

LEADERSHIP COURSE

**FARMER
EDUCATION
LEVELS AND
THE UPTAKE
OF NEW
TECHNOLOGY**

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1 Summary of Main Points

There is a distinct lack of knowledge about the education attainment levels of NZ farmers.

There is little evidence to substantiate a link between the education levels of New Zealand farmers and the uptake or lack of uptake of new or improved technology. The survey by Ken Moore in *Learning on the Farm, the Educational Background and Needs of New Zealand Farmers* established a meaningful link between formal education attained and higher ratings in a measurement of their management ability. This may or may not be a useful guide as to the uptake or not of new or improved technology.

Ample evidence exists to show that appropriate technology is readily adopted by farmers. Examples of apparently useful technology not being adopted by some farmers also exist but far too little is understood from the farmers point of view to judge why this is so.

Among other factors, the prices received by farmers for their pastoral production appear to have had a major influence on the adoption of new technology. It is not clear whether new technology has driven real prices for output down [by enabling increased volume of production] or whether new technology [through serendipity] has been on hand to enable productivity gains to offset real price declines.

More effort needs to be given to understanding the process of technology transfer in New Zealand's pastoral agricultural sector. Many millions of dollars [mainly public but including some private] are spent annually on research and development. Researchers have too often assumed that they know what research is relevant to farmers and that they will be able to transfer any new technology that is developed.

There is no evidence to substantiate the assertion that farmer education levels may be inadequate, thus resulting in poor uptake of new technology.

2 Introduction and Background

This project was initiated with the aim of achieving a definitive conclusion as to the role a farmers education plays in his/her uptake of new or improved technology.

Early on it became apparent that it was very unlikely that this aim could be met. This was clear from reading other papers on agricultural extension/technology transfer where it was identified that a large number of inter-related factors influence such decisions and that drawing conclusions about one of them was difficult.

It also became very clear that in New Zealand large gaps exist in the knowledge about technology transfer. Despite this, tens of millions of dollars are spent annually on research with insufficient information used to determine its relevance to the pastoral sector and how the knowledge can move from the researcher to the farmer.

Therefore it seemed appropriate to continue with the project so that all these issues could be addressed in the hope that others will pick up on the areas to be further researched.

Ultimately this knowledge will enable the Government and the private sector to better target the millions of dollars spent on research and extension to the benefit of all New Zealand.

The choice of topic was prompted by some assertions made in the discussion paper "*Long Term Priorities for the Public Good Science Fund*" prepared by the Science and Technology Expert Panel [STEP] under the auspices of the Ministry of Research Science and Technology. This was published in May 1992.

The STEP paper questioned the value of publicly funded scientific research and development in the pastoral agricultural sector on the basis that the education attainment levels of New Zealand farmers may be insufficient for farmers to understand and adopt new and improved technologies. However, this assertion was not accompanied by any evidence to substantiate its validity.

Finally when the bottom line recommendation from the STEP final report was that pastoral agricultural production research should be cut substantially, the need to resolve the issue had become compelling.

3 Objectives of this Project

The first objective was to ascertain the education attainment levels of New Zealand farmers. Comprehensive statistics proved to be somewhat elusive. Nevertheless some useful data has been compiled from various surveys.

The second objective was to establish whether or not any link exists between the formal education attainment level of farmers and their uptake of new and improved technology. In this regard it was necessary to explore other aspects of a farmers "*education*" because considerable learning is undertaken by farmers that is not recognised formally.

As the project unfolded it became apparent that it was necessary to widen the scope to look at some of the other factors [other than education levels] that interact to affect farmers uptake of new and improved technology. Thus the third objective was to identify these factors and attempt to establish how to improve technology transfer in the New Zealand pastoral sector in the future.

4 Education Attainment Levels

There is a dearth of comprehensive information about the education level achieved by farmers. It is possible to obtain information such as "dairy and sheep workers" by

qualification from Department of Statistics census information but at a cost in excess of \$400 this was too expensive for this project.

