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AN OPPORTUNITY LOST AND SORTING FACT FROM FICTION

J. R. CARADUS
Grasslanz Technology Ltd, PB 11008, Palmerston North
john.caradus@grasslanz.com

At the conference in Taupo last year, I identified 12 critical issues confronting agriculture that needed to be managed so that we continue to earn a first world living as a nation from the produce off the land. These were:

1. Productivity – increasing our international competitiveness
2. Labour supply and skills
3. Environment – including land, water and air sustainability, food miles, climate change
4. Regulation and bureaucracy
5. Cost and availability of land and capital
6. Feed supply for our agricultural animals
7. Exchange rate volatility
8. Added value opportunities – creating new value from agricultural outputs
9. Biosecurity – direct threats to our biological economy
10. Public perceptions of agriculture – the growing divide between town and country
11. Energy supply and efficiency
12. Market and consumer dynamics and opportunities.

So what has changed? Probably very little – all these issues are still relevant – although some have gained increased profile, such as energy supply due to the rocketing price of crude oil. The impact of this is to increase costs of any item requiring transport – such as stock to sale yards, delivery of newspapers to rural areas etc. This in turn will require increased reliance on the internet for sales and for information – hence the urgent need for improved broadband access, particularly in rural areas.

This year I want to discuss two issues related to improving the effectiveness of grassland technologies that will assist in addressing several of the issues listed above:

1. The feed barrier challenge and options to address it, and
2. Marketing of grassland technologies for improved production and productivity.

The Feed Barrier Challenge

It is generally assumed and often stated that pasture yields have reached a plateau and that ryegrass-based pasture yields rarely exceed 18 to 20 T DM/ha/yr.

However, strategic objectives for both the dairy and meat industries indicate that a major limitation to improved milk and meat productivity is pasture yield. Targets of increasing pasture growth by 50% (dairy) and 35% (meat and wool) over the next decade are aspirational targets. Considerable industry and government investment is now being directed towards providing technologies that will attempt to progress us towards these targets.

Options to increase pasture yield include:

1. Better plant breeding outcomes – perhaps through effective marker assisted selection or hybrid vigour
2. Use of species other than ryegrass
3. Multiple annual crops
4. Cisgenic plants
5. Transgenic plants
6. Improved fertiliser and management practices
7. Increased rate of pasture renovation
8. Combinations of any of the above

Each of these options has issues:

Better plant breeding outcomes – are still only likely to achieve incremental gains of around 1% per year.

Use of species other than ryegrass – will require different management strategies by farmers than those used with ryegrass.

Multiple annual crops – will need to balance the costs versus the benefits of this and will require specialist management systems.

Cisgenic plants – will require ERMA approval but are not transgenic and may still only give incremental improvements limited by the genetics of the plant species themselves.

Transgenic plants – will require ERMA approval and is a likely option for a step change but maybe limited by weaknesses in the background germplasm the trait is transformed into.

Improved fertiliser and management practices – will need to balance the costs versus the benefits and ensure that environmental guidelines/ requirements are not breached.

Improved rate of pasture renovation – intensive

farming systems struggle to increase renovation rates into highly stocked farming systems; and technology for renovating hill country needs improvement.

My personal view is that transgenic options are the most likely to provide the scale of improvement required to continue to improve agricultural productivity. Government investment agencies must also be convinced of this based on the large investment made into this area of research. Over the past decade the Government and industry has invested heavily in plant biotechnology research (defined here as not traditional plant breeding based on phenotypic selection and population development). Conservative estimates would indicate that approximately $16m per year has been invested in plant cisgenic and transgenic research over the last decade (Table 1).

Table 1 Level of investment by Government and industry in plant cisgenic and transgenic research in New Zealand.

Sector	Last 10 years	Current annual
FRST	≈$90m	$12m
Dairy	≈$50m	$2m
Meat	$6m	$1.5m
Seed companies	$4m	$1m (including NZTE[1])
TOTAL	≈$150m	$16.5m

[1] New Zealand Trade and Industry.

