Ministry for Primary Industries
Manatū Ahu Matua

PASTORAL INPUT TRENDS IN NEW ZEALAND: A SNAPSHOT

New Zealand Government

Growing and Protecting New Zealand

Publisher
Ministry for Primary Industries
PO Box 2526, Pastoral House, 25 The Terrace
Wellington 6140
Tel 0800 00 83 33
Fax +64 4 894 0300
www.mpi.govt.nz

ISBN 978-0-478-38864-0 (online)

Disclaimer

The information in this publication is not government policy. While every effort has been made to ensure the information is accurate, the Ministry for Primary Industries does not accept any responsibility or liability for error of fact, omission, interpretation or opinion that may be present, nor for the consequences of any decisions based on this information. Any view or opinion expressed does not necessarily represent the view of the Ministry for Primary Industries.

FOREWORD

The New Zealand pastoral sector is our largest export sector and is also one of the largest users of our natural resources. As such, a better understanding of how our land is being used could help us to improve not only our economic performance but also the sustainable use of our resources.

This study charts the trends of physical inputs that went into pastoral farming and connects these trends to the outputs (milk solids, beef and lamb production) of those farms, but leaves aside complicating financial or economic influences such as commodity prices or exchange rate.

Unsurprisingly, this has been a challenging task. Pastoral farm systems are becoming more and more sophisticated, with many pastoral farms now used for multiple farming activities. This has made it difficult to attribute land use to particular farming activities and specific outputs. Furthermore, continual changes to the collection of data meant that usable data were only available from 2002. With such a short time series, shocks such as the 2008 national drought could have a relatively strong effect on the overall trends in the data.

We therefore needed to develop new ways of interpreting the data in order to address the questions we set ourselves around pastoral productivity and intensification, which in turn are bringing new perspectives to how we understand the change that pastoral farming is facing.

This report illustrates where our dairy, sheep and beef industries are heading in terms of land and animal numbers and how their productivity is changing, as well as how their debt is growing and how the nature of on-farm inputs is changing. It highlights how difficult it is to define what "intensification" means, with some inputs increasing and others decreasing.

I hope this report stimulates debate, and I encourage you to read and discuss it. Every year brings new challenges that our farmers must contend with. It is important to explore the trends over the last decade and to consider what this may mean as the pastoral sector moves forward.

Paul Stocks
Deputy Director-General Policy
Ministry for Primary Industries

CONTENTS

LIST OF FIGURES

EXECUTIVE SUMMARY

This is an investigation of input use and production trends in the New Zealand pastoral sector between 2002 and 2009. It sheds light on intensification and productivity, two key parameters of resource use.

The research found that overall, the pastoral farming landscape is becoming more dynamic and sophisticated. Given this development, current measures of intensification seem too simplistic to capture the essence of how pastoral farm management practices have changed.

An interesting feature of this dynamism is the land-use change underway, and particularly the dairy support activity occurring on properties not classed as dairy farms. Sheep-beef properties have been supporting increasing numbers of dairy cows (for example, for winter grazing or rearing replacement heifers). Extreme weather events during this period and possible expansion of dairying on better quality land may also have had particular impacts that warrant further investigation.

In general, productivity has been increasing: at the end of this period it took fewer animals and less labour to produce one kilogram of milk, beef or lamb. Dairying has also increased production per hectare.

On the input side, fertiliser application per hectare and per unit of production fell significantly between 2002 and 2009. The only exception was nitrogen use on dairy farms, where there was a slight increase. At the same time, farmers have increasingly adopted more advanced management of effluent and also used more bought-in feed, which introduces added nutrients to the farm system.

The labour used per hectare and per unit of production decreased significantly between 2002 and 2009 on all types of pastoral farms, suggesting efficiency gains in farm management (such as increasing use of automation in dairy sheds).

At the same time, the amount of debt farmers have taken on has climbed dramatically. During this period, total debt per hectare increased for both dairy and sheep-beef farms; and total debt per kilogram of output increased by similar margins. Overall, the approximate debt ratio is much higher for the dairy farms than in the sheep-beef farms, but the sheep-beef sector's estimated debt ratio appears to be growing faster. The reasons behind this need further investigation.

The remaining question from this investigation is how we can best monitor and understand the trends and progress of these sectors in the future.

INTRODUCTION

Different farm management practices tend to come with certain assumptions about their economic, environmental and social consequences and about the relationship between intensification and productivity. The Ministry for Primary Industries' (MPI) aim in this investigation is to analyse available statistical data about the inputs used for pastoral farming in order to test some of these common assumptions.

SCOPE AND LIMITATIONS OF THIS REPORT

This report examines dairy and sheep-beef farming in New Zealand between 2002 and 2009, including the amount of land used for these activities; animal numbers; three specific inputs (fertiliser, labour and capital (debt)); and output of milk or lamb/beef. It considers trends of how input use and production have changed on dairy and sheep-beef farms and comments on the implications of these findings for productivity and intensification.

In general, the data relating to the area of interest were limited. The year ending at 30 June 2002 was the earliest year in which consistent data were available for the above variables (2003 in the case of debt) and at the time the data analysis was begun, 2009 was the last available year.

A number of data sets are used in this work. The base data come from the Agricultural Production Survey (APS)[1], a periodic survey run by Statistics New Zealand to record and identify changes in the agricultural sector for planning and forecasting purposes. Additional data sets, for example data about fertiliser use, labour, and debt, were used to provide information not available from the APS. These data sets are described briefly as they arise in the text and in more detail in the accompanying appendix to this report.

Ideally, we had hoped to include energy and water in this study, to help round out the picture of what goes onto pastoral land and into the production of milk, beef and lamb. However, we found no robust data at the national level measuring water or energy use by farm class. It was therefore not possible to make substantive comment in this paper about the environmental performance trends of the pastoral sectors over this timeframe.

In general, the data sets we used were noisy, with many factors causing confusion, and the time series is relatively short (only eight years), which made interpretation a challenge. The data noise reflected the influence of a range of factors, some of which are statistical (for example, changing methods of collecting data over the specified time period) and some of which are external (for example, economic events or climatic events such as the nationwide drought in 2008).

We believe that we have mitigated against this noise as best as we can and explain generally in the text, and in more detail in the appendix, how we have interpreted the available data. We recognise, however, that despite our best efforts at interpretation, in some cases individual data points or year-to-year fluctuations still may not "look right." For this reason, the analysis in this paper focuses on linear trends of the data, rather than on data points themselves. We consider that these trends are broadly correct. In the text of the paper, changes indicated between 2002 and 2009 (percent or absolute changes) refer to the change between the start and end points of linear trends.

1 For a full technical description of Agricultural Production Survey and the detailed explanation of the data collected under the Survey, please navigate through the Statistics New Zealand website: http://www.stats.govt.nz/surveys_and_methods/completing-a-survey/faqs-about-our-surveys/agricultural-production-survey.aspx#about (accessed on 26 March 2012).

SETTING THE SCENE

Agriculture and forestry dominate not only New Zealand's economy, but also its landscape. More than half of New Zealand's 27 million hectares of land – about 15 million hectares – is used for agriculture and forestry, and, in turn, about half of this land (7–8 million hectares) is improved pasture. Between 2002 and 2009, the amount of land being used for agriculture and forestry in New Zealand dropped from 15.6 million hectares to 14.7 million hectares. Within this area, there has been continued interplay between different land uses.

Based on APS data about land use, the graphs below (Figure 1 and Figure 2) show that in 2002, sheep-beef was the dominant agricultural land use in New Zealand (69 percent), followed by forestry (14 percent) and dairy (12 percent). By 2009, dairy had overtaken forestry (15 percent and 12 percent, respectively), while sheep-beef declined slightly to 66 percent.

In addition to the changes in land area used for different pastoral systems and other agricultural uses from 2002 to 2009, we would like to understand how management of the pastoral land has changed over the same time period.

Figure 1: Agricultural and forestry land use (2002).