The pricing policies of the Department of Statistics appear to be a major barrier to research.

Various surveys conducted by other organisations give some useful information however.

A survey of Manawatu Co-op Dairy Co. suppliers in 1988 yielded the information in Table 1.

Table 1

The Formal Educational Qualifications of 350 Respondents and 289 of Their Spouses; MCDC Suppliers:

Highest level of Educational Qualification	Males	% of Total	Females
less than 6th form	57		54
6/7th form	15		24
trade certificate	12		7
1 or 2 years university	11		10
bachelors degree	5		4
post graduate degree	0		2
Totals	100		100

Source: Survey of Manawatu Co-op Dairy Company Suppliers, 1988

In *"Learning on the Farm, the educational background and needs of New Zealand farmers"* Ken Moore surveyed 110 Darfield [Canterbury] farmers. The results are in Table 2.

Table 2

Education Qualifications of Male Darfield Farmers

Highest level of School Qualification	Number	% [total]	% [under 40 age group]
None	54	49	33
School Certificate	19	17	11
Sixth form Certificate	7	6	11
University entrance	21	19	31
Higher school certificate	9	8	13
	110	100	100

Source: Learning on the Farm, K. Moore 1990

Moore's survey showed that farmers differed widely in the extent to which they had undertaken further education after leaving school.

Forty percent had undertaken no further formal education after leaving school while twenty-two percent had taken courses ranging from short courses to bachelors degrees. A further thirty-eight percent had trained in a variety of other ways ranging from welding to theology.

J G Pryde in his *"Survey of New Zealand Farmer Intention and Opinions, September-*

November 1981" analysed the responses of around 1500 farmers who responded to questions concerning their tertiary education.

The results are shown in Table 3.

Table 3

Tertiary Education - by Age of the Farmer

	No. of Respondents	<35 %	36-50 %	51-60 %	>60 %	All Ages %
No Tertiary Education	1044	55	65	76	87	67.5
University	230	19	17	10	7	14.9
Technical Correspondence Course	69	6	5	3	3	4.5
Trades Certificate in Farming	45	6	2	2	1	2.9
Course at Flock House or Telford	69	7	5	2	1	4.5
Other	90	7	6	6	3	5.8
	1547	100	100	100	100	100.0

Source: Survey of New Zealand Farmer Intentions and Opinions, September- November 1981 J G Pryde

This survey clearly shows that as the age of the farmer declines so the likelihood of having attained a tertiary qualification rises.

If the assertion linking poor uptake of new technology with low education attainment levels has validity, then extrapolation of these survey results suggest that over time this potential problem may be effectively eliminated. Indeed, over the 11 years since this survey was done it is probable that the proportion of farmers with some tertiary qualification has increased significantly.

A follow-up to this survey would be very useful to establish what the current position is.

5 How Should We Measure a Farmer's "Education"

Even if available, comprehensive statistics on the formal education attainment levels of New Zealand farmers need not be very informative about how well "educated" farmers are.

It would be easy to just look at the highest level of education achievement as measured by years at school or qualification from a tertiary institution. However, this takes no account of learning that occurs in the job.

If many farmers were to add up over a number of years time spent at discussion groups, field-days, seminars, talking to advisers and reading technical journals, they would find that it far exceeded the input needed to obtain a tertiary diploma for example. However, no formal recognition is obtained for this learning.

Continuing education is normal in most occupations. However, because of the on-the-job nature of continuing education in many farming situations, it may suffer by way of statistical comparison with other sectors.

As with many occupations, many of the participants in farming have received specialist education in largely unrelated fields of endeavour. This is evident from some of the responses in K. Moore's *Learning on the Farm*.

This raises the question of how important specialist farmer education is compared to any other type of education. In many cases it is apparent that people learn a framework for thinking and analysing and adapt it to fit their changed circumstances.

Thus in terms of education attained it is difficult to come to meaningful conclusions as to how farmers compare with other sectors of the economy. Perhaps it is more useful to focus on the findings of Porter et al in *Upgrading New Zealand's Competitive Advantage*.

