Improving technology uptake for whole-crop cereal silage production

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Abstract. Rapid dairy industry expansion in the South Island of New Zealand during the 1990's increased demand for agistment and supplementary feed. Consultants and retailers recognised the ability of whole-crop cereal silage to provide the extra feed required. The local arable industry had declined, creating the opportunity to develop commercial technical support packages from establishment to harvesting for sheep and dairy farmers growing whole-crop cereal silage. Industry technical support packages were supported by 'just in time' local research into the growing, making and feeding of whole-crop cereal silage. The package, based on several methods of payment, captured the benefits of new Triticale cultivars. Further investigation into the uptake of whole-crop cereal silage found that the knowledge of whole-crop cereal silage and the interactions between users, growers, technical support agents and agricultural contractors were significant factors in the use of this technology in the South Island of New Zealand.

Keywords: whole-crop cereal silage, technology transfer, New Zealand, dairy farming

Introduction

The dairy industry

The dairy industry in the South Island of New Zealand expanded from 0.56 million dairy cattle in 1994 to 1.31 million dairy cattle in 2003 (Agricultural Production Statistics 2003). This represents a contribution to the national herd of 15% in 1994 and 26% in 2003.

The rapid increase in dairy cow numbers increased the demand for both agistment and supplementary feed. Many operations were milking platforms only, with off-farm wintering of cows to avoid damage to pastures (Greenwood and McNamara 1992) at a time of low pasture growth (Davis 1996).

Farmers, using mainly green feed oats, were aware of green chop silage. The switching from green chop to whole-crop silage improved feed quality and also provided an opportunity to improve milk production by providing a high quality supplement to pasture (Penno et al. 1996).

Whole-crop cereal silage can be used to provide a supplement or replacement for forage during winter when pasture production does not meet cow demand. Whole-crop cereal silage can also be used in spring to ensure cow feed requirements are met when pasture growth and feeding conditions may be less than desirable. Supplementary feeding during autumn, while extending the lactation, will also mitigate the effects of dry summer and autumn weather conditions.

Consultants and retailers recognised that whole-crop cereal silage could provide an opportunity to fill the extra feed demand.

The cropping industry

Sustainability issues for the arable industry were recognised during the 1990's (Dunbier

1996; Pyke 1996) though the threat from the expanding dairy industry was not recognised by either author. The expansion into dairying, however, with agistment and supplementary feed requirements, meant that a further market in forage supply was opening up (Hogg et al. 2002). The arable industry throughout the South Island was declining due to pressure from diminishing returns and dairy farm expansion. This led to a concurrent decline in the skills base for crop growing.

Options to increase feed production using cereal crops have been identified, but acceptance of their use in New Zealand as whole-crop cereal silage has only recently been adopted (Jermyn et al. 1993; de Ruiter 2001). Maize has been used widely in the North Island, but climatic constraints have limited its use in the South Island (Wilson et al. 1991).

Whole-crop cereal silage was identified as a way to provide quantities of feed large enough to meet the increased demand in the cool South Island climate (Hogg et al. 2002). The large quantities of feed grown on relatively small areas, often off-farm, provided the opportunity for dairy farmers to concentrate on feeding pasture to milking cows.

The opportunity

The local cereal growing industry had declined to the extent that the demand for supplementary forage exceeded the supply capacity of arable farms. This led to the opportunity to develop packages maximising yield and quality of whole-crop cereal silage grown on sheep and dairy farms.

Questions were raised about crop choice, agronomy, harvesting and the role of whole-crop cereal silage in a predominantly pasture-based forage system. These questions were addressed through a series of research projects as well as transfer of current technologies.

This paper documents the evolution of a commercial technical support package for the cropping and dairy farming industries. It also reports the results of a workshop with growers, users and contractors after five years of development of the whole-crop cereal silage industry.

