Arable farming and research - into the next century

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Abstract

Past research has placed the arable industry in a position where current practices have due regard for the physical, social and financial environment in which we live. New technology and products will allow researchers to provide effective solutions for the production of arable crops into the next century. Because of grower involvement in arable research (through the Foundation for Arable Research), and effective systems to transfer information from researchers to growers, the arable industry is well positioned to rapidly implement research findings into farm operations in the future. These factors, plus predicted world shortages of grain, place the industry in a very sound position to meet the demands of the future.

Additional key words: *cultivars, crop management, yields, quality, plant breeding, agrochemicals, Foundation for Arable Research.*

The Industry and Research

Research on arable crops in New Zealand has been essential for ensuring that arable farming is profitable. It has also positioned farmers to be able to capitalize on the benefits of future research. Arable farmers are, in many respects, more able to implement new technology into their farming systems than most other primary producers, as the annual cropping cycle allows new cultivars and crop management practices to be rapidly introduced, and the benefits of research can be realized almost immediately. Thus the opportunities for researchers to introduce new technology are increased.

The existence of an arable industry in New Zealand is a clear indication that farmers have responded to the challenges of growing arable crops - that arable farming has, and is, satisfying the physical and social environmental criteria expected of it by our society. The financial rewards are still sufficient to prevent widespread movement of growers to other farming practices. While in recent years there has been considerable pressure on arable farmers to move to other profitable farming practices (dairying or process vegetable production in particular), any losses to these farming practices have been compensated by movement into arable farming from other sectors, primarily due to below average returns from some other sectors. Recent returns for growing a number of arable crops have remained relatively static on a weight basis. However, for most crops there has been a steady increase in yields which has boosted returns per hectare (Table 1). The value of some commodities has increased steadily (e.g., ryegrass $1.10 per kg to $1.50 per kg from 1991 to 1996), while other commodities have seen recent increases in returns (Table 2) and, for wheat and barley, large price increases are predicted for the 1997 harvest. With the world grain supply at extremely low levels and huge increases in demand projected for grain products in relation to the rapidly increasing world population, the value of arable products is likely to increase.

Table 1. Approximate areas and yields of some major New Zealand arable commodities in 1990/91 and 1995/96[a]

	Area (ha)		Yield (t/ha)	
	1990/91	1995/96	1990/91	1995/96
Wheat	40,000	55,000	4.8	5.8
Barley	83,000	82,000	4.6	5.7
Oats	21,000	23,000	*	5.2
Legumes	19,000	18,000	3.4	3.4
Maize	19,000	20,000	9.0	9.1[b]
Ryegrass	11,000	15,000	1.0	1.2

[a] from Dunbier and Bezar (1996)
[b] This maize yield was lower than many average yields reported by the seed industry.

To define where arable farming and research are going, it is necessary to look at developments in New

Table 2. Median values ($/tonne) for some arable commodities in 1994 and 1995

	1994	1995
Wheat (milling)	$285	$295
Barley (malting)	$240	$250
Peas (maples)	$320	$320
Maize	$270	$280

Zealand, and also how the industry is positioned to capitalize on developments, particularly with regard to new technology, to enable it to move towards the future.

There have been a large number of significant developments in the arable industry which have not only enabled the industry to survive, but have also positioned it to be able to capitalize on recent research. For an industry to survive in the current climate it needs to operate in a manner which is acceptable from the physical, social and financial environmental perspectives. The ability of the arable industry to be in a position from which it can expand reflects both previous research which has, often indirectly, had objectives which fulfill these criteria, and its ability to meet the increased demands from processors for products which meet stringent quality parameters. Past research in the areas of plant breeding, agronomic research and processing has had objectives which have resulted in cultivar changes or changes in farming practices to produce the yields and quality of product required.

Plant Breeding

There have been significant changes in the cultivars of arable crops being grown, as breeders develop cultivars which meet the quality and yield requirements of the different industry sectors. Yield increases and variable payment scales for quality provide major opportunities for growers to survive the financial pressure within their farming operation. Cultivars have been developed which have significant levels of resistance to a wide range of diseases, thus reducing the need for both costly and potentially environmentally less acceptable use of fungicides. Cultivars with lower management input requirements have been developed, providing the opportunity for improved lifestyle of the New Zealand growers. Many of the plant breeding developments are a direct result of New Zealand breeding efforts (e.g., wheat, oats) as opposed to the evaluation of overseas bred cultivars.

Agronomic Research

Research has contributed to a good understanding of the physiology of many arable crop species and this has allowed, for example, the development of improved irrigation and nutrient management practices. These practices often result in reduced expenditure and/or better returns for arable farmers. For example, optimized water use in irrigation through scheduling, and more effective utilisation of nutrients through measurement of the soil and herbage reservoir of nutrients. The result: better yields and quality, with reducing leaching and volatilisation.

In the areas of disease and weed control there have been significant developments in the range, effectiveness and environmental acceptability of many agrochemicals. Like all primary production sectors arable farmers were attracted to the 'security' of using agrochemicals to manage disease, weeds and pests through the mid 1900s. As with the other primary production sectors, arable farmers made some expensive (financially and environmentally unsound) decisions based on the best information available to them as new chemicals became available. The opportunity that agrochemicals provided to growers to control weeds, diseases and pests, often regardless of other management practices or the impact of the control method on non-target organisms, has been used by producers to satisfy the yield requirements and to reduce work loads associated with other control practices. Some agrochemicals provided only short-term solutions and resistance has developed to a number of chemical groups. Over recent years there has been a change to more targeted use of agrochemicals, facilitated by both new agrochemicals which have very specific activities for very specific uses, and the pressures for responsible use of agrochemicals. Recent developments with regard to integrated management practices and biological controls have provided new long-term control solutions.