They found that New Zealand as a whole compares badly with many other developed nations in terms of participation rates in education beyond secondary schooling.

6 Correlation Between Education Attained and Management Index

Moore's survey included twenty questions - the answers to which enabled a management index to be generated. The management index is a measure of the farmers ability to run

the various aspects of the business. The questions were based on two sources of good management indicators; the work of Osburn and Schneeberger [*Modern Agricultural Management*, 1978] and Christchurch farm accountant Pita Alexander's list of characteristics of his top ten percent clients. The index is 0-100 based with 100 being outstanding.

The results are summarised in Table 4 where correlation is apparent between the level of secondary school attainment and the management index.

Table 4

Average Management Index by Secondary School Attainment

	No secondary qualification	School Certificate	University Entrance	Higher School Certificate
Number in sample	18	47	19	6
Average management index	51	60	70	81

Source: Learning on the Farm, K. Moore, 1990

Moore further analysed the management index in relation to farmer education undertaken after secondary school. This is shown in Table 5 and once again shows a strong correlation between education attained and the management index rating.

Table 5

Average Management Index by Type of Tertiary Training

Type of Tertiary Training	None	Short Course	TCB/ Dip. Ag.	VFM or Degree
Number in sample	38	41	11	6
Average Management index	55	58	63	84

Source: Learning on the Farm, K. Moore, 1990

These results are clear. However, because the results represent averages it is quite possible that some farmers with minimal education have a high management index rating. Equally it is possible that the reverse may exist within the statistics.

Knowing why these variations exist will be important, particularly with regard to other issues such as the uptake of new technology.

The answer to this can be established by research such as that currently being undertaken by Massey University's Alan McRae in the "*Farmer First*" research project.

7 Other Factors Affecting Uptake of New Technology

It is reasonable to assume that many factors [other than education] are involved in the uptake of new technology. Many studies have identified these factors but it appears that inadequate understanding of what really affects farmers decision making remains.

Some of these factors include the financial circumstances of the farmer, risk aversion, lifestyle considerations, age and peer influence. The other main influence is the changing circumstances of the industry in general; particularly trends in real [or inflation adjusted] product returns.

An important driving force behind change in the different sectors of New Zealand's pastoral industries has been the decline in real prices or returns for farm produce.

Table 6 shows prices received by dairy farmers since 1950. It clearly shows a steady decline in real prices which has forced farmers to expand their average herd size to maintain a reasonable standard of living.

This expansion has required productivity per farmer or farm worker to rise as can be seen later from Table 12. This rise in productivity has only been possible because of the adoption of new technology.

Table 6

Prices Received for Milkfat

Year	Total Actual Payout \$/kg	Inflation Adjusted Payout \$/kg [Dec. 1990]
1950/51	0.63	12.41
1955/56	0.74	11.23
1960/61	0.69	8.99
1965/66	0.80	9.14
1970/71	0.85	7.41
1975/76	1.44	7.61
1980/81	2.64	7.02
1985/86	3.98	6.07
1990/91	4.23	4.23

Source: Livestock Improvement Corporation *Dairy Statistics 1990/91*

The same trends are evident in the sheep and beef industries with stock units per farmer expanding [see Table 13] while real returns have fallen; as shown in Table 7.

Table 7

Index of Prices Received for Meat and Wool

[base 1938/39 =1000]

Year	Wool		Sheep Meat		Beef	
	Nominal 1	Real 2	Nominal	Real	Nominal	Real
1938/39	1000	1000	1000	1000	1000	1000
1955/56	7690	3860	4570	2294	2790	1401
1960/61	8510	3736	4480	1967	4170	1831
1965/66	10460	3998	6840	2615	7310	2794
1970/71	7150	2077	6740	1958	14910	4331
1975/76	12280	2130	10537	1827	14185	2460
1982/83	26973	1807	22591	1513	42342	2836
1985/86	28729	1453	18380	930	58626	2965
1990/91 _p	28220	1091	28955	1120	85818	3319
1990/91 _{est}	25673	983	29429	1127	84400	3232

1 actual dollars

2 deflated by the consumers price index

Source: Estimates made by the Author from Department of Statistics and Meat and Wool Board's Economic Service

To survive farmers have had to adopt new technology. The replacement of most horses with farmbikes and the further development of easy care ewes are but two examples of labour saving changes aimed at minimising costs.