Developing and delivering a commercial technical support package

'Just in time' research and technical support

Both national government and industry (arable growers, seed companies and dairy industries) funding was channelled into researching whole-crop cereal silage production and use. Crop & Food Research Ltd researched the growing and making of whole-crop cereal silage (de Ruiter et al. 2002; Hogg et al. 2002). Research was also done using an on-farm demonstration project to assess the place of whole-crop cereal silage on commercial dairy farms using a pasture-based feeding platform (Platfoot and Stevens 2002).

How the technical support package was developed

A critical limiting factor for whole-crop cereal silage in the region was the lack of knowledge by sheep and dairy farmers of cereal agronomy. This provided the opportunity to work with growers, consultants, field agents and agricultural contractors to develop a package to assist farmers growing a new crop. The information provided from the research by Crop and Food Research Ltd helped to ensure that whole-crop cereal silage didn't fail through poor agronomic practice.

The first step in developing a package for the farmers was to identify in detail the requirements to grow, harvest and ensile the crop. This enabled early identification of potential issues.

Checklists were developed for the field agent and grower resulting in a visit timeline to assist in establishing, monitoring and harvesting the crop, balancing adequate visits and cost effectiveness. For each visit a checklist of critical factors was identified i.e. soil testing; plant and tiller counts; weed, insect and fungal checks; fertiliser and spray recommendations; potential harvest date identification; harvest date verification; and yield assessment.

What the package contained

The original package included a proprietary Triticale cultivar, a monitoring programme, coordination with contractors for cultivation, sowing, weed and pest control and harvesting, and a final yield assessment. This provided a vehicle to launch the relatively unknown crop, Triticale, into the farming sector. This approach provided a safety net to those farmers using the new crop, as well as ensuring rapid market penetration for that crop through its successful use.

How the package was delivered to farmers and how they paid for it

The package was marketed to farmers through the traditional rural supply agents and via consultants using an advertising and direct marketing campaign. As the process developed this was expanded to include technical workshops.

The package evolved into a set of options for the grower after the first season. Growers could select from monitoring plus seed or a

monitoring only option. Triticale varieties were only initially available as a monitoring plus seed package to ensure that the crop yields were maximised. This helped to ensure a good track record for the Triticale before substantial amounts of seed became available.

Advantages of the monitoring plus seed option for the farmer included deferred payment as they paid for the seed after harvest; they were able to grow a 'new' crop at less risk; and they accessed plant genetics of both high yield and harvest index.

On-going development

Feedback was continually sought from rural retailers and the growers to ensure that the whole-crop cereal silage package was acceptable to growers. As a result the packages have altered to meet market demand. The package pricing has changed and more options have been added. This increased flexibility was designed to meet the farmers' expectations.

The whole-crop cereal silage package was a model designed to incorporate any cultivar or forage blend. To this end, time and money were invested in developing good contracts for the grower. This expanded to include sale and purchase contracts for feed (standing crop, silage, baleage or hay) as the growers moved from speculative to contract growing for sale to dairy farmers. This has proved challenging as the spot price changes during the growing season depending on the climate and the perceived need for supplementary feed.

Agricultural contractors played a major role in uptake and development of the technical package. Working alongside the consultants delivering the whole-crop cereal silage package helped to up-skill the contractors. This had a significant flow-on effect into the industry with greater technical skill becoming embedded in the wider industry.

Continued investment was made to meet the ongoing needs of this type of technical transfer. The package was only keeping a step ahead of the growers/contractors in developing the model and providing the answers to their problems. Staff training occurred concurrently with on-farm delivery of the package, meaning that the quality of the staff involved was critical.

The process of sale of the seed, and tracking of clients and contracts was managed through a central database. Ongoing investment was made in developing this database. Included in this was use of handheld data recorders for recording monitoring data, visit history and weed and pest control recommendations. A long-term goal was a reduction in data handling and faster reporting back to growers and other relevant parties such as contractors. The analysis of crop growth and yield from the database provided the opportunity to further improve crop husbandry and final feed quality.