SOURCE: APS

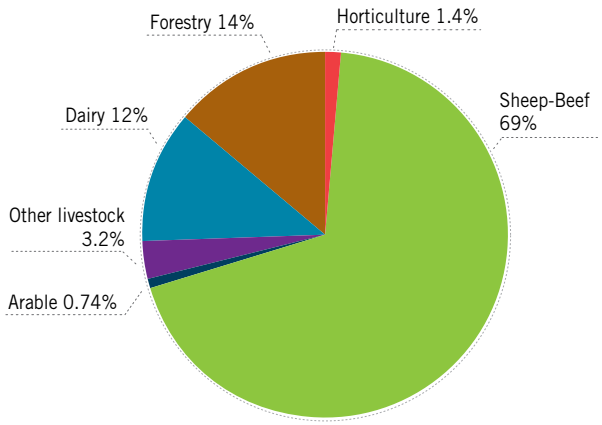
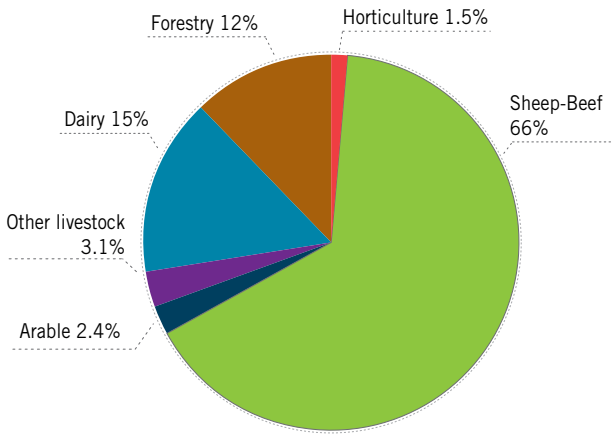


Figure 2: Agricultural and forestry land use (2009).

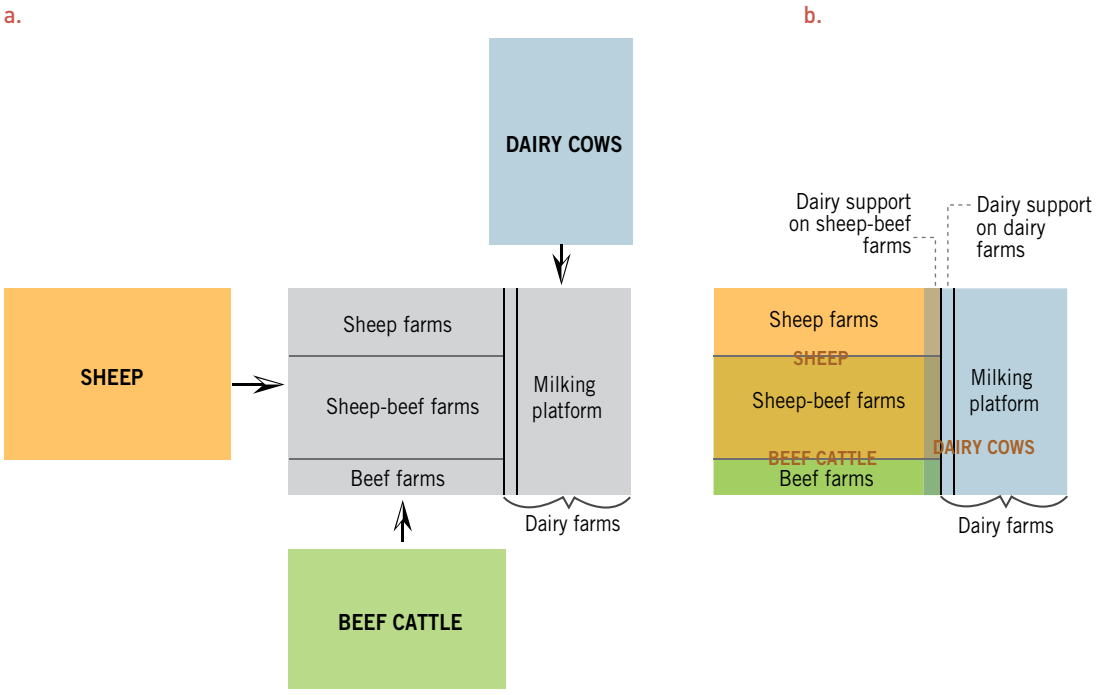
SOURCE: APS



1 PRODUCTION LANDSCAPE TRENDS

The first part of this paper considers trends in the land area used for dairy, sheep and beef activities; numbers of animals; and output (milk solids or meat) produced. However, although the APS classifies pastoral farms according to the farming activity that generates the majority of their revenue, many pastoral farms are used for multiple farming activities. For instance, some dairy support activity in particular occurs on properties not classed as dairy farms. The figure below (Figure 3) is an illustrative example showing the difference between farm classification (for example, a dairy farm or a sheep farm) and where animals are actually living and grazing.

Figure 3: Farm classification and location of animals.



a. Different farm classes (sheep farms, sheep-beef farms, beef farms and dairy farms) are shown in grey, while populations of animals (dairy cows, sheep and beef cattle) are shown as coloured boxes. **b.** Overlay of animal populations onto farm classes, showing in particular that dairy cows are not limited to dairy farms. Some dairy support activity, for example, occurs on land classified as sheep or beef farms.

MPI has calculated the land areas that we estimate have actually been used for dairy, sheep and beef activities, regardless of farm class. For example, the estimated area used for dairying activity includes not only the milking platform but also "dairy support," including run-offs and ungrazeable land on dairy farms as well as a portion of some beef/sheep properties used for activities such as winter grazing of dairy cows, rearing replacement dairy heifers and growing silage crops. The areas calculated by MPI are referred to in this paper as "estimated hectares" and are used in this section to provide what we believe are more realistic figures of animals per hectare and output per hectare.

PASTURE

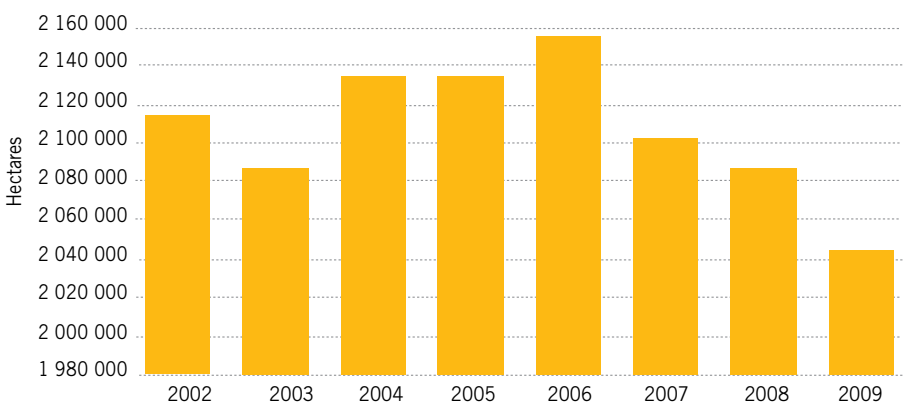
Between 2002 and 2009, the estimated area of grassland used for dairy farming activity increased by about 6 percent (approximately +120 000 hectares) (Figure 4), while grassland used for sheep-beef farming activity decreased by about 6 percent (approximately –240 000 hectares) (Figure 5) and 2 percent (approximately –45 000 hectares) (Figure 6) respectively.

Figure 4: Estimated pasture area (dairy). **SOURCE: MPI ESTIMATE (SEE APPENDIX)**

This is one data set where noise appears to be a particular problem. It is hard to explain the apparent dip in this graph suggesting the loss of hundreds of thousands of hectares of dairy pasture area from 2002–2005 and their recovery from 2005–2009. This is likely to reflect, in part, changes in how the data were collected between 2002 and 2009 (explained in more detail in the appendix). However, we believe the upward trend for this graph is broadly correct.

Figure 5: Estimated pasture area (sheep). **SOURCE: MPI ESTIMATE (SEE APPENDIX)**

Figure 6: Estimated pasture area (beef). **SOURCE: MPI ESTIMATE (SEE APPENDIX)**



LIVESTOCK

Between 2002 and 2009, the number of total dairy cows increased by about 13 percent. Of these, the number of milking cows has gone up by about 16 percent (Figure 7). By contrast, the number of total sheep has gone down by about 16 percent (Figure 8), and beef cattle numbers dropped by 9 percent (Figure 9), during this period.