This level of investment exceeds that for traditional plant breeding and yet to date there are no cisgenic or transgenic plant products marketed in New Zealand. Reasons for this include:

- Public perception and reaction
- Regulatory process is complex
- Technical challenge is high
- Changes in FRST policy (shifts in the late 1990s were responsible for Bt mediated porina resistance and white clover mosaic virus resistance never being commercialised)
- Freedom to operate and intellectual property issues
- Transgenic options that will provide value to the food chain are only in their infancy

Transgenic plants marketed overseas are predominantly row crops such as maize, soybean, cotton and brassicas. The traits introduced into most existing commercial transgenic varieties of crop plants are agronomic in character and have little or no effect on feed composition or the bioavailability of nutrients. There is no evidence to date from such studies to suggest that the performance of animals fed transgenic feed differed in any respect from those fed the non-transgenic counterpart or from the performance predicted by the composition of the feed (Faust 2002).

In 2005, the World Health Organisation published an evidence based study on the impact of modern food biotechnology on human health and development and concluded that genetically modified food currently available on the international market have undergone risk assessments and are not likely to present risk for human health any more than their conventional counterparts.

At least 42 publications from the PubMed database describe research reports of feeding studies of genetically modified (GM) feed or food products derived from GM crops. The overwhelming majority of publications report that GM feed and food produced no significant differences in the test animals. Two studies reporting negative results were published in 1998 and 1999 and no confirmation of these effects have since been published. Many studies have been published since 2002 and all have reported no negative impact of feeding GM feed to the test species (Preston 2005).

Probable transgenic forage options include for New Zealand –

- Condensed tannins in white clover
- Drought tolerance in perennial ryegrass
- Increased energy content of feed either as lipids or carbohydrate
- Increased biomass in perennial ryegrass
- Resistance to foliar viruses in white clover
- Transgenes carried in endophytes
- Increased digestibility in forage grasses

If transgenic forages are of likely benefit to improve productivity and environmental integrity of New Zealand pastoral agriculture then what needs to happen to allow transgenic plants to become a viable option for New Zealand farmers? Currently, expense and regulatory bureaucracy stifles most initiatives. But Governments need to clarify what they are regulating for (safety and environmental impact) and what they are leaving to consumers (informed choice). In this regard the challenge is to ensure that objective risk drives regulation and risk perception (informed or otherwise) drives choice. For transgenic crops and forages the balance of evidence strongly suggests that:

- The technology is not innately hazardous
- Some applications do produce negative environmental impacts, but these are known and can be managed
- The overall impacts of conventional intensive

agriculture are as great or greater

So where is the problem?

- Public attitudes?
- Consumer choice?
- Regulatory/Government?
- Science community?
- Farming community?

How are the science and agricultural communities establishing transgenic options and developing a strategy to gain public and consumer acceptance? Currently CRIs and Universities are supporting capability in this area (plant biotechnology) and setting targets and goals they and their investors believe will provide economic and environmental value. Crop & Food have been very active in this area. Very few others have moved to seeking regulatory approval through ERMA for a field release. Some New Zealand investors are using offshore capability in Australia, USA and South America to ensure that these plant biotechnology developments continue and that viable options for field testing are available. For forage transgenics there is an additional complication with the need to test these plants in terms of their effects on, and benefits to, animal production and product quality. There are no easy solutions here but I believe we are approaching a point where either we begin to embrace these new technologies or we reject them outright and therefore close down funded research in this area.

Marketing grassland technologies

This discussion could perhaps be entitled "Separating fact from fiction", or how do we differentiate the "good oil" from the "snake oil". Who should farmers trust for advice on the efficacy of new technologies?

Promotion and marketing of new technologies and solutions to on-farm problems continues to feature as an issue. Competition amongst technology providers is nothing new and is a natural part of any market led economy.