Issues arising from the commercial package

'Just in time' model

Was it successful? A model was developed that helped farmers try a new crop option successfully. Since the initial development of the technical support package the area sown in whole-crop cereal silage in New Zealand has increased significantly from a negligible base 5 years ago to an estimated 15,000 to 18,000 ha, of which 10,000 to 12,000 ha are Triticale. Other rural supply companies have also developed expertise in whole-crop cereal silage.

It was recognised at the outset that any company only has a limited time leading a new market. By developing this type of package on a small scale, with supportive staff and commercial potential, it provided an opportunity to trial a model that could then be expanded for any type of forage/crop. Consequently the whole-crop cereal silage market expanded significantly throughout the South Island and a similar set of packages developed for maize growers in the North Island.

Where growers know how to grow these crops advantages still exist because monitoring provides extra labour and timely decision making.

Assessing the impact of whole-crop cereal silage

An independent analysis of the impact and future for whole-crop cereal silage in the southern South Island was done in May 2004. This was part of a Ministry of Agriculture and Forestry (MAF) Sustainable Farm Fund (SFF) project which had demonstrated the on-farm results of feeding whole-crop cereal silage to dairy cows.

The on-farm demonstration project was jointly funded by the Foundation for Arable Research (FAR), the Sustainable Farming Fund, and farmers in Southland, Otago and Canterbury. As part of the project a final workshop was held with the farming community. The workshop participants were divided into groups representing growers, contractors and end users of whole-crop cereal silage. The overall theme was 'Do cereals make profitable silage?'

The groups were asked to identify the strengths in terms of business contribution that whole-crop cereal silage gave them, and then to identify barriers to further

development of whole-crop cereal silage as a feed source. Responses were reported back to the group and grouped into key issues. These key issues were ranked to identify their importance to continued whole-crop cereal silage use.

Strengths in business contribution

Dairy farm users This group had four key areas where whole-crop cereal silage had strengthened their businesses. These were: economic aspects, cow nutrition, environmental and farm systems (Table 1 – Appendix).

Economic aspects encompassed three main areas. The first was increased milk production in spring and autumn as deficits in pasture production were overcome. Secondly, some farmers had noticed perceived improvements in the fertility and liveweight gain of cows. A third important feature was the ability to increase milk production on the shoulders of the season, lowering the need to buy more 'peak notes'. These 'peak notes' are a requirement of the industry when peak production exceeds a certain level. They are used as a disincentive to increased peak season production when processing capacity is exceeded.

The nutritional advantages of the crop were identified as filling a feed deficit, balancing of diet fibre and carbohydrate, and improving cow condition.

Environmental benefits included less effluent from whole-crop cereal silage stacks.

Advantages at the farm systems level included ease of use of the silage, maximisation of land use due to high yields from small land areas, and opportunities to improve crop and pasture renewal programmes.

Growers The growers found that whole-crop cereal silage brought three key areas of benefit to their business. These were: economics, farm systems and simplicity (Table 1 – Appendix).

Economically whole-crop cereal silage provided an alternative source of income creating diversity in their businesses. It also gave the growers the opportunity to use the product for more than one market.

Farm Systems advantages included high yields from a small area, the opportunity for weed control following other crops or pasture, the fit of the crop with pasture surpluses in the spring, extra winter feed when autumn-sown due to the option to graze before growing on for harvest, and flexibility of the crop to sell or use when required.

Farmers felt that this option was simple to achieve due to the packaging of information and support of consultants and industry representatives.

Contractors The contractors felt that whole-crop cereal silage contributed to their businesses in two major ways. These were: economics, and fit with other business activities (Table 1 – Appendix).

Economically whole-crop cereal silage provided some return on investment in equipment and the opportunity to invest in more cost-effective equipment as tonnages increased. They warned, however, that the area sown in whole-crop cereal silage had to increase further to provide an adequate return on investment in some equipment that was required to service the industry.

The contractors also found that whole-crop cereal silage had advantages at the whole business level. This included spreading the workload as harvesting comes between other planting or harvesting activities, improvement of the pasture silage business, and better retention of staff due to the spread of workload.