Figure 7: Total dairy cattle and milking cows. **SOURCE: APS**

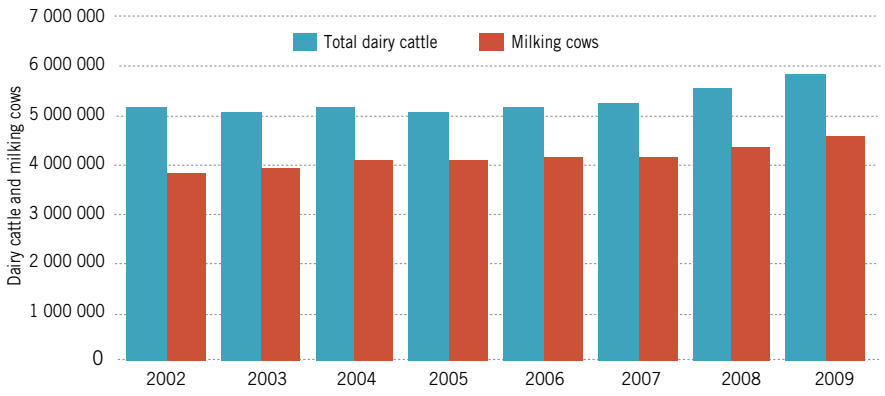
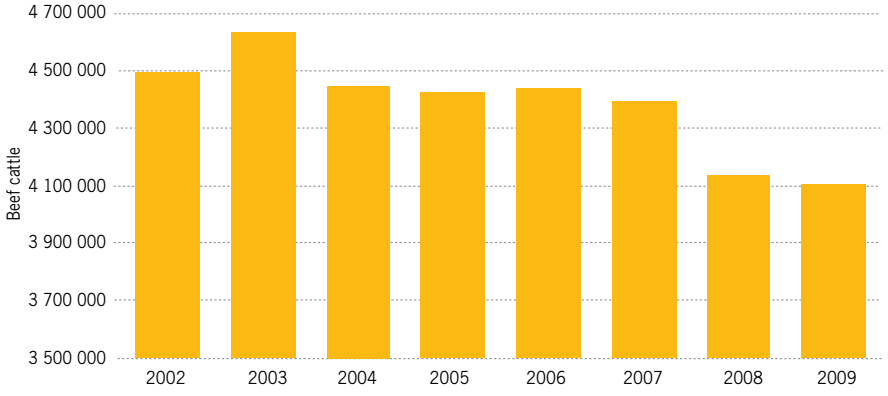


Figure 8: Total number of sheep. **SOURCE: APS**

Figure 9: Total number of beef cattle. **SOURCE: APS**



ANIMALS PER HECTARE

Overall, given the total numbers of dairy cows and total estimated hectares used for dairy activities, dairy cows per hectare increased by about five percent from 2002 to 2009 (Figure 10). During the same period, sheep per hectare decreased by about 11 percent (Figure 11), while beef cattle per hectare decreased by eight percent (Figure 12).

Figure 10: Total dairy cows per hectare. **SOURCES: ANIMALS – APS, LAND – MPI ESTIMATE (SEE APPENDIX)**

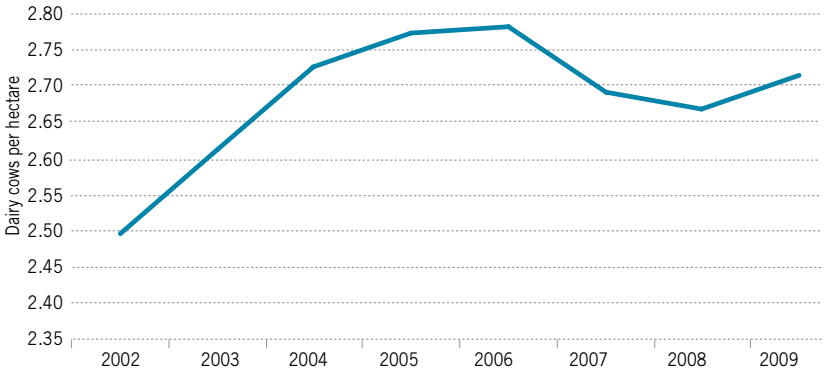


Figure 11: Sheep per hectare. **SOURCES: ANIMALS – APS, LAND – MPI ESTIMATE (SEE APPENDIX)**

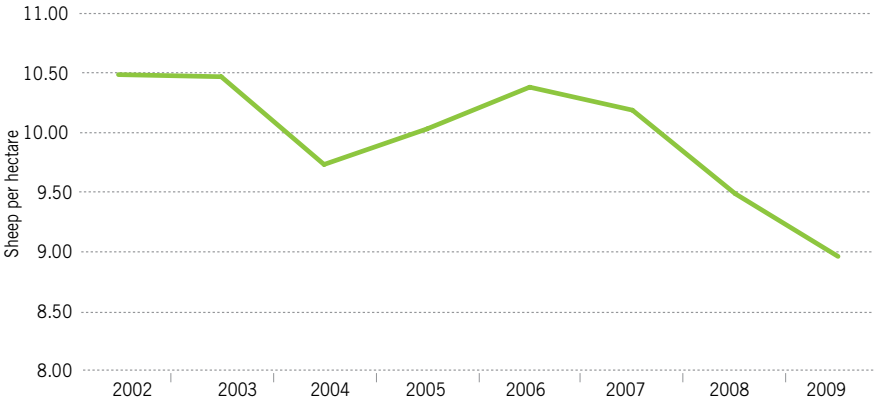
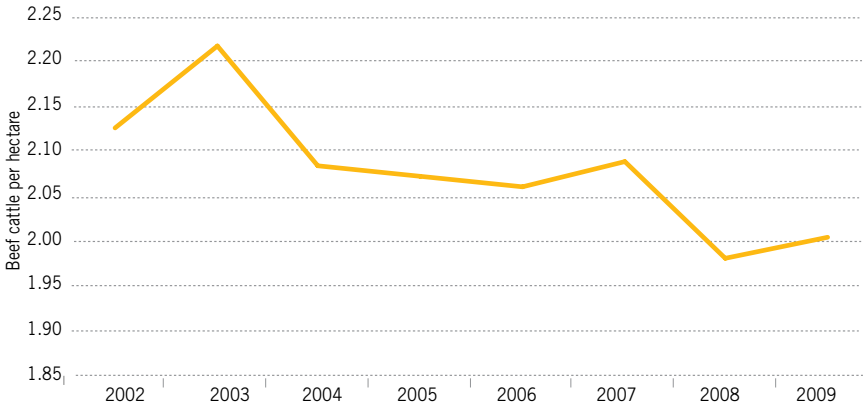


Figure 12: Beef cattle per hectare. **SOURCES: ANIMALS – APS, LAND – MPI ESTIMATE (SEE APPENDIX)**



MILK AND MEAT PRODUCTION

Annual production of milk solids has gone up by about 19 percent (Figure 13), while annual beef and lamb production each declined by about 7–8 percent between 2002 and 2009 (Figure 14).

Figure 13: Milk production. **SOURCE: LIC DAIRY STATISTICS**

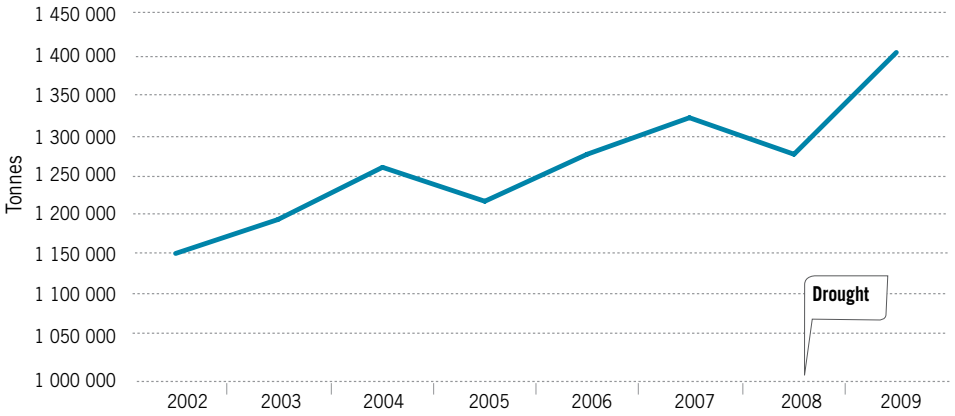
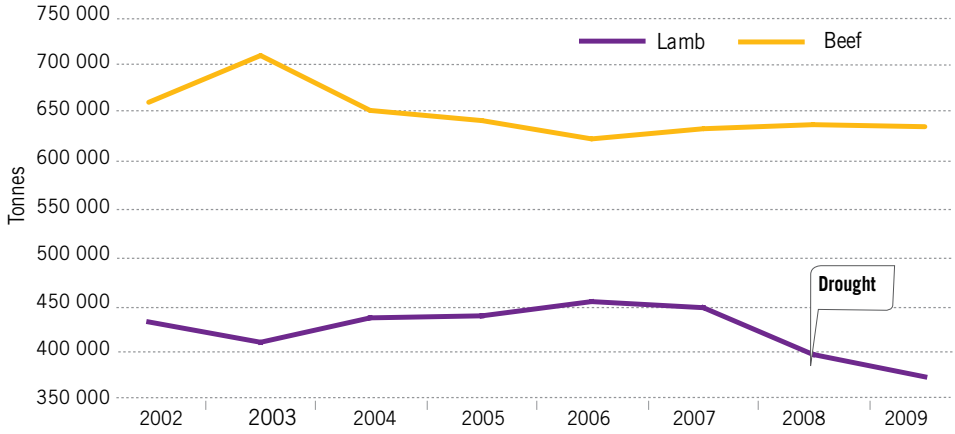


Figure 14: Meat production. **SOURCE: MPI LIVESTOCK SLAUGHTER DATA**



PRODUCTION PER HECTARE

Between 2002 and 2009 the average milk solids produced per hectare of total estimated land used for dairying increased by about 9 percent (Figure 15). On the other hand, average beef and lamb production per hectare went down by about 5 percent and 2 percent respectively (Figure 16 and 17).

