrass seed infected with endophyte. There has also been a small substitution of AR1 seed for low endophyte (LE) seed. In the first 2 years of release, 1570 tonnes of AR1 seed was sold (2001 to 2003), making up half of the total perennial ryegrass market (Clarke 2003), or 67% of the endophyte-infected seed market. It is likely that between 2004 and 2007 the percentage has increased above 80% of the ryegrass seed infected with endophyte. In 2007, novel endophyte is available in 19 of 24 (80%) perennial and long-rotation ryegrass varieties (CRT 2006).

Discussion

This high adoption rate is the result of development of good technology, sound validation of its effects and benefits, a farming industry always looking for technology that can boost their productivity and/or solve existing problems, and effective transfer of information.

The farming industry has been well primed for the release of novel endophytes. The discovery of the link between endophyte and ryegrass staggers in 1981 (Fletcher *et al.* 1999) and insect tolerance was heavily publicised, and by the late 1980s most consultants and farmers had a reasonable awareness and knowledge of ryegrass endophyte. The release of the first novel endophyte (Endosafe) in the early 1900s was therefore

adopted with just a moderate amount of publicity from the two companies involved. Publicity was magnified when one variety with Endosafe was withdrawn from the market when scientists discovered it produced ergovaline with potentially detrimental animal health problems. When AR1 was released in 2001, awareness and knowledge had advanced further, making it easier to get information to the farming community. Other novel endophytes (NEA2 and Endo5) were easy to introduce from 2005 due to the success of AR1. AR37 was launched in 2006 and first available in 2007, and early reactions from farmers and consultants indicate that achieving adoption will be straightforward.

The continuing uptake of AR1 3 to 5 years after release has also been due to the fact that the technology actually worked well on farms, and farmers were pleased with results. There were even benefits that farmers observed that were not measured in trials, including control of seed heads in pastures being easier on AR1 ryegrass due to them being more readily eaten than standard endophyte-infected (SE) ryegrass stem.

The 'climate' for adoption of new technology on farms is different to some other countries. The NZ farming industry has a history of continually striving to improve production efficiency. The forces behind this include high debts and loan repayment costs, high land prices (competition from many other land users, including urban expansion and small land holders) and complete exposure to fluctuations in world commodity prices (no subsidies) and exchange rates, and a steady decline in terms of trade for products. Farmers have therefore got a strong interest in information about research and development (Leggett 2006). Science has provided the food for this increased production efficiency, firstly through excellent state-funded science (1930 to 1988), and then industry-funded science (1988 to present). Farmers have a positive attitude to spending money on new pastures because they are confident the costs are easily outweighed by the benefits. This attitude to new pastures has been enhanced during the 1990s through the Monitor Farm Programme funded by Meat & Wool New Zealand.

Validation of the effects and benefits of novel endophytes was essential. Understanding of the effects of standard endophyte enabled farmers to estimate the costs of the previous system, animal production research quantified the gains in sheep growth and milk production, which allowed farmers to calculate the benefits/costs of taking on the technology. Farmers needed to spend about \$30/ha more to use AR1 seed, so they needed to be confident that they would get a good return for that extra cost. The benefits that were estimated from animal research were much greater than the costs, so there were few people who could argue against its adoption.

An 8.9% increase in milk production was found by Bluett *et al.* (2003). On a dairy farm producing 1000 kg/ha/year milk solids, with a milk solids value of \$3.80/kg, the estimated benefit would be \$338/ha/year. Income from lamb production was also estimated to increase by \$10 000 per 1000 lambs farmed (Lester Fletcher pers. comm.), or about \$200/ha/year.

This validation was done in NZ and in a way that farmers had confidence in the results, and they were seldom doubted. This may have contributed to the slower adoption in Australia, where local scientific pride and politics formed a barrier to adoption of the technology because it was not discovered or validated in Australia. This barrier extended through the government scientists to the government extension agents, who provided most of the information and advice to farmers. Another factor in Australia has been that AR1 was only available in varieties suited to dairy

farms, so adoption by the sheep and beef sector was restricted by a lack of varieties adapted to their climate and management.

The following is an example of the way that validation has worked for endophyte adoption. The novel endophyte AR37 was tested against SE, AR1 and nil endophyte in the same perennial ryegrass variety at Kerikeri in the North Island by Bruce Cooper of AgResearch from 1996 to 2000. In 2006, following the launch of AR37, consultant Gavin Ussher presented an analysis of the data at a field day for local farmers. He calculated that in year three after sowing AR37, the advantages over SE could increase gross revenue by \$585/ha on a dairy farm (Ussher 2006). This is a compelling argument for farmers in that region to use AR37 instead of SE because the cost is only \$50/ha.

The rate of pasture renewal in NZ has been estimated at between 2.5% per annum (Lancashire 2005b). While seed companies consider this to be too low, it may be higher than in some other countries (e.g. Australia, USA), so the conversion of pastures to novel endophytes in NZ may have an inherently faster rate.

Before the release of AR1, farmers were well educated about endophyte and its impacts, and could therefore absorb and understand the benefits of the technology. This was not the case in some other countries where uptake has been slower.

The success of technology transfer can be influenced by commercial realities. In 1997 AgResearch offered all members of the New Zealand Plant Breeding and Research Association (NZPBRA) AR1 technology (Green & McKenzie 1999), and most major seed companies requested that AgResearch inoculate their varieties immediately. The NZPBRA also made an agreement with AgResearch on protocols for testing AR1 with animal performance and productivity trials, insect persistence and yield trials, conducted by both AgResearch and member companies. This universal adoption of AR1 by the seed industry meant that companies were all giving the same positive message to farmers and retailers. This contrasts with Australia, where most of the perennial ryegrass is supplied by NZ companies. With the change to AR1-infected seed in the NZ market, some companies had a large inventory of seed with SE, and as the Australian market was an established SE one, it was the ideal way to sell the stock without making any losses. As a result, those companies quelled any interest in novel endophytes in Australia by downplaying any suggestions that SE had negative effects on animal production. This has since changed as a result of inventories of SE being depleted. In a similar way, some new companies have set up in NZ recently to sell ryegrass seed bred in Europe. As this seed had no endophyte, the companies sold it with a message that their plants did not need endophyte for survival because they were bred for relatively high tiller density. Again, their message changed as AR1 became available in their seeds. The lesson with all of this is that the adoption of novel endophytes will be more successful in markets where all the major seed companies introduce it at the same time.

Could the rate of adoption of novel endophytes been even faster? It is possible that rates could have been faster. Not all companies strongly supported each novel endophyte introduction because they did not have access to the endophyte, or had delays in producing new seed with the endophyte, or delays in selling stock with old endophyte types.

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