Barriers to further development

Dairy Farmer Users The dairy farmers found that cost, competition, animal responses and knowledge needed to be addressed for the on-going development of whole-crop cereal silage (Table 2 - Appendix).

There was a clear requirement for the cost of the crop to provide value, especially in light of falling income from milk-solids. It was acknowledged that the product was more expensive than grass silage, because often grass silage was sold as a by-product of unutilised spring grass, and was therefore undervalued. Thus it was also acknowledged that yields had to be high to ensure an economic crop.

The users highlighted that the opportunity seen by the growers in having a product that had more than one end use was actually a threat to its use as a forage product. They also acknowledged that world grain prices would play a role in the commitment of growers to supplying the whole-crop cereal silage product to them as users. The opportunity for growers to move to other crops in the future that may be more economic may also become a barrier to future development of the industry.

The dairy farmer users identified the lack of quantification of the cow responses to the product as a barrier as current industry knowledge of the product was low. This included palatability, milk yield and body condition factors. Knowledge was also lacking in the optimum harvest time for yield and quality, and yield and quality assessment. Another factor requiring quantification was

the risk of avian tuberculosis due to crop fouling by feeding birds when crops had significant proportions of grain.

Knowledge of specific interest to the users was the optimum harvest time. The overall quality of information from some sectors of the industry was also a concern due to some conflict of information. Another concern, which was shared by the contractors, was a lack of both care and knowledge exhibited by some of those offering their services as agricultural contractors.

Growers The growers of the crop identified infrastructure, variability and knowledge as key barriers for the industry (Table 2 - Appendix).

Infrastructure problems included the availability of contractors for crop establishment, husbandry and harvest. The amount of crop sown and harvested was rapidly outstripping the ability of the contractors to service the industry. Also of concern were the issues of contracting the user to buy the crop and measurement of yield during a sale. The growers, while identifying the diversity of uses for the crop, also wanted to be able to contract grow the crop to ensure an economic return, rather than having to sell product into a spot market.

The variability in crop yield and harvesting time were a concern to growers. These arose due to the rapid expansion of the industry leading to a dilution of expertise. It was also due to a cooler than expected summer. This led to the usual prediction of harvest times from growing degree days being unreliable, with harvest times being later than expected. Another variable was the crop quality after harvesting.

The growers identified a key lack of knowledge in harvesting, as had the dairy farmers. Another issue was the appropriate land-use and forage establishment options to follow the whole-crop cereal silage harvest. A further issue was that of realistic expectations of users, growers and contractors. This related both to paddock selection and expected yield as well as the requirements for fertiliser, crop husbandry and harvest losses.

Contractors The contractors recognised several factors that were influencing the use of whole-crop cereal silage (Table 2). The contractors are an integral link between grower and user and many of the issues identified were around managing that link and the often-misaligned expectations that the grower and user had.

Aspects of the farmer-contractor interaction of importance were the conflict between the costs of the job and doing a good job that would maximise both yield and efficiency. The contractors recognised several areas that could improve both the cost and efficiency of the operation if they were allowed to help plan and advise on the whole operation. First was initial paddock selection and cultivation. Some time spent on this would increase initial costs in cultivation, but would reduce future costs of crop husbandry and harvesting due to appropriate contour, higher yields and smoother harvesting surfaces. However, growers were relatively reluctant to spend extra money at the beginning. Another area that grew out of this was unrealistic expectations by the grower. This included yield expectations as well as harvesting efficiencies. Of particular note were the extra efficiencies and hence cost savings that may be achieved by consulting with the contractors on bunker placement and track maintenance as well as those mentioned above.

Contractors identified the monitoring and assessment of crops as a key issue for future success. They acknowledged that formal monitoring programmes did help in the assessment of crop husbandry needs and harvesting timing. However, they identified a general lack of awareness in many growers and users regarding the growth and harvest timing of the crops. Yield assessment was also included here, especially when crops were being grown for sale. There was a growing awareness of both the need to assess crop yield but a relative unwillingness to pay for the extra inputs required to achieve that monitoring. This also extended to the acceptance of crop losses both when harvesting and during the ensiling process. Once a crop was measured then the losses in the process were highlighted.