Figure 15: Kilograms of milk solids produced per hectare. **SOURCES: PRODUCTION – LIC DAIRY STATISTICS, LAND – MPI ESTIMATE (SEE APPENDIX)**

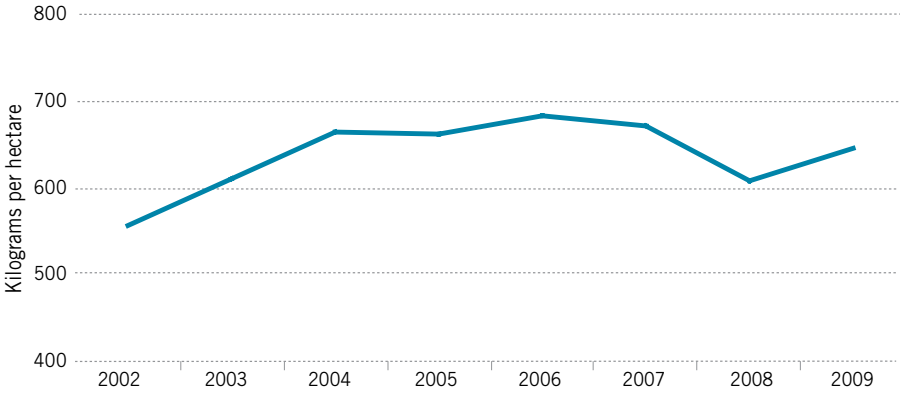


Figure 16: Kilograms of beef produced per hectare. **SOURCES: PRODUCTION – MPI LIVESTOCK SLAUGHTER DATA, LAND – MPI ESTIMATE (SEE APPENDIX)**

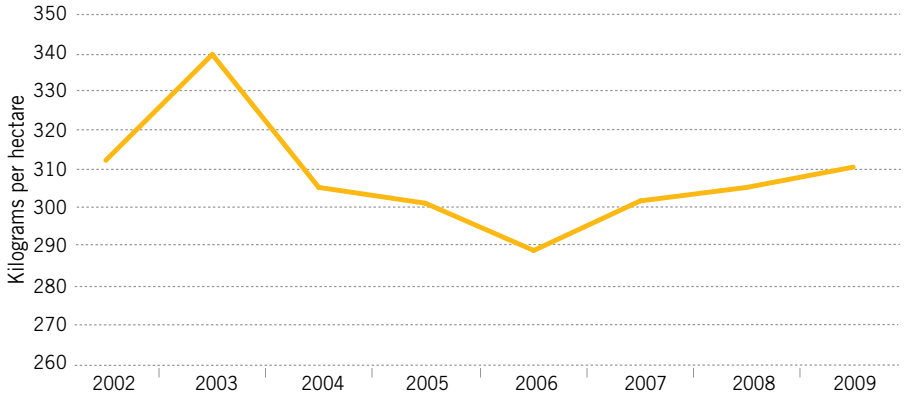
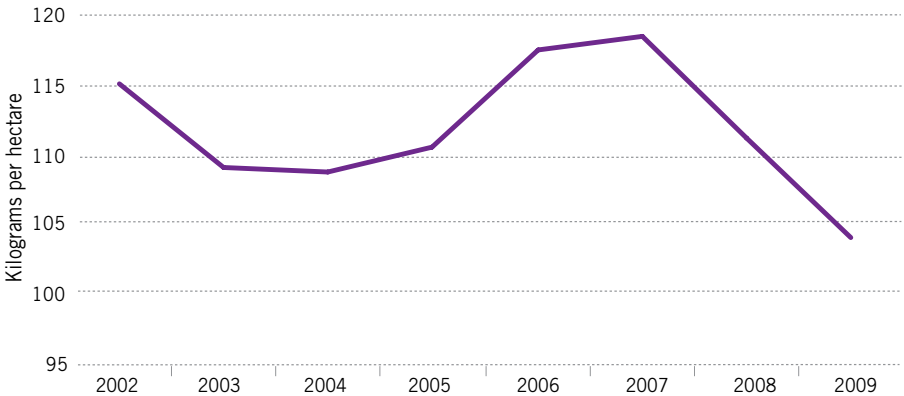


Figure 17: Kilograms of lamb produced per hectare. **SOURCES: PRODUCTION – MPI LIVESTOCK SLAUGHTER DATA, LAND – MPI ESTIMATE (SEE APPENDIX)**



SUMMARY OF PRODUCTION LANDSCAPE TRENDS

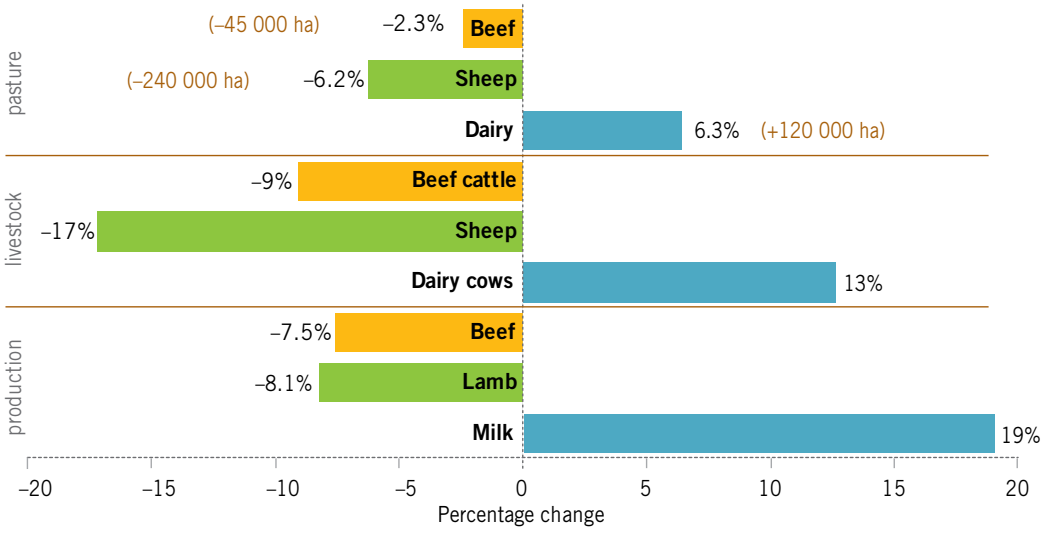
Overall, the total area of improved pasture dropped by about 160 000 hectare between 2002 and 2009. It is likely that this reflects a mixture of urban and peri-urban development, as well as land going into forestry, conservation and horticulture and arable farming. The precise distribution of these – or the contribution of general survey noise – cannot be determined from available data. At the same time there has been a shift to dairying, with land losses from sheep farming of approximately 240 000 hectares and beef farming of approximately 45 000 hectares partially offset by land gains to dairying of approximately 120 000 hectares over this period.

Sheep and beef farming reduced the number of animals per hectare from 2002–2009, and production per hectare has also reduced slightly over this period. However, because animal numbers have dropped faster than production, production per animal has effectively increased.

In dairy farming, by contrast, animals per hectare have gone up by two percent over 2002–2009. Dairying has also increased production per hectare and production per animal.

The decline in sheep-beef farming in terms of land area, animal numbers and production per hectare may reflect the particular impact of extreme weather events on these sectors through the period being investigated. It is also likely that the expansion of dairy and dairy support has occurred on better quality, typically flatter land, effectively pushing sheep-beef farming onto harder land on which achieving higher production is more challenging (and which may, in turn, be more vulnerable to drought or floods). Resolving these questions requires more data.

Figure 18: Summary of pastoral production trends.



2 INPUT TRENDS

The second part of this paper considers trends over 2002–2009 about the use of key inputs in terms of changes in use per hectare and levels of outputs produced. We have focused on application of nitrogen (N), phosphate (P) and potassium (K) fertilisers, labour, and capital.