Cultivation practices in the past have often had little regard for maintaining the quality of the soil, but have been necessary to create a seedbed within a specific time frame to sow crops. Increased understanding of the role of the soil as an effective media in which to grow plants, and the characteristics of different soil types, has resulted in better use of crop rotation and developments with regard to the types and operation of cultivation equipment to more effectively manage the structural, organic matter and nutrient status of the soil, thus ensuring effective crop production. These soil management practices also play a major role in disease and weed control.

Processing

Quality requirements of the processors or end users can provide significant financial benefits to producers who can meet the quality criteria. Indirectly they can also have a significant impact on the environmentally sound use of inputs for arable farming systems. The obvious controls on inputs relate to the use of agrochemicals to meet the residue standards imposed by an end user, but quality standards also encourage the responsible use of nutrients and crop management practices for disease and weed control. New consumer demands and new processing practices have developed and, for example, have resulted in cultivars being used to fill a niche in a non-traditional food market, or, new processes have been developed to reduce energy requirements or achieve better extraction rates in processing.

There is close communication between end-users and growers in determining quality requirements of a number of arable crops, and joint funding of a number of research projects to achieve these objectives. This joint approach has major benefits to the arable industry.

Where Are We Now?

Current trends are placing increased pressures on arable growers to produce quality products using environmentally acceptable practices and, generally, with a view to developing longer term solutions. These demands need to be met with decreased government expenditure (in real dollar terms) on research and information transfer in the arable sector. However, these demands present new and exciting challenges for both the researchers and arable farmers. Many of these challenges are provided by the rapidly developing technology which is available to both researchers and to growers. Researchers have the opportunity to use technology which, for example, enables them to identify and utilise the individual genes in breeding programmes, to accurately and rapidly measure the nutrient and moisture status of plants and soil, and to use remote sensing systems to develop accurate and effective crop simulation models. Growers have the opportunity to use much of the same technology to effectively improve the accuracy of decision making through monitoring, and to rapidly receive accurate and complete information by way of modern communication systems.

The Foundation for Arable Research (FAR) has been established to manage an applied research portfolio, and to distribute information from research to growers. A levy collected on arable commodities sold is used to fund research, information transfer and the operation of FAR. Growers are responsible for establishing research priorities and determining what research will be funded, and are also involved in the transfer of information. All 3800 growers currently receive information in the form of updates and newsletters to include in a folder to keep them informed of the latest research results. Systems are being established to supply more rapid and on-demand access for growers to information. FAR is proving to be an effective body to manage these responsibilities for growers as it has a single function, and is not encumbered with other industry responsibilities. The interaction of growers, researchers and consultants is an effective system for ensuring that the research funded is pro-active and addresses the financial, social and physical environmental requirements of the arable growers and industries in New Zealand.

While the PGSF expenditure on arable research and development is approximately $10 million, there is also a large contribution from private companies and end-user groups (approximately $5 million) and from the growers (FAR $1.2 million).

The Future

What practices will arable growers use to produce arable crops in the next century and what technology will researchers use to solve problems for arable producers?

Researchers will be increasingly able to use the molecular biology methodologies as they become available. In breeding programmes this increases the opportunity to identify or incorporate genes for resistance, yield or quality into a number of crop types. New technology with regard to direct and indirect measuring systems using a range of different equipment from hand held meters to satellite sensing, will provide new opportunities when modelling crop responses to a whole range of variables and, importantly, the interaction of these variables can be more readily determined using new and improved statistical analysis techniques. New technology and products (e.g., agrochemicals, biologicals and fertilisers) will allow the development of more detailed, accurate and targeted integrated management practices to be evaluated in whole paddocks or within paddocks. These practices need to provide benefits to the growers or the environment in which the crops are being grown.

Arable farmers are consistently using models in their decision making procedures. Many of these are simple models which may operate within their head (will I make a profit from growing this cultivar) or appear as regressions between two variables (the relationships between nitrogen and yield). As researchers produce results there is more information a grower needs to incorporate into each model, and thus models could become increasingly complex. A successful crop relies on a grower's ability to manage the response between the plant and the environment. Technology which allows growers to better achieve this will be incorporated into the grower's operation. With improved ability to forecast climatic events for long periods in advance (e.g., based on the Southern Oscillation Index) growers will be able to select species and cultivars, times of sowing and fertiliser application, predict periods of disease risk and introduce management practices to avoid deleterious effects of the weather. Current technology allows accurate monitoring for nutrients, diseases etc, but new equipment will allow more rapid and widespread testing and targeted solutions to problems. Satellite mapping practices linked to global positioning systems on sprayers and cultivators, and yield monitors in combines, should enable growers to accurately target management practices to address within paddock variability.

The arable industry will continue to rapidly implement and reap the benefits of research. New technology and products should result in the growers effectively developing farming practices which satisfy the physical, social and financial demands which will be placed on them in the future.

Reference

Dunbier, M.A. and Bezar, H.J. 1996. Crop Profiles 1995. CropInfo Report No. 10. Crop and Food Research Ltd, Lincoln.