To many observers who look at farm production statistics superficially, it is possible to conclude that little new technology has been adopted because stock numbers have not expanded hugely over 40 years and per head production changes have not been dramatic.

This overlooks the critical point that new technology has been employed to raise efficiency in order to minimise costs in the face of falling real returns.

Table 8 shows that the volume of pastoral agricultural production has expanded quite solidly over the past 50 years none-the-less. The information presented takes no account of the diversification in to other livestock farming such as deer and goats. In 1979 42,000 deer were farmed and 49,000 goats. By 1991 deer numbers had risen to 1.13 million and goats to 793,000.

Also there has been a significant expansion of the area farmed under intensive horticulture.

These examples reinforce the view that change and the adoption of new technology have been clearly evident. However, this change has tended to be evolutionary. Some farmers at the centre of incremental changes over a number of years are often surprised to reflect back on the total impact of those changes.

Risk aversion would appear to have emerged in more recent times to be another important factor involved with the adoption or non-adoption of new technology.

A farmer who has to borrow money to purchase new technology [and thus go deeper in to debt] may be averse to the idea even though the technology is well proven. The argument from the farmer is that other factors [e.g.. adverse weather] may intervene before a return is generated from the new technology and that financial viability may be lost.

This line of reasoning would suggest that financiers need to be well informed as to the potential benefits of new technology so that credit is advanced to facilitate worthwhile development.

A comprehensive study is required to learn more about the inter-related factors affecting the uptake of new technology. Solid information could then replace the many [often dubious] assumptions on which technology transfer decisions are now made.

Table 8
 Index of the Volume of Pastoral Production
 base 1938/39 = 1000

Year	Wool	Sheep Meat	Beef	Dairy
1938/39	1000	1000	1000	1000
1955/56	1430	1520	1500	1310
1960/61	1830	1990	1720	1430
1965/66	2220	2280	2090	1670
1970/71	2280	2530	3170	1490
1975/76	2213	2481	2801	1718
1980/81	2750	3120	2683	1728
1985/86	2594	3570	2749	2145
1991/92	2148	3150 est.	3331	2225

Source: Department of Statistics and Meat and Wool Boards Economic Service

8 Examples of the Uptake of New Technology

The use of electric fence systems and farmbikes are just two examples of new technology that have achieved widespread use in New Zealand.

Electric fence technology was developed to a useful stage during the late 1940's, and as the statistics in Table 9 show, the uptake after further improvements in the 1950's was dramatic.

In *Upgrading New Zealand's Competitive Advantage*, the authors argue that demand for electric fences was fuelled by farmer efforts to drive down costs and increase productivity.

Table 9

Farm Machinery Use
000's

Machine	1960	1965	1970	1974	1977	1980	1983	1986	1989
Electric Fence Units	55	64	70	71	68	72	72	65	n.a.....
Farmbikes	32	38	43	44	n.a.

Source: Department of Statistics

Note: 1960 was the first year statistics were collected for electric fence units and 1977 the first year for farmbikes

The use of artificial breeding and herd testing services in the dairy industry is an added example of the progressive uptake of new technology over time. This is shown in Table 10 with regard to the use of herd testing services provided by the Livestock Improvement Corporation.

The use of artificial breeding services has grown from a zero base some forty years ago to the point where in 1990/91 around 95 percent of dairy herds have at least some cows artificially inseminated.