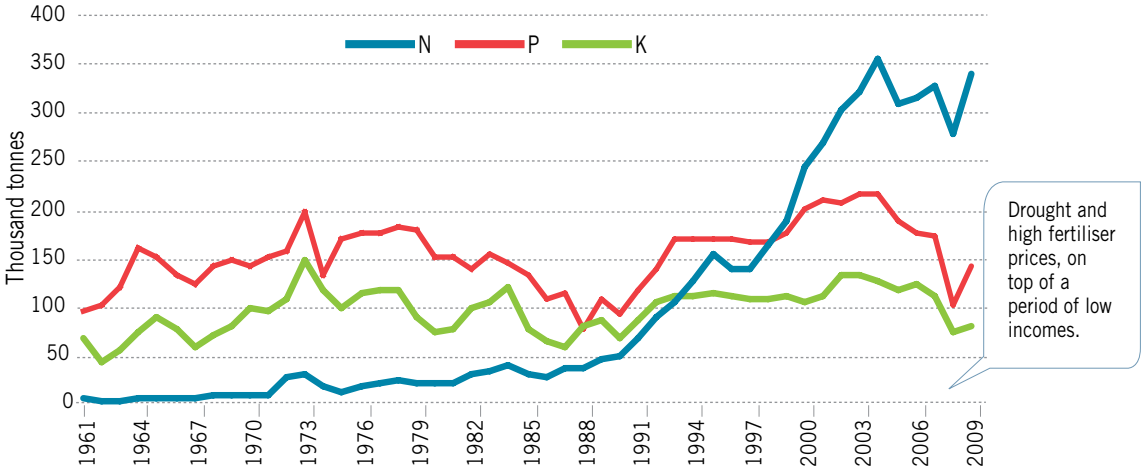
These inputs are likely to be farm-specific: even if a dairy farmer is grazing his cows on someone else's property, that farmer will apply his fertiliser, labour and capital only to his own farm. Therefore, per-hectare calculations in this part of the paper use the APS land area data based on farm classification of whole properties.

FERTILISER

Fertiliser is a critical input for the production of feed. In New Zealand, this has traditionally consisted of ryegrass and clover pastures, but farmers are increasing the diversity of their pasture species and the use of alternative feed sources such as forage crops, maize silage and palm kernel expeller meal (PKE).

Over the past 50 years, use of fertiliser has increased, particularly the application of nitrogen between 1990 and 2004 (Figure 19).

Figure 19: N-P-K consumption in New Zealand. SOURCE: FERT RESEARCH



In almost all cases, fertiliser use per hectare fell between 2002 and 2009. For sheep and beef farms, average per-hectare use of all three fertilisers dropped by between 37–47 percent over this time period (Figure 21). Dairy farms used, on average, 27 percent less phosphate and 38 percent less potassium per hectare (Figure 20). The only exception to this trend has been nitrogen use on dairy farms, where there was a slight increase of about one percent per hectare from 2002 to 2009.

Figure 20: Dairy farms' use of N-P-K. **SOURCES: FERTILISER – APS AND FERT RESEARCH, LAND – APS**

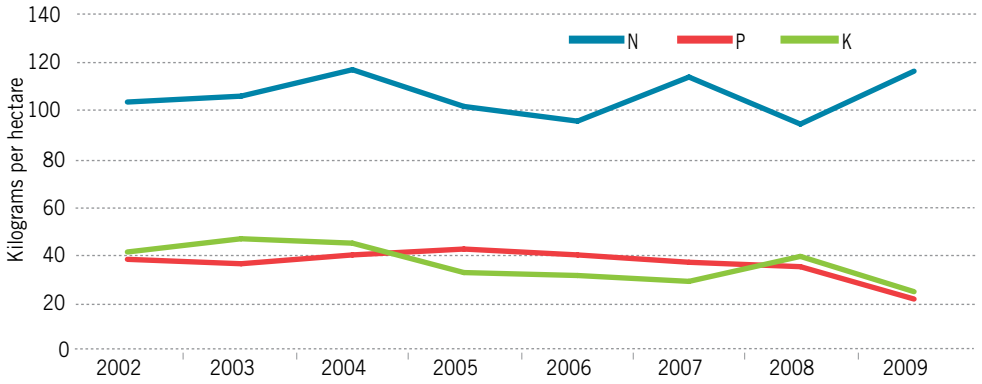
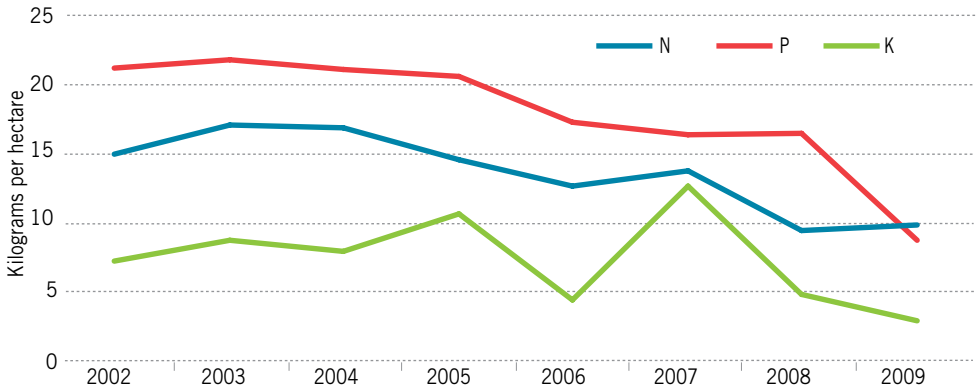
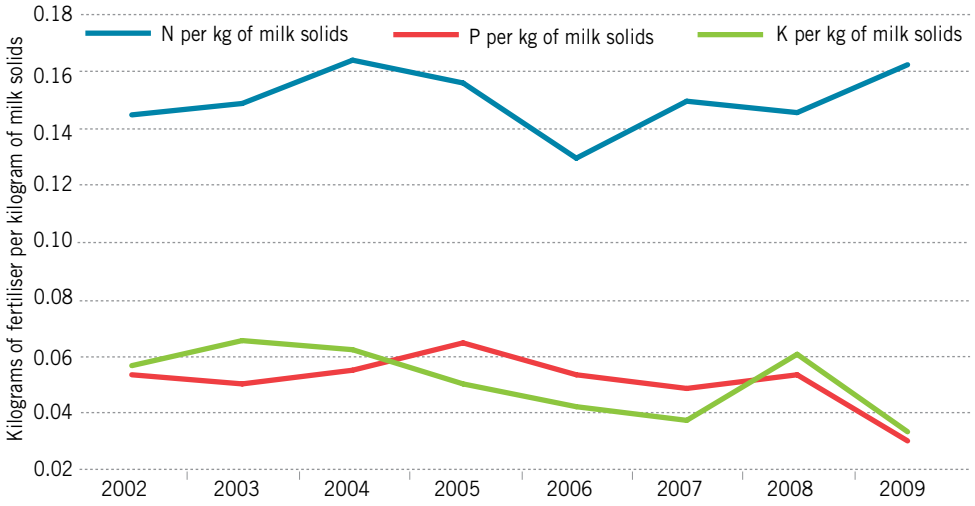


Figure 21: Sheep-beef farms' use of N-P-K. **SOURCES: FERTILISER – APS AND FERT RESEARCH, LAND – APS**



This is also reflected in the average amount of fertiliser applied per kilogram of output produced by these farm types. From 2002 to 2009, the average kilogram of milk solids has been produced with about two percent more nitrogrn but 25 percent less phosphorus and 36 percent less potassium (Figure 22).

Figure 22: Kilograms of N-P-K used per kilogram of milk solids produced. **SOURCES: FERTILISERS – APS AND FERT RESEARCH, PRODUCTION – LIC DAIRY STATISTICS**



The trends for lamb and beef are broadly similar to each other, with an average kilogram of lamb and beef having been produced in 2009 with 43–44 percent less nitrogen, 48–50 percent less phosphorus and 39–42 percent less potassium than in 2002 (Figures 23 and 24).

Figure 23: Kilograms of N-P-K used per kilogram of lamb produced. **SOURCES: FERTILISERS – APS AND FERT RESEARCH, PRODUCTION – MPI LIVESTOCK SLAUGHTER DATA**