Contractors, like the users and grower, also identified gaps in knowledge as an impediment to further development of the whole-crop cereal silage industry. Of particular concern was harvest timing. This was both from a lack of general information to draw from as well as a tendency for growers and users to be conservative in their assessment of harvest timing resulting in harvesting too early. The information about the use of the paddock after the crop was raised and some poor decisions such as autumn sowing of pastures were identified due to a lack of local knowledge. This has arisen due to the recent expansions in both the farming and retailing industry. Many of the dairy farmers have moved into the region along with the increase in dairy cow numbers. This lack of local knowledge was also identified as a lack of understanding of the limitations of the system. Of note was a lack of understanding of the soil type and

climatic conditions leading to unrealistic demands by the growers and users on the contractors to cut corners when cultivating and re-sowing.

Key issues

The groups were brought together to discuss and prioritise the key issues in further developing whole-crop cereal silage. Ten areas of concern were developed from the joint feedback session. These were then ranked by each group from 1 to 10 (1 being high) to highlight their relative importance (Table 3 – Appendix).

Economics This was identified by all groups as the most important factor. The crop had to provide a return for all sectors to continue its success.

Palatability and wastage The final utilisation of the crop was highlighted as an area where variability was high, often mistakes were costly and little was known about what caused changes in palatability and utilisation. This was raised as the most important area for further scientific research.

Paddock selection and preparation This factor was a high priority for users and contractors (average score 2.5), while growers rated it only moderately (average score 6). This was directly related to crop yield and harvesting efficiency. As the final harvesting cost was usually paid for by the user, this did not directly impact on the profitability of the grower. The contractor, as a service agent, saw paddock selection and preparation as key to delivering a good final service and good product to the user.

Yield measurement This factor was a high priority for growers (average 2.5) while lower for users and contractors (average score 7). As the grower was paid for paddock yield this was a prime concern, while some users also grew the crop themselves so had no need for accurate measurement of yield. The contractors saw this as less important for the future as crop measurement was already becoming standard and accepted in the industry.

Harvesting Harvesting included assessment of optimum harvest time and harvest methods. All groups ranked this equally with similar reasoning being to maximise both yield and quality.

Information expertise Users ranked this area highly (average score 3) compared to contractors and growers (average score 7.2). Users expressed a problem of access to information. The contractors suggested that the users weren't listening to the right sources. Both the contractors and growers acknowledged that the development of the commercial technical support package had enabled a significant up-skilling in those sectors.

Crop analysis Each group gave this issue a similar score. The ability to rapidly and accurately predict both crop dry matter content and crop quality would aid the assessment of the value of the crop.

Training Training for the industry was important for the users (average score 4), while growers and contractors did not rank training highly (average score 8.5). This reflected the exposure of the grower and contractor to the commercial technical support package. It also reflected the relative lack of information about the use of the final product, including milk production responses, improvements in body condition and liveweight gain responses.

Another area highlighted by the contractors was the lack of local soil, pasture and climatic knowledge by the dairy farming sectors and some of their service agents. This would have impacted directly on dairy farmers but not on growers or contractors.

Benchmarking for other farming enterprises The extension of whole-crop cereal silage into the sheep, beef and deer industries was recognised as an opportunity by the growers (average score 3.5), while it was of lesser importance for users (currently dairy farmers) and contractors (average score 9). The growers saw a new potential market for their product which would provide a more reliable long-term profitability if prices for dairy products varied, affecting the ability of the dairy farm users to buy the product.

Comparisons to maize This area was seen as the least important by all groups. The climatic restrictions of out of season frosts and low summer temperatures ruled out significant use of maize.

Comparing the outcomes of commercial technical support and end-users views after 3 years

Several factors are apparent when the results of the end-user workshop are analysed and compared to the outcomes from the commercial technical support programme.

