Lincoln University
Te Whare Wānaka o Aoraki

A Five Year Financial and Productivity Report for LUDF 2002/03 to 2006/07

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30 June 2007

Note: This analysis is based on Years 2 to Year 6 of the Lincoln University Dairy Farm (LUDF). In the first year (2001/02) the cows only arrived on the property in October, having been milked on the old farm for the first part of that season.

	2002/03	2003/04	2004/05	2005/06	2006/07
Milk Solids	**228,440**	**271,963**	**277,634**	**286,115**	**274,599**
Total Cash Income	900,045	1,168,315	1,295,806	1,237,567	1,312,315
Total Cash Expenses	712,928	719,083	732,310	765,500	770,514
Cash Surplus	**187,117**	**449,232**	**563,496**	**472,067**	**541,801**
Cash surplus /kg MS	**0.82**	**1.65**	**2.03**	**1.65**	**1.97**

Some messages

1. From year 2 (20002/03) to Year 6 (2006/07) MS production per hectare increased 20.2%
   A big tick!

2. Total farm expenditure increased by less than 8% over this period, even with no adjustment for inflation. *Another big tick!*

3. But there was no clear trend in either farm cash surplus or cash surplus per kg MS. Instead there is lots of volatility. And this volatility is driven by the volatility of payout.

   So has LUDF really moved forwards in terms of the things it has control over?

If we want to investigate whether or not the LUDF farm is improving its overall efficiency, not only in producing more milk, *but is doing so efficiently in relation to total resource use*, then we need to look at something else than profitability.

We need to look at productivity!

Productivity at LUDF

The big question: ***To what extent has LUDF improved its productivity between 2002/03 and 2006/07?***

Another way of asking this is: to what extent has LUDF become more efficient, not just in converting grass into milk, but in relation to its *total resource use?*

We need to be very clear that productivity is quite different to both production and profitability.

Both production and profitability are important KPIs (key performance indicators).

Productivity is a *different* KPI that measures how efficiently resources are turned into outputs.

Productivity measures what farmers are doing to improve their efficiency.

Productivity measures do not replace profitability measures. Instead they sit alongside. In particular, they answer the question as to whether or not we are becoming more efficient over time!

Productivity is important because if we are not becoming more efficient over time then eventually we are going to get caught out when there is an inevitable downturn. The downturn might be two years away or 10 years away. But eventually there will be a downturn and the farmers that drop out the bottom will be the ones that have not been working on their productivity.

The problem:

Until now we have not, as an industry, had any accepted way of measuring productivity (efficiency of resource use) at the level of individual farms.

I am now going to show you how this can be done using the LUDF.

I am going to do this using two simple measures, both based on the cost of production per kg MS.

The first measure is the *cash cost* of producing a kg MS. If these costs are to be compared between years then they must be adjusted for the effects of price changes for farm inputs.

The second measure is an *economic cost* of producing a kg of MS that includes depreciation. Once again there is a need to adjust for price changes in farm inputs. In general this economic measure that includes depreciation is my preferred measure (but there are arguments both ways).

The starting point:

	2002/03	2003/04	2004/05	2005/06	2006/07
MS production	228,440	271,963	277,634	286,115	274,599
Total farm expenses	712,928	719,083	732,310	765,500	770,514
Cash cost per kg MS	**3.12**	**2.64**	**2.64**	**2.68**	**2.81**

But these figures are misleading because of inflation. Therefore if we want to see the real trend in relation to resources per kg of milk solids we need to divide by an inflation index. I have used the Dairy Farm Expenses Price Index produced by Statistics New Zealand, which I have adjusted to a base figure of 1.00 for March 2007. What this does is adjust all cost figures to 2007 dollar values.

	2002/03	2003/04	2004/05	2005/06	2006/07
Cash cost per kg MS before adjustment for inflation	3.12	2.64	2.64	2.68	2.81
Dairy Farm Expenses Price Index	0.896	0.893	0.930	0.975	1.000
Inflation adjusted cash cost per kg MS	**3.48**	**2.96**	**2.84**	**2.75**	**2.81**
Productivity Improvement (%)		**17.6%**	**4.4%**	**3.3%**	**-2.2%**

From this we can see that in the latest year (2006/07) LUDF used a lot less cash inputs per kg MS than it did in 2002/03 ($2.81 compared to $3.48). We can also see that most of the improvement came early on and in fact resource use efficiency declined somewhat in the latest year. I will come back to this point about 2006/07 later.