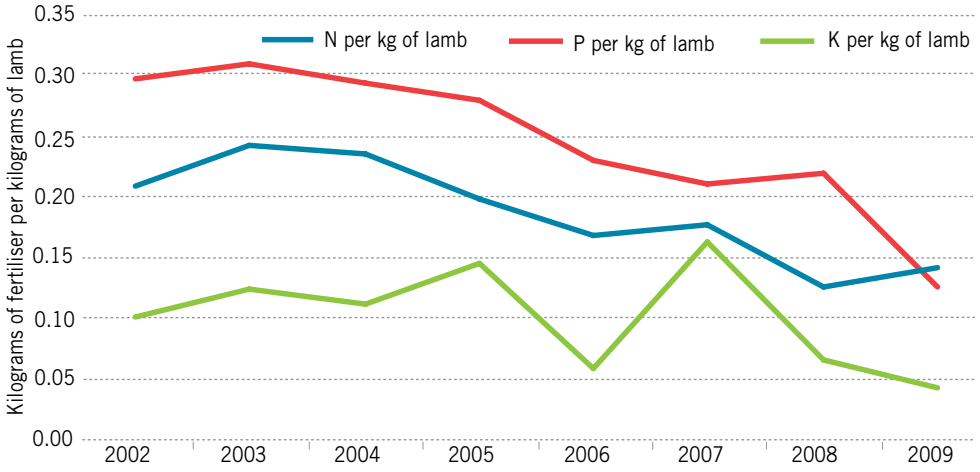
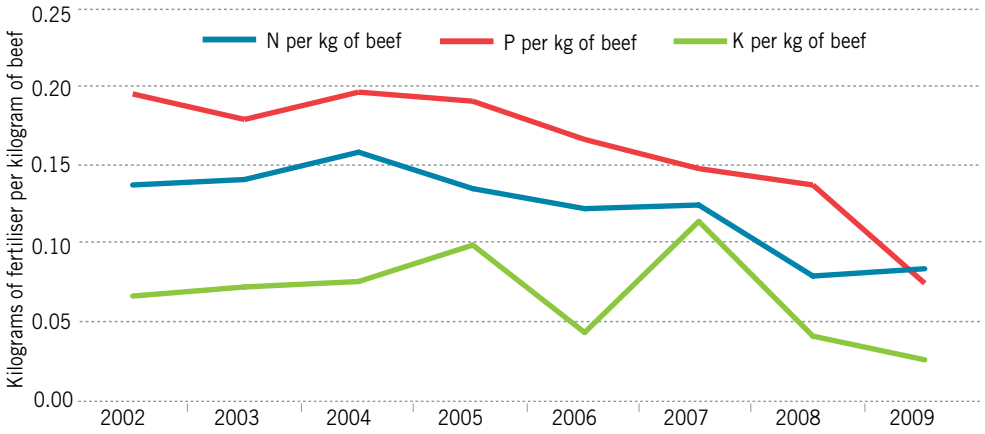


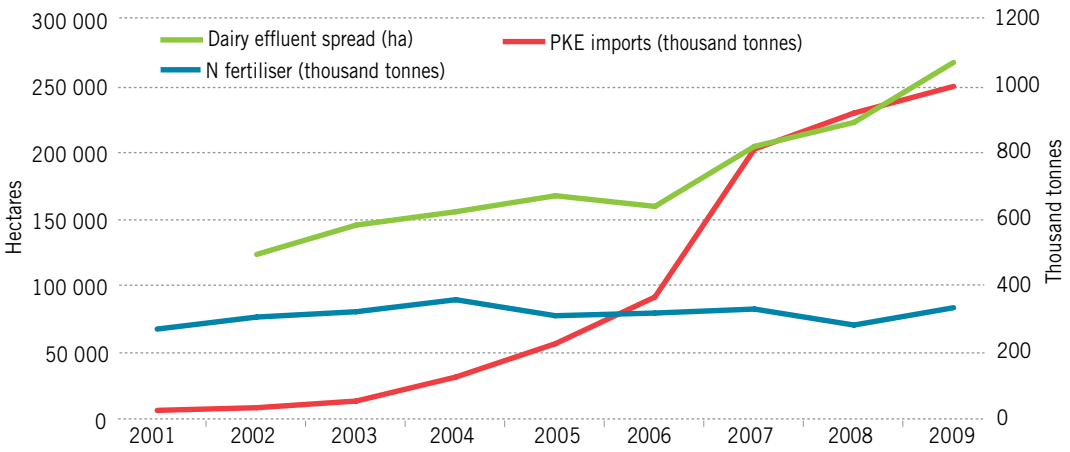
Figure 24: Kilograms of N-P-K used per kilogram of beef produced. **SOURCES: FERTILISERS – APS AND FERT RESEARCH, PRODUCTION – MPI LIVESTOCK SLAUGHTER DATA**



There are a number of reasons why fertiliser input trends may have arisen. One factor is likely to be changing economic conditions over 2002–2009, as levels of fertiliser use over time may partially reflect the tendency of farmers to treat fertiliser as a discretionary item to be applied only when finances allow. According to a recent sector update from Fert Research, there has been a noticeable upswing in the application of all three fertilisers since 2009 as farm returns have improved.[2]

Overall, however, the increasing diversity of feed sources and supplements is adding complexity to how nutrients are introduced to farm systems. Furthermore, increasing use of effluent spreading as an effluent management tool also re-introduces some nutrients onto pastures. The graph below (Figure 25) provides an example of the increasing use of some of these practices on dairy farms.

Figure 25: Nitrogen inputs on dairy farms. **SOURCES: PKE – WORLD TRADE ATLAS STATISTICS NZ, FERTILISER – FERT RESEARCH, EFFLUENT – APS**



The decline in application of phosphate and potassium fertilisers on dairy and sheep/beef properties may be concerning from a longer term perspective, as phosphate and potassium persist in the soil, and there is a lag between when they are applied (or when they stop being applied) and when effects on soil fertility become evident. However, effluent spreading is a source of nitrogen, phosphorus and potassium and other nutrients so may be at least partially substituting for the application of artificial fertilisers. It is also possible that the increasing uptake of nutrient budgeting technologies such as Overseer™, particularly in the dairy industry, may simply reflect increasing use of best practice and efficient and targeted application.

2 Fert Research, Annual Update: 2010, accessed at http://www.fertresearch.org.nz/resource-centre/annual-updates (accessed on 26 March 2012).

LABOUR

Labour is another key farm input. To investigate trends in the deployment of labour on-farm, we used the Linked Employer and Employee data (LEED) longitudinal dataset developed by Statistics New Zealand[3]. LEED collects employee data by farm businesses and class and is a reasonable measure of the total labour used on-farm, including the dairy farmer/owner and employees.

Between 2002 and 2009, the labour used per hectare decreased significantly on all types of pastoral farms. During this period dairy farms used 25 percent less labour and sheep-beef farms used 10 percent less (Figures 26 and 27).

Figure 26: Labour per hectare (dairy). **SOURCES: LABOUR – LEED, LAND – APS**

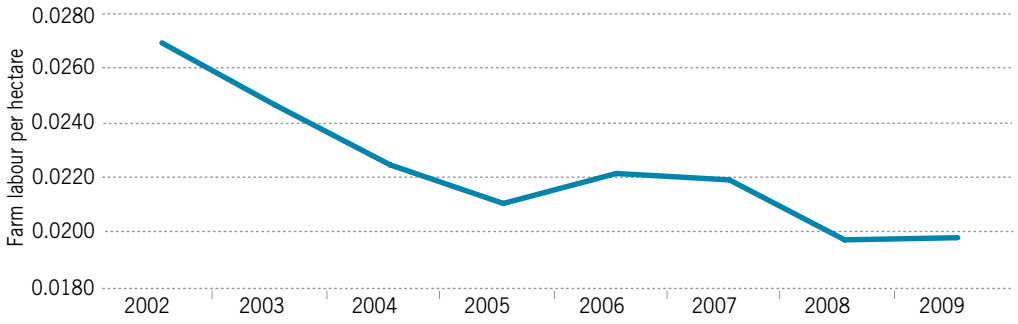
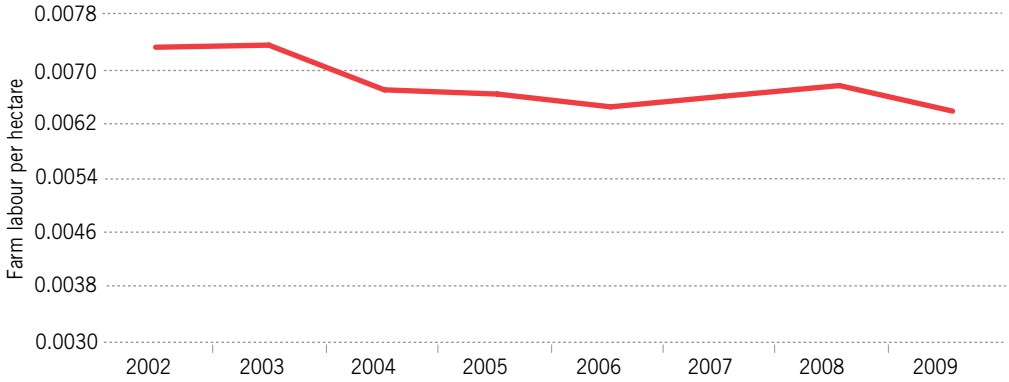


Figure 27: Labour per hectare (sheep-beef). **SOURCES: LABOUR – LEED, LAND – APS**



3 More information on LEED and technical details can be found at: http://www.stats.govt.nz/browse_for_stats/income-and-work/employment_and_unemployment/leed.aspx (accessed on 26 March 2012).

Between 2002–2009, the labour required to produce one kilogram of milk solids and one kilogram of meat has decreased by 18 percent and 16 percent respectively (Figures 28 and 29).