Farmers are constantly bombarded with publicity on the latest products technologies and fads - most of which are likened to the "best thing since sliced bread" and as such will deliver significant benefits. There is no doubt that some will. But how do farmers determine which is the best and most likely to work and how, as researchers, can we assist farmers in this endeavour?

Over the past 2 years there have been vigorous debates on the merits of a number of new technologies. Some of the contentious technologies debated in newspapers and farmer magazines over the past 2 years include –

1. High sugar grasses
2. Grass endophytes
3. Nitrification inhibitors
4. Cultivar performance, with a call for an impartial testing system
5. Animal dietary supplements
6. Products for producing improved pasture responses to nitrogen fertiliser

Not wanting to spark a new outburst of opinion and possible litigation I will discuss these incidents collectively and attempt to put forward some general principles of why differences of opinion have occurred. My observation of these debates has led me to conclude that much of the disagreement stems from:

1. Selective use of data
2. Reporting progress on partly finished trials
3. Using data without statistical analysis or ignoring statistical analysis
4. Not acknowledging that products do not necessarily perform to specification in all environments
5. Messages about product efficacy getting confused between developer and retailer
6. New products and technologies may need changes in on-farm management to achieve claims
7. Uncertainty about the position and role of CRIs in the current investor lead funding system where the Government does not adequately fund CRIs for them to be fully independent
8. Agricultural journalists exacerbating confused or polarised positions on a new technology
9. Biases for and against various research providers and in some cases individual researchers.

Independent cultivar testing

A recent request has called for impartial cultivar testing trials in New Zealand. This seems very reasonable if it would indeed aid farmers in selecting cultivars that will perform well/ appropriately on their farm. From marketing material and seed company websites the numbers of cultivars available to New Zealand farmers is large. An approximate estimate of the number of cultivars on the New Zealand market is –

- 33+ perennial and long rotation ryegrasses (22 were listed in 1999 - Charlton & Stewart 1999), and over twice that number if you include endophyte options
- 20+ annual, Italian and short rotation ryegrasses

- 17+ tall fescues, cocksfoots and bromes
- 17+ white clovers
- 4+ red clovers
- 36+ forage brassicas (kale, swede etc)
- 4 herbs (chicory and plantain)

So how do our farmers choose which species and cultivars to use?

ForageMaster has been developed through funding by Meat and Wool NZ as a tool for assisting in selection of appropriate forage species for sheep and beef farmers. (Finlayson *et al*. 2004). It allows farmers to ask why one forage might be preferred to another, but provides little information on cultivar options.

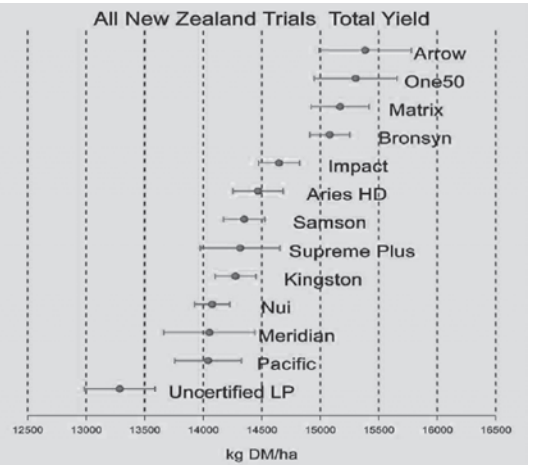
Farmer cultivar selection is currently made on the basis of retailer advice, marketing information from the proprietary seed companies, retailer influence, consultant influence, previous history, other farmer opinions, cultivar availability, published trial results etc. What cultivar evaluation schemes are available in New Zealand and how do these compare with other countries?