The ***overall*** productivity improvement between 2002/03 and 2006/07 has been 24%.

The ***average annual*** productivity improvement (compound) has been 5.5%.

(Doing these last calculations can be a bit tricky because they are based on compounding. If anyone wants to know the details then send me an email)

Including depreciation

If depreciation is included, we get an economic measure rather than a cash measure. On the Lincoln farm the depreciation has been declining and hence these economic estimates of productivity gain are somewhat higher than the cash measures.

	2002/03	2003/04	2004/05	2005/06	2006/07
Nominal economic cost per kg MS	3.67	3.10	3.06	3.00	3.15
Inflation adjusted cost per kg MS	4.09	3.47	3.29	3.07	3.15
Productivity improvement		**17.8%**	**5.7%**	**7.0%**	**-2.5%**

The total productivity improvement from 2002/03 to 2006/07 is 30%
The average annual compound rate of improvement is 6.8% per annum.

How should we interpret these figures?

The 'big message' is that Lincoln has achieved very high productivity gains between 2002/03 and 2006/07, regardless of how they are measured.

Another way of looking at this is that in inflation adjusted terms Lincoln spent 3% less in cash terms on operating the farm in 2006/07 than in 2002/03, and 8% less in economic terms (including depreciation) but produced 20% more milk solids.

But there is another side to the story as well. It is that much of the improvement actually occurred between 2002/03 and 2003/04 (i.e. by the end of the third year of conversion). Improvement since then has been less and was actually negative in 2006/07.

The 2006/07 results probably reflect that the 2006 winter was very difficult. There are always going to be seasonal effects and a *short term* decline is no big issue.

But it does illustrate that getting ongoing productivity improvements is going to be a challenge.

So what is a realistic target for the future?

The industry keeps talking of 4% per annum.

But 4% year-after-year is a huge challenge for a developed farm.

If LUDF is to achieve this, then in ten years time (2016/17) they will need to increase production from 1700kg MS per ha to more than 2500 kg MS per ha, and to be achieving this with no more inputs of fertiliser, labour and other resources than at present!

If inputs do increase then MS production will need to go even higher to achieve the 4%! Remember we are talking productivity (efficiency) not production.

Therefore a more realistic goal might be 2% per annum productivity improvement from here on.

Industry leaders who talk of 4% per annum productivity growth are either getting confused between production and productivity, or else they are setting unrealistic targets.

How should LUDF respond to the increased milk price?

Given that milk payout is expected to be over $5.50 and could rise even higher, there *may* be opportunities for increasing profits by tactical feeding of high quality silage etc.

If the cost of producing an extra kg of MS is less than the price of MS then profits can be increased by extra spending. But if these marginal costs per kg MS are more than the current cost of production per kg MS then this will show up as a decline in productivity. This is not of concern if the increased expenditure is tactical (and easily reversed) rather than strategic and system based (and hence hard to reverse). *This illustrates that there are some situations where profits can be increased at the expense of productivity (efficiency).*

BUT: it is a slippery path. It is easy to underestimate additional costs, and tactical responses can sometimes be built into the system and be hard to reverse.

Can farmers do these calculations on their own farms?

Yes and No.

Yes, if farmers are used to working with figures.

But for most farmers it will be easier to leave it to their accountant or consultant.

Currently these calculations are not built into either the DairyBase or Red Sky farm analysis systems. But they would be easy to incorporate.

Where to from here?
There are other more sophisticated measures that could be calculated. One of these would be to include an allowance for total capital invested in the business. I do not favour this both for practical and theoretical reasons. In practical terms measuring the value of total assets is typically problematic. In theoretical terms there is a problem of circularity in that the benefits of improved technology are capitalised into land values.

Also note that in these notes I have not adjusted the cost per kg MS to account for non milk income. Accordingly, the figures as presented here are not necessarily equivalent, for example, to the cost per kg MS figures as produced by other organisations. (There is a lack of consistency within the industry as to how cost of production is calculated.)