The disparity between the crop users (dairy farmers) and the grower and contractors on the need for information and training is significant. The contractors and growers had the greatest exposure to the commercial model, and other initiatives that copied that approach. The needs of the growers and contractors were apparently met, as indicated by the low emphasis these groups gave to information expertise and training. The crop agronomy and harvesting research that underpinned the commercial model has given them significant confidence in growing and

harvesting the crop. The growers and contractors still acknowledge some areas for improvement by rating palatability as the second highest factor influencing further expansion of the industry.

The package also highlighted the need for improved yield measurement and feed quality assessment and provided some solutions for this. Contractors have provided some improved techniques for yield measurement as a response to the commercial package. This was reflected in the low emphasis contractors put on this factor. However, concerns still remained with the growers as they rated yield measurement relatively highly. This may reflect a lack of understanding of the losses associated with the harvesting and ensiling processes, as estimated paddock yields and final amounts fed out can vary significantly.

Research for the users through dairy cow responses was limited. International research into the benefits of whole-crop cereal silage (Stark and Wilkinson 1992) does not apply directly to the use of whole-crop cereal silage as a supplement to pasture. Therefore, more research is required to demonstrate the use of whole-crop cereal silage. The variability in silage quality (Platfoot and Stevens 2002), as the industry developed, may have also limited the rate of uptake.

The dairy industry has yet to fully understand the extent of animal production and economic benefits of whole-crop cereal silage compared to grass silage (Stevens et al. 2004). This has caused a plateau in the uptake of whole-crop cereal silage.

Conclusions

The commercial approach provided a rapid entry of new technology and cultivars into the industry. The expansion of the areas sown to whole-crop cereal silage was an indicator of that uptake.

The development of whole-crop cereal silage in the region was the culmination of the rapid expansion of the dairy industry coupled with the introduction of a new cereal option in Triticale. The commercial package provided a competitive edge to both the farmer and the package developers in the initial development of the market. These factors have also led to the need to continue development of the delivery approach and the content of the package as the industry knowledge increased and other companies copied some services.

While economics was the greatest driver for use of whole-crop cereal silage, each group was wary of the other in costing and valuing the crop. For example, users wanted the crop at the same price as grass silage, even though they thought that whole-crop cereal silage was a superior product. Contractors recognised several ways that could save money for both growers and users but could not get either to act effectively on their advice. Contractors also saw themselves as having the greatest capital investment in the industry and saw the need for it to expand further to get an economic return on that investment.

The speed of uptake of whole-crop cereal silage by the dairy industry has outstripped the development of new knowledge through research, especially for the end-user. Further research is required into the responses of all grazing livestock species to provide the confidence of end-users to continue to take up this technology.

Acknowledgements

The authors would like to acknowledge the farmers and contractors involved in the Sustainable Farming Fund project, the Ministry of Agriculture and Forestry Sustainable Farming Fund, the Foundation for Arable Research, and Wrightson Ltd for their contributions.

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Appendix

Table 1. Strengths of whole-crop cereal silage to the businesses of dairy farmer users, cereal growers and contractors

Business	Strength
Dairy farmers	Economics
	Cow nutrition
	Environmental
	Farm systems fit
Cereal growers	Economics
	Farm systems fit
	Simplicity
Contractors	Economics
	Fit with other activities

Table 2. Barriers to further development of whole-crop cereal silage in the businesses of dairy farmer users, cereal growers and contractors

Business	Barriers
Dairy farmers	Cost
	Competition
	Animal responses
	Knowledge
Cereal growers	Infrastructure
	Variability
	Knowledge
Contractors	Farmer-contractor interaction
	Monitoring and assessment
	Knowledge

Table 3. Ranking of the key issues (1 being high and 10 being low)

Issue	Average ranking
Economics	1
Palatability and wastage	3.3
Paddock selection and preparation	3.7
Yield measurement	5.5
Harvesting	5.5
Information expertise	5.8
Crop analysis	6.3
Training	7
Benchmarking for other farming enterprises	7.2
Comparisons to maize	9.7