Table 10

Trends in the Use of Herd Testing Services

Year	Number of Herds	% of All Herds	Number of Cows 000's	% of All Cows
1955/56	7469	21.0	476	23.8
1960/61	7006	22.5	494	25.6
1965/66	6206	23.5	521	25.0
1970/71	6574	29.3	716	32.0
1975/76	5858	31.8	706	33.7
1980/81	6789	42.2	909	44.8
1985/86	9026	57.3	1484	63.9
1990/91	8918	62.4	1566	68.2

Source: Livestock Improvement Corporation

These examples of new technology uptake are not compelling evidence that farmers in the pastoral agricultural sector readily adopt new technology. However, there is sufficient information to refute any suggestion that research spending in the pastoral sector may not be worthwhile because of lack of farmer adoption of resultant new technology.

9 Correlation Between Improved Productivity and New Technology

Productivity per person employed in the New Zealand agricultural sector has increased dramatically over the last 50 years.

In the dairy industry, for example, it is apparent that new and improved milking technology has been readily adopted to achieve large productivity gains.

Milking cow numbers have not changed significantly over a number of decades but the number of herds has declined sixty percent between 1955/56 and 1990/91 [see Table 11] As a consequence the average herd size has increased in an inversely proportional way.

As the ability to milk large numbers of cows has grown so has the need for new technology in other areas e.g. calf rearing, pasture management etc.

Table 11

YEAR	No. of Herds	No. of Cows m	Average Herd Size	Average Per Cow Prod.. kg/mf
1955/56	35500	1.90	54	113
1960/61	31150	1.93	62	129
1965/66	26443	2.09	79	140
1970/71	22415	2.24	100	113
1975/76	18442	2.08	113	128
1980/81	16089	2.03	126	151
1985/86	15753	2.32	147	151
1990/91	14685	2.40	163	154

Source: Department of Statistics and Livestock Improvement Corporation

The adoption of new dairy farming technology has enabled large productivity gains as capital equipment has substituted labour. The data of Table 12 shows that the average number of cows milked per labour unit has grown from 30 in 1930 to an estimated 150 in 1992.

As a consequence, milkfat produced per labour unit has also risen hugely but by a factor of nine compared with a factor of only five for cows milked. This extra gain is explained by the application of new technology to breed genetically better cows able to produce more milkfat.

Table 12

Approximate Data for Cows Milked
and Milkfat Produced per Labour Unit

Year	Cows Milked per Person	Milkfat Produced per Person [kg]
1930	30	2,700
1965	60	7,500
1975	75	10,000
1985	135	19,000
1992 est.	150	24,200

Source: Dr C W Holmes, Massey University, 1989

In the sheep and beef industry a similar trend is apparent from studying data over the past 25 years or so. As shown in Table 13 the number of stock units per labour unit has increased 50 percent between 1968 and 1991.

Table 13

Sheep and Beef Sector

Livestock Units per Labour Unit

Year	Average Total Stock Units per Farm	Total Labour Units per Farm	Stock Units per Labour Unit
1968/69	2912	2.07	1407
1970/71	2943	2.02	1457
1975/76	3109	1.83	1699
1980/81	3461	1.83	1891
1985/86	3364	1.67	2014
1990/91	3340	1.58	2114

Source: Meat and Wool Boards Economic Service and Department of Statistics

Table 8 shows information on the volume of pastoral agricultural production since 1938/39. It does not indicate productivity gains however.

These productivity gains have only been possible because of the application of new and improved technology. Thus the correlation between increased productivity and the application of new technology is very strong.

These figures provide clear evidence that appropriate new technology is readily adopted in the pastoral agricultural sector.

10 The Future

There is no reason to restrict public research and development funding in the pastoral agricultural sector based on fears of low education attainment levels of farmers adversely affecting technology uptake.

There is a clear need for more research effort to enable a better understanding of the technology transfer process as it applies to pastoral farmers.

The author fully supports the *Farmer First* research project currently underway at Massey University. This work needs to be extended to cover the dairy farming sector as well.

The Public Good Science Fund and the process of research funding through the Foundation for Research Science and Technology must take more account of the need to have appropriate technology transfer mechanisms running parallel to the output of scientific advances.