Also note that all calculations here have been undertaken on an EBIT basis. This means that interest and tax are not included. Hence, and for example, the cash cost of production for this latest year at LUDF was $2.81. However, total income was $4.77 per kg MS (comprising $4.40 for milk, $0.34 for livestock, $0.03 for other). This means that the difference of $1.96 per kg MS is what is available for

- debt servicing,
- capital replacement,
- new capital, and
- return to equity capital.

So this leads to a final reminder. Everything I have said in these notes is for the purpose of measuring *improvement over time on a particular farm*, which might be either LUDF or any other farm. But it is not for comparing farms at a point in time. For within-farm comparisons it really does not matter too much exactly how particular inputs (such as labour) are calculated as long as there is consistency of treatment ***between years***. But once comparisons between farms are undertaken (for example comparing cost of production) then consistency of treatment ***between farms*** does become of great importance.

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dexcel
Partners in profitable dairying

PRODUCTIVITY UNRAVELLED

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8 July 2007

The purpose of this paper to unravel productivity by discussing what it is, the relationship with profit and where gains have and are likely to made in the future as well as the relevance of the 4% target.

Introduction:
In October 2006 the Fonterra Shareholders Council called for a review of dairy industry "Good Activities". The rationale for the review was that "the current structure is not reaching targeted levels of performance". Specifically, "on farm productivity gains over recent years have been less than 1% - well below the industry target of 4%".

There are two points that must be investigated:
1. We must firstly understand what productivity is and the key drivers.
2. Secondly we must examine the target to determine if it is appropriate.

What is Productivity?
When analysing a farms performance it is important to look at 4 key areas:
1. Physical performance (production, days in milk, stocking rate, feed eaten and utilisation, animal and reproductive performance, other resources used such as labour, fertiliser and irrigation)
2. Liquidity or the cash generated by the business and its allocation eg Farm Working Expenses, debt (interest and mortgage payments) tax, drawings, capital development)
3. Profitability – the difference between the revenue generated from the sale of outputs and the full account of the costs of the factors used in the production of the output.
4. Wealth Creation – return on investments, equity growth and if that growth comes from retained profit of the operating business or from the change in capital value (eg land appreciation and change in share values)

The physical performance of the farm is essentially productivity. Productivity measures physical farm efficiency or the level of production (outputs) per resources used (inputs) to generate the production.

Productivity = Physical Outputs or Production

Physical Inputs or Resources Used

Outputs = the quantity of milksolids, livestock sold, hay or other outputs
Inputs = the quantity of labour, farm working inputs, maintenance and running, overheads plus the assets
Note: The outputs are relatively straight forward as the main output from dairy farms is milksolids. However, inputs are more difficult to measure and deal with, particularly as we have a number of different units. There are five main categories of inputs:

1. Labour - includes non-paid labour and management
2. Farm working inputs – all the inputs used to ensure optimal production is achieved eg feed, fertiliser, animal health, breeding
3. Maintenance and Running – eg electricity, R&M, fuel
4. Overheads – administration, rates and compliance, insurance
5. Assets – land, livestock, plant & machinery, vehicles, and milk company shares

To become more efficient a farm must increase production and/or reduce inputs. Essentially it is More from Less, although you can become more efficient by producing less, provided inputs decrease by more than outputs.

In order to understand what is happening on farm it is appropriate to investigate the diagnosis of the physicals. The best way to do this is to look at a series of partial productivity measures over the last decade