New Zealand

Currently the benchmarking of grasses in New Zealand is with the National Forage Variety Trials (NFVT) established by the New Zealand Plant Breeding Research Association whose member seed companies conduct the majority of regional NFVT plot trials measuring dry matter yield. Features of NFVT (National Forage Variety Trials) for pastures in New Zealand are:

- It is managed by industry stakeholders – largely breeders and commercial seed companies
- Sites are located at both stakeholder and independently contracted sites
  - Each year summaries of the NFVT's results are released. For inclusion the minimum number of sites required is three per cultivar for perennial ryegrasses or four per cultivar for Italian or annual ryegrasses
  - Contracted sites are reasonably expensive - $2000-3000 per entry per site per year, but the system has full cost recovery
  - There are a reasonable number of entries per site
  - Most seed companies are involved with free data exchange on their own sites
- Data is not under code
  - Test cultivar data are compared with the most recent commercial cultivars
  - Results must be published – poor performing lines cannot be left out of result summaries
- Good results
  - Managed by group and audited
  - Standard trial reporting
- Short delays in reporting
  - 6 months after trial completion
- Most marketing material still reports using in-house trials and some NFVT data

Figure 1 NZPBRA NFVT trial summary for total annual yield of perennial ryegrass cultivars. (http://www.nzpbra.org/files/LP%20NFVT%20%20Perennial%20ryegrass%202007.pdf). Summary from trials at sites across NZ, cultivars must be in a minimum of 3 trials. Trials run for 3 years and simulate rotational grazing under high nutrient conditions. Trials have four replicates and dry matter is measured by cutting or by pasture probe. Error bars indicate 95% confidence levels. Published with permission from NZPBRA



Australia

The recent Pastures Australia (2007) review of genetic evaluation in pasture plant breeding has raised the potential for a National Variety Testing (NVT) scheme for pastures (Pastures Australia Newsletter - June 2007). The aim of the NVT scheme is to provide transparent information to producers and advisors as a basis for making informed decisions. This initiative proposes to develop a prototype low cost scheme and engage in industry consultation to evaluate potential for its adoption.

Ideas for the new NVT for pastures in Australia

- Needs to be accepted by the majority to be worthwhile
- It must be supported by retail sector and industry
- Sound protocols, need to address quality, persistence, and animal performance
- Needs to be fairly priced
  - It should be largely funded by public sector
  - Minimum entry fee - $100-200 per entry per site per year

- Varieties listed as either commercial or trial line to be named
- Programme to involve a public and private sector management committee
- Specialist evaluation agronomy team
  - Funded by Pastures Australia within State DPI system
  - Also allow sites to be run on commercial R&D farms
  - Possible contracted operators, approved by committee
- Strict audit system
  - Poor site management, weeds, pests, uneven sowing by hand to be avoided
  - High coefficients of variation will lead to poor acceptance of data
- Requires rapid reporting of results

Europe

In Europe, it is compulsory for the agronomic performance of new cultivars to be tested before being added to a National List and becoming eligible for marketing and sale. It has been proposed that a similar scheme should be developed in New Zealand. So what are the features of the European National List trials?

National listing is a legal requirement (managed through a Government department - Department of Environment, Food and Rural Affairs) for new varieties of the mainstream agricultural species (http://www.niab.com/services/trial-and-evaluation/national-lists.html). This process seeks to ensure that a new variety can only be marketed if it passes stringent criteria and is deemed to be a genuinely new variety and a significant improvement over what is being currently sold.

To join the National List a variety must be distinct, uniform and stable (DUS) and for agricultural crops, have successfully completed 2 years of comparative trials and have achieved value for cultivation and use (VCU). If these tests are passed the cultivar is placed on the National List and can legally be marketed. However, being a listed cultivar does not mean that anyone will buy the seed. In the UK, an additional cultivar listing, the National Recommended List, is also provided. The VCU tests for the Recommended Lists are undertaken by an independent national organisation – in the UK the National Institute of Agricultural Botany (NIAB). For a cultivar to be recommended it must perform better in at least one characteristic than cultivars already on the market.