Figure 28: Labour per kilogram of milk solids. **SOURCES: LABOUR – LEED, MILK SOLIDS – LIC DAIRY STATISTICS**

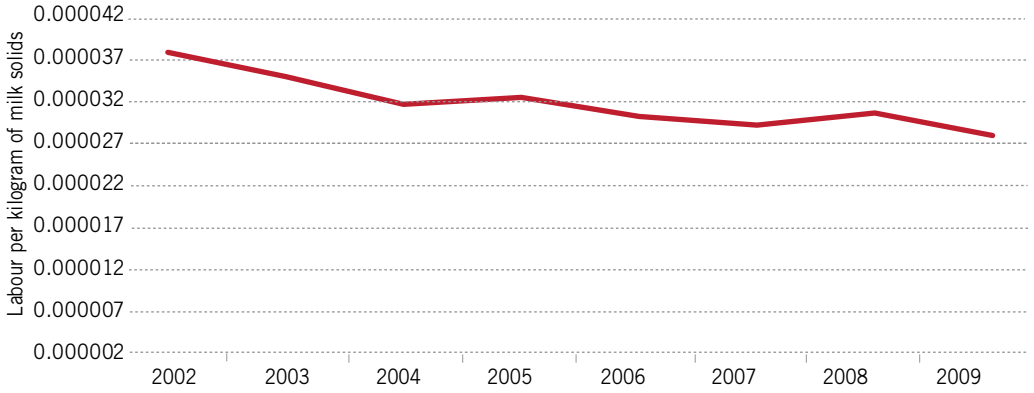
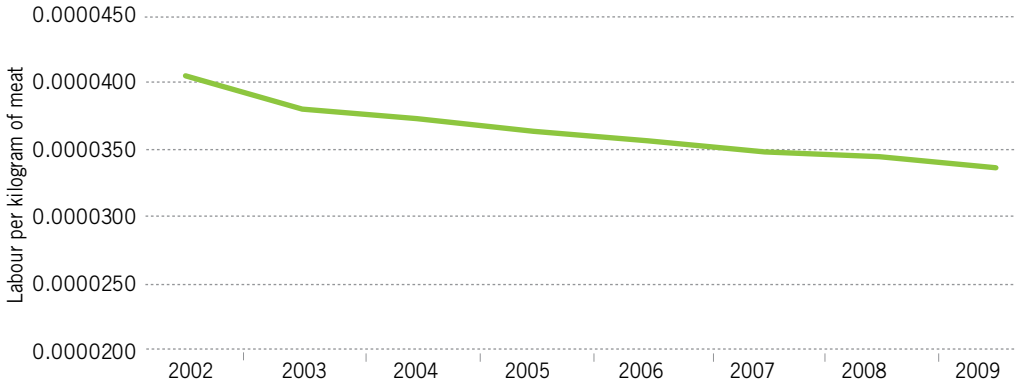


Figure 29: Labour per kilogram of beef and lamb. **SOURCES: LABOUR – LEED, MEAT (BEEF + LAMB) – MPI LIVESTOCK SLAUGHTER DATA**



The labour trends across the dairy and sheep-beef sectors suggest that each individual working on a farm is responsible, on average, for more land – and that the land they are managing produces more output. This suggests efficiency gains in farm management and production. In the case of dairy farms, this is likely to have been driven particularly by automation, for example, in the milking shed.

CAPITAL

The base data used for analysis of farm capital comes from Reserve Bank of New Zealand (RBNZ)'s Annual Agriculture Credit Series, a long-run series of loans outstanding to the agriculture sector beginning in December 1980 and with measured annual intervals[4].

Between 2003 and 2009, total debt per hectare increased 139 percent for dairy (Figure 30) and 143 percent for sheep and beef per hectare (Figure 31); while total debt per kilogram of output increased 143 percent for dairy (Figure 32) and 132 percent sheep-beef (Figure 33) between 2003 and 2009.

Figure 30: Debt per hectare (dairy). **SOURCES: DEBT – RBNZ, LAND – APS**

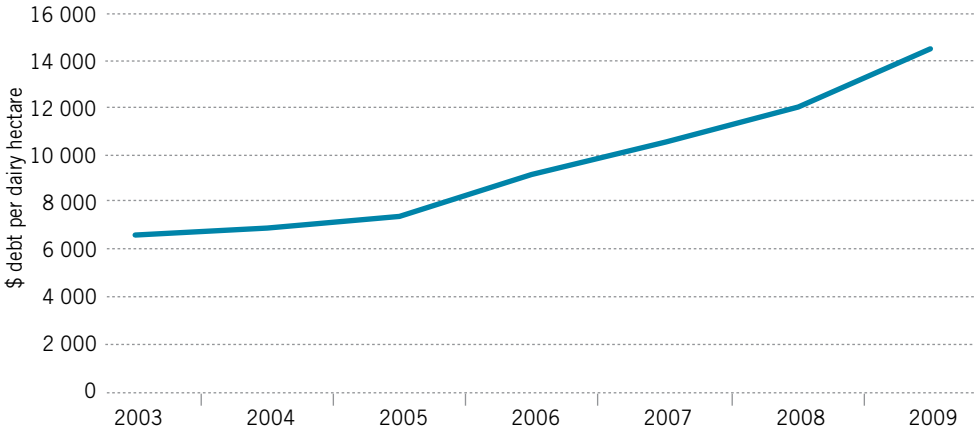
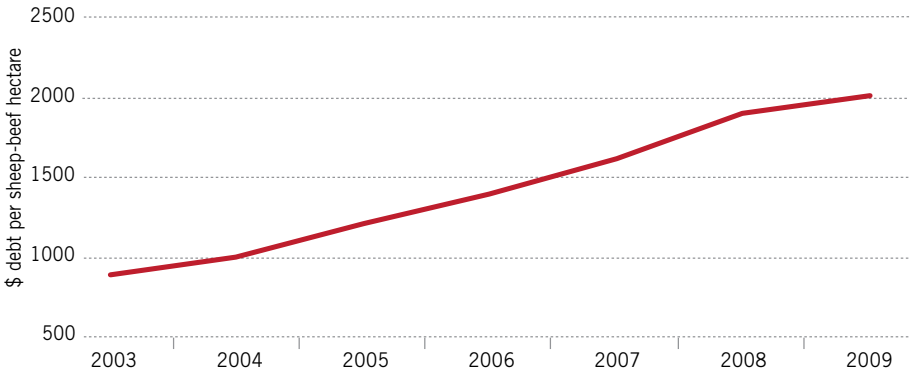


Figure 31: Debt per hectare (sheep-beef). **SOURCES: DEBT – RBNZ, LAND – APS**



4 A detailed description of the series can be found in the *Reserve Bank Bulletin* June 2002 pages 38-50 which can be accessed on RBNZ website: http://www.rbnz.govt.nz/research/bulletin/2002_2006/jun2002.html (accessed on 26 March 2012). Note that while the overall data series goes back to 1980, the way the data were collected meant that we could only use data from 2003 onwards in this study.

Figure 32: Debt per kilogram of milk solids. **SOURCES: DEBT – RBNZ, MILK SOLIDS – LIC DAIRY STATISTICS**

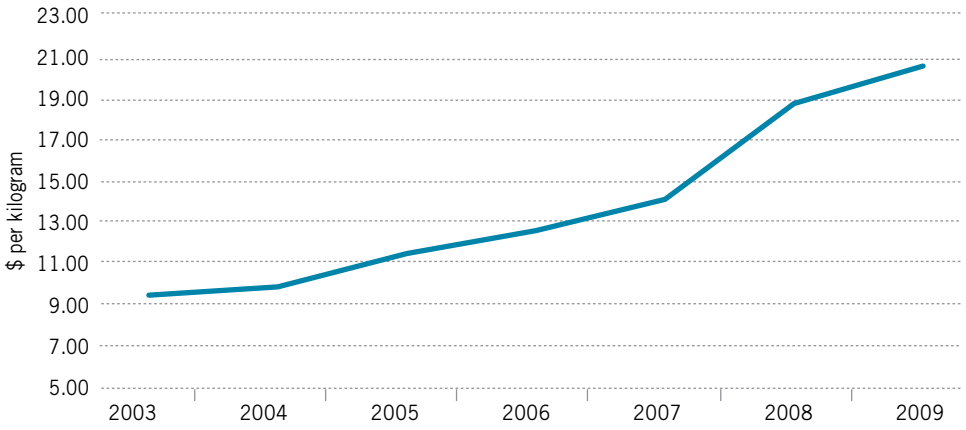
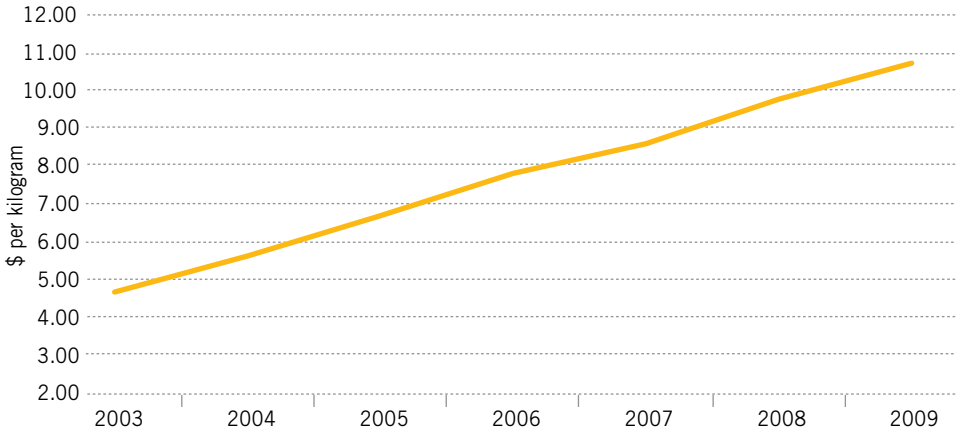