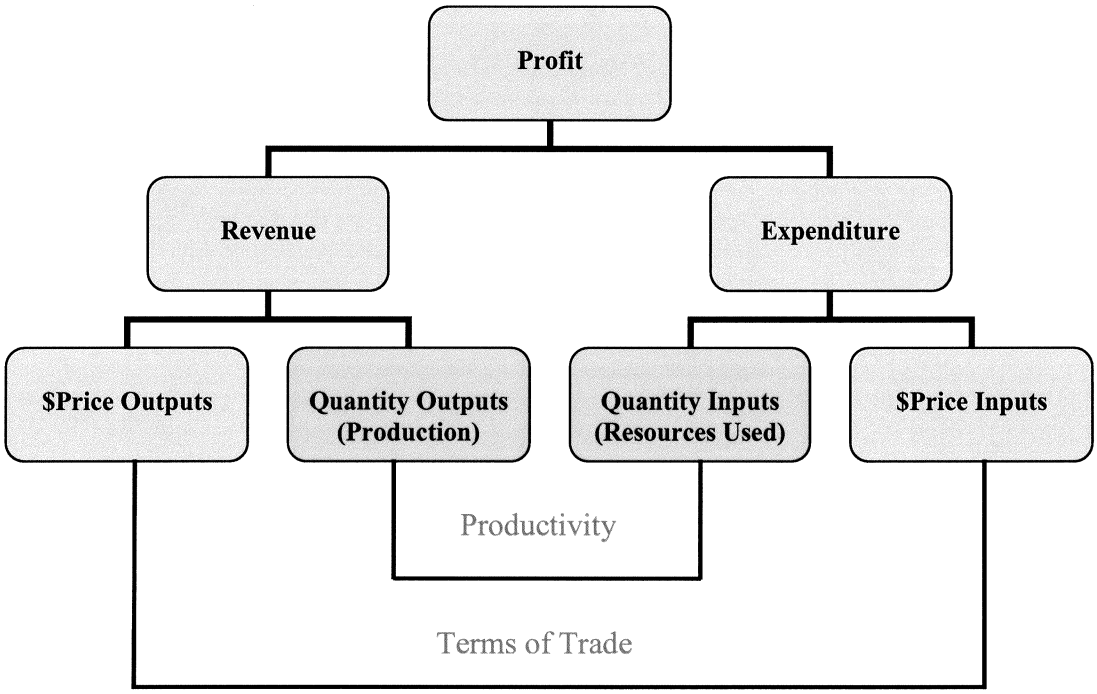
Partial Measures	**% Change last 10 years**
Kg MS /ha	+20%
Kg MS/cow	+ 7%
Kg MS/Kg Liveweight	+ 5%
Kg MS/Kg DM feed consumed	+13%
Kg MS/FTE (labour)	+45%
MS/Kg N	-24%

Source: Dexcel – Economic Survey of New Zealand Dairy Farmers

Analysis of the above KPIs for the last decade would indicate that productivity would be increasing dramatically over this period.

Partial productivity measures are simple, easy to understand and transparent, but on their own do not provide a complete picture of the farm performance. Partial productivity measures are dangerous when comparing results with other farms running different systems and hence the industry adopting a complete measure of productivity know as *Total Factor Productivity* (TFP). This assesses the efficiency of producing all outputs against the usage of all inputs used in the production process based on the New Zealand average farm.

Profit and Productivity:
Productivity is one of the key drivers of profit; the other is prices as demonstrated in the diagram below.