This appears, at least at face value, to be an excellent scheme that provides independent unbiased information to aid farmers in making sensible decisions on which cultivar to sow on their farms. However, there are some issues:

1. Cost – £2330 per entry if taken through to Listing (www.defra.gov.uk/planthv/pvs/guides/feesnlt1.pdf). The UK scheme has struggled to match costs with income, despite the Government policy of full cost recovery since the mid 1990s. Simply continuing to increase the fee per entry will inevitably reduce the number of entries, which, with a large number of fixed costs, will drive up the fee per entry – a vicious circle. There is therefore a need to look at reducing costs and still maintaining a credible testing system. In 2006/07, the National Listing scheme achieved 88% cost recovery from entry fees. It was concluded that (a) 100% cost recovery is unlikely to be achieved in the near future, and (b) fees represent a significant burden on industry and in the light of reduced royalties in recent years could present a threat to the long term viability of the UK plant breeding industry.
2. Genotype X cultivar interactions means that many sites are needed to get useful data for the range of climatic and geographical zones
3. For forage, the method and frequency of defoliation can have dramatic effects on agronomic performance – for List Trials the majority of trials are measured under a fixed-period cutting regime and have little relevance to performance under grazing
4. Most often measurements in these trials are for dry matter yield and persistence – more dry matter does not necessarily result in improved animal production.
5. If trials were to be grazed rather than cut, to provide a more realistic management system, plot size may become an issue
6. Some breeders simply breed for the testing system and not the farmers' needs
7. The National List trialling system does not identify the best cultivar for a particular farm it simply provides a list of which are the better options under their standard management regime – is this an improvement on the current system in New Zealand?
8. In the UK, all ryegrasses must be endophyte free for entry into the trialling system – because of the impact of endophytes should trials be run with no endophyte or only with endophyte (and if so which one) or not discriminate?

The following briefly compares the current New Zealand and UK cultivar testing systems

New Zealand	United Kingdom
Voluntary	Compulsory
Managed by the industry	Managed by Government (Defra) and contracted to NIAB
Full cost recovery	Government subsidised
Attempts to duplicate on-farm grazing	Cutting trials
Combines dry weight cuts and pasture probe measurements	Dry weight cuts
Data freely available on NZPBRA website	Data hard to find on internet, but available through published National Lists to participating companies
Data can be used in marketing material but rarely is	Data cannot be used in marketing material
Range of management through NZ, to simulate local farming	Fixed regime, e.g. 4 or 6 cuts a year at pre-determined dates

So what is the solution? Can we afford a compulsory system? Why don't we have greater support for the existing voluntary system if it is believed that farmers take note of published lists on agronomic performance?

Concluding comment

New Zealand is highly reliant on pastoral agriculture for its new wealth creation. This is unlikely to change in the foreseeable future. But to be internationally competitive New Zealand needs to be in a position to adopt new and innovative technologies that will increase productivity. Currently, this is being adversely affected by regulatory bureaucracy, questioned science, poor reporting, marketing hype, biased and polarised views, and the lack of any truly independent research organisation. But perhaps that is what we should expect in a market led economy where the research community is reliant on support from stakeholders with commercial imperatives for its survival. Most of the new funding opportunities are reliant on private-public partnerships (e.g. Consortia, Fast Forward, and Pastoral 21) based on the Government view that industry (whether that be commercial companies or sectors) knows best. That being the case we will continue to see more heat than light being generated in the search for new technologies that will continue to drive up productivity in the agriculture industries.

In my view the only way to change this is for Government support for on-farm agricultural research to be unfettered from commercial imperatives and industry strategies so that through rigorous peer reviewed science we can have an independent commentary on the value of new technologies and products in improving productivity and environmental integrity in pastoral agriculture. This will require a considerable increase in funding by the taxpayer, a change of thinking by the Government, a change in research funding processes, a change in the structure of our research organisations, and the recruitment of scientists capable of undertaking high quality field based research.

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