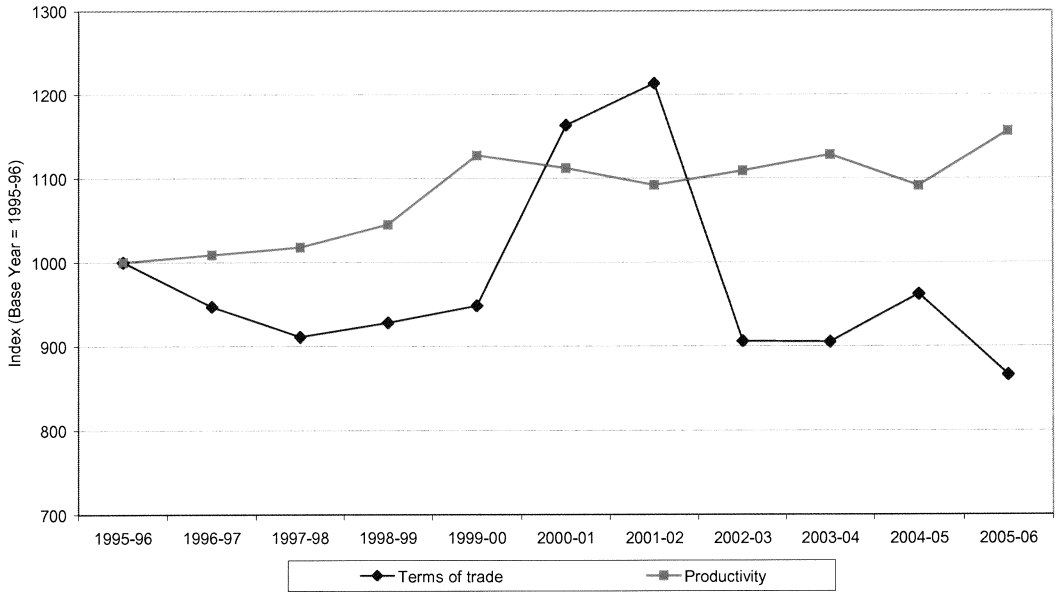


The terms of trade is the ratio of farm gate prices received for outputs to prices paid for inputs. If the price of outputs eg milksolids and the price of all inputs remain constant the only way to increase profit is to improve productivity. This should be the aim of all farm managers as productivity is what can be controlled or influenced as prices are set by market forces outside the farm gate. However, the reverse also applies, if productivity shows no movement the only way to increase profit is through a change in the terms of trade, either an increase in output prices and/or a decrease in input prices.

History shows us that in years of high payout (over $4.40 per kilogram MS) such as 2000-01, 2001-02 and 2004-05, productivity tends to decrease due to a reliance on the price of outputs for profit. It is likely that in 2007-08 with a payout of $5.53 per Kg MS that productivity will decline. For starters labour, particularly casual work like relief milking is likely to increase as farm owners have a few more breaks. Purchased feed will increase as farmers look to increase production to take advantage of high payouts, some more successfully than others. Repairs and Maintenance will increase and part of this is a catch up, the other part is spending some money on upgrading to avoid taxation and for personal satisfaction.

The graph below shows the movements in productivity and terms of trade from 1995-96. It is clear that prices are a lot more volatile than movements in productivity. Therefore, changes in prices, particularly milksolid payout has had a larger impact on profitability than productivity has over this period.

Movements in Owner-Operators Productivity and Terms of Trade



Source: Dexcel - Economic Survey of New Zealand Dairy Farmers

What influences productivity results?

Unfortunately productivity as measured by the industry is not a simple direct consequence of factors apparent to farmers. There are a number of factors, often out of farmers' control that will impact indirectly on productivity. These factors are not independent of one another and movements in one factor may result in a compensating movement elsewhere. For example, increasing farm intensity (more cows per hectare) is likely to result in an increase in fertiliser, feed use and animal health inputs. Another example is if new technologies are introduced they could substitute labour, such as the Greenfield automatic milking system.

Despite common misconceptions, milksolids price and the value of land do **not** directly affect productivity as it is a measure of the physical quantities only. However, milksolids payout will indirectly influence productivity as it encourages greater use of inputs as mentioned above. If the price of land increases as it has rapidly over the last five years then this does not represent any change in the physical inputs in the production process, and will therefore have no direct impact on productivity. However, in the long run high land prices will encourage efficient utilisation of the land resource. In the short run a change in land value does not impact on farmer behaviour.

Capital is an interesting input because unlike other inputs such as fertiliser, capital is not consumed or transformed in the production process and is still present (often improved) at the end of the year. I believe land should be incorporated into calculations of productivity as it allows for the situation where there is a change in the number of hectares available to produce milk.

Price changes of inputs and availability of resources can also influence farmer behaviour in the same way that milksolids pricing does. Eg the price of certain feed supplements, fuel, urea or animal health products may alter the quantities used, often a cheaper substitute may be found.

Seasonal conditions have a major direct impact on both outputs (milksolids and livestock sold) and inputs (feed, fertiliser). Severe weather conditions can also impact on the following year's productivity, through stock numbers, stock condition and feed reserves.

The adoption of research and development through both new technologies and knowledge of improved farm systems will impact on productivity, but the magnitude of this impact is difficult to quantify.

Decisions made by dairy farmers are not generally aimed at maximising productivity but at maximising profitability. Therefore TFP provides a robust 'run-rate' as to how the industry is progressing, but individual farms are actually concerned with profitability and wealth creation.

Where has productivity gains come from in the last decade?
Analysis shows us that the major gains have come from adopting new technologies as well as some improvement in the way things are done. Some examples of these include:

- Labour - adoption of rotary dairy platforms, automatic cup removers, improved methods of cleaning milking equipment and yards and small things that improve the system, help with decisions and safe time
- Animal genetics - has been significant and provided these animals are fed well will be more efficient at converting feed into milksolids.
- Feed utilisation - grazing management strategies such as winter grazing off, use of stand off and feedpads, knowledge of optimal pasture residuals at different times of the year, simple tools such as feed wedge, storage and feeding of supplements.
- Use of imported feed, including nitrogen, knowledge about high protein feeds and their benefits
- Irrigation to reduce climate risk and ensure feed is grown year round.
- New pasture species, particularly AR1 to grow more feed.
- Improved knowledge and understanding of different production systems.

Likely Drivers of Productivity in next 10 years
Just as it has in the last decade the two potential areas where productivity improvements will come from in the future are new technologies and gains made by changes in management and improved farm systems. Innovation can impact through by either a big jump or in incremental steps.

- Further substitution of labour for capital. This is necessary given farms are growing in size and labour is increasingly becoming harder to source.

- New grass species – AR37 will have an impact over this period but if we don't know about them now it is unlikely further new grasses will have much impact over this period.
- Further gains in genetics and animal health – likely to be smaller gains than the last decade.
- Energy savings – reduced electricity for water heating, milk chilling, vacuum pump and milking plant through improved technologies.
- Irrigation efficiency through improved equipment, improved allocation and scheduling of water to pasture, reduced running and maintenance costs and adoption of best practices.
- The availability of improved information and data for better decision making eg selected feeding for individual animals via electronic identification, scanning and drafting. This also reduced labour issues with drafting. DairyBase will help farmers better understand the key drivers on their farms and areas for improvement and cost saving.

The 4% Productivity target

In the late 1990s McKinsey & Co conducted a review of the dairy industry. McKinsey recommended a 4 per cent per annum productivity target across the entire value chain based on the following rationale:

- Other countries were achieving this growth in dairy
- Other industries were exceeding this level of productivity growth
- NZ needed this growth to stay ahead of real price declines and our competitors

The report did not define how this measure should be developed or reported. Dexcel was formed following this review to conduct research, development, extension and education for the New Zealand dairy industry. As a result the 4% target growth in productivity was adopted by Dexcel and written into the Dexcel Trust Deed. Dexcel then contracted an economic expert to construct a measure of industry on-farm productivity.

A 4% increase in productivity over 10 years implies:

- Outputs will increase by 48% (+4%pa) with no increase in inputs or
- Outputs will increase by 34% (+3%pa) with a 10% (-1%pa) reduction in inputs or
- Outputs will increase by 63% (5%pa) with a 10%(+1%) increase in inputs

We know that large productivity gains can be achieved on individual farms, particularly those changing system, managers and on new farm conversions. This has been demonstrated by the Lincoln University Dairy Farm (LUDF). However, a sustained 4% increase in productivity across the entire industry is considered to be physically impossible and therefore not a relevant target.

The TFP model is relatively complex and would not be easily replicated for individual farms. However, the methodology for recording TFP is the best available for recording changes in dairy industry productivity. TFP should not

be reported in isolation, and should be reported with some other key measures of industry and farm performance.

In addition as discussed earlier, a number of things will impact on farmer decisions which are not influenced by the industry. Leaders of the new organisation (Dairy InSight and Dexcel combined) for industry good activities are aware of this and will ensure that industry success is measured in other appropriate ways. Notwithstanding this, productivity is widely accepted internationally as a key performance benchmark for businesses. Increasing productivity is related to increasing profitability, reducing expenditure and sustained competitiveness. It is important that farmers strive to become more efficient.

Key Messages

- Productivity measures physical farm efficiency
- To improve efficiency there are two areas to concentrate on – lift production and/or reduce inputs
- Improving productivity is one avenue to increasing profitability
- There are a number of things that impact directly (seasonal conditions, adoption of new technologies and improved farming knowledge) and indirectly (milksolids payout and price and availability of inputs) on productivity but it is ultimately farmers reaction and decisions to these changes that impact on productivity.
- The 4% target is not a realistic goal and should be reduced to something more attainable.
- While productivity is not engaging farmers it is a very important measure of business performance so productivity gains should be the focus for all individual farm managers.
- Productivity should not be the measure of industry good activity success, but should still be measured and reported with other key performance measures such as profitability, liquidity and wealth creation.