Figure 33: Debt per kilogram of beef and lamb. **SOURCES: DEBT – RBNZ, MEAT (BEEF+LAMB) – MPI LIVESTOCK SLAUGHTER DATA**



The graphs below (Figures 34 and 35) show a comparison between estimated total farm assets and total debt (borrowing) in 2003 and 2009[5] for the dairy and sheep-beef industries. Overall, the approximate debt ratio is much higher in the dairy industry (0.30 and 0.41 in 2003 and 2009) than in the sheep and beef industry (0.09 and 0.16 in 2003 and 2009). However, the sheep-beef industry's estimated debt ratio appears to be growing faster than that in the dairy industry.

Figure 34: Estimated total dairy assets and total dairy debt. **SOURCES: ASSETS – ESTIMATED FROM DAIRYNZ ECONOMIC SURVEY, DEBT – RBNZ**

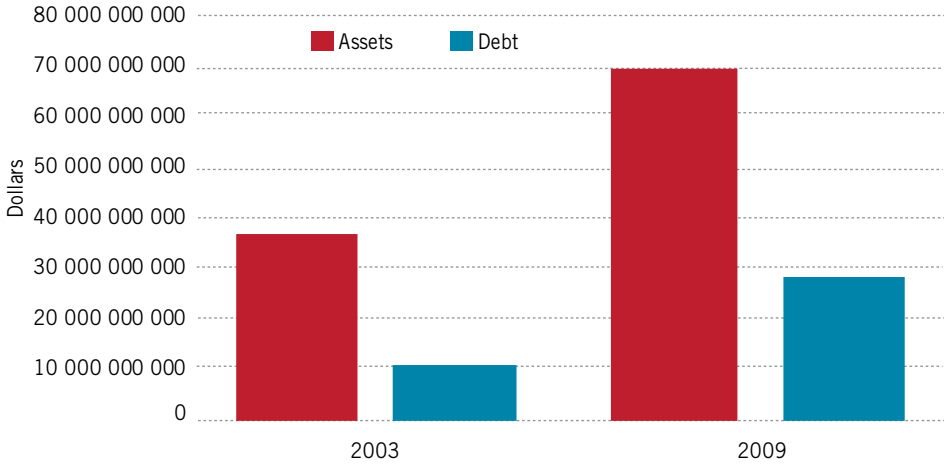


Figure 35: Estimated total sheep-beef assets and total sheep-beef debt. **SOURCES: ASSETS – ESTIMATED FROM BEEF+LAMB NEW ZEALAND ECONOMIC SERVICE, DEBT – RBNZ**

5 There were no available data for a robust analysis of total farm assets. However, it was possible to estimate total farm assets using data from DairyNZ and the Beef and Lamb New Zealand Economic Service, which were sufficient to illustrate the approximate magnitude of the debt ratios. More detail is in the appendix.

3 ANALYSIS

IMPLICATIONS FOR LAND INTENSIFICATION AND PRODUCTIVITY

The graphs below (Figures 36 and 37) summarise the above data, showing the change in inputs per hectare on dairy farms and on sheep-beef farms between 2002 and 2009. Debt, labour and fertiliser use APS land areas, while animals and output use MPI's estimated land areas. Note also that debt figures are for 2003–2009.

Figure 36: Summary – Changes in inputs and outputs on dairy land.

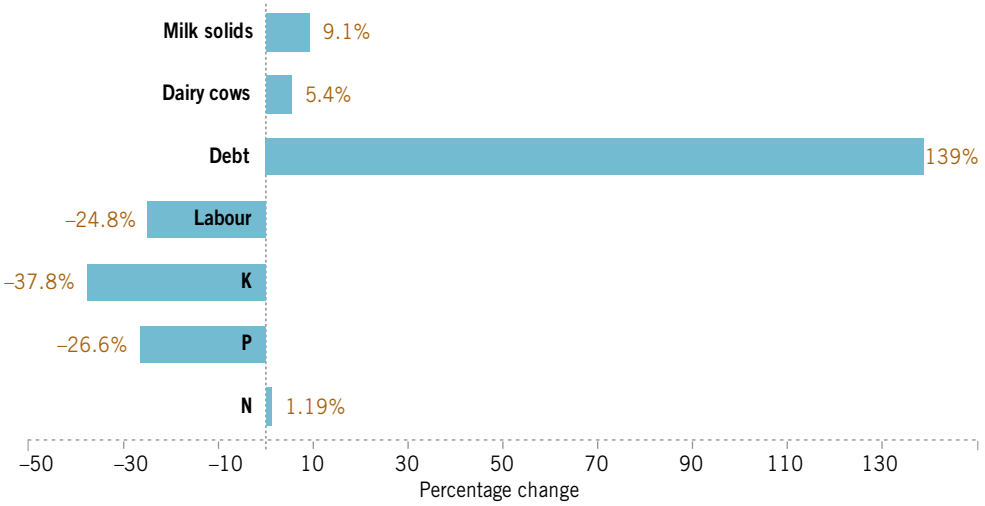
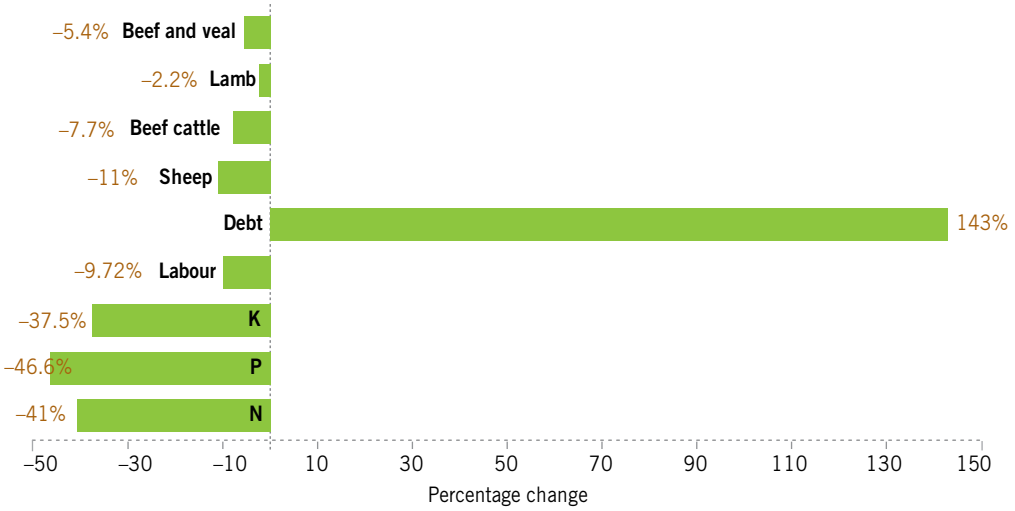


Figure 37: Summary – Changes in inputs and outputs on sheep-beef land.



Has the use of pastoral land intensified between 2002 and 2009?

Is New Zealand's pastoral farming "intensifying?" This is a key parameter for considering farmers' performance as managers of their resources.

The answer depends on how intensification is defined. In common use, intensification of farming is taken to refer to increasing animal numbers per hectare, usually coupled with increasing output per hectare. In practice however, these measures seem too simplistic to capture the essence of how pastoral farm management practices have changed.

The management of pastoral farms has become much more sophisticated, with increasing use of practices such as use of PKE and silage crops, winter grazing, feed pads, and effluent management. The success of these practices, in turn, contributes to increasing intensity particularly on the milking platform. Unfortunately, however, we were unable to find data that would allow us to examine in more detail how the composition of dairy cows' diets is changing (for example, what percentage of their diets comes from pasture, silage, and other types of supplements).

While the APS collects data about the total area of dairy farms and total cow numbers, the Livestock Improvement Corporation (LIC) collects data specifically about the milking platform. Instead of counting total dairy cows, the LIC counts only lactating dairy cows. Likewise, rather than collecting the total area of dairy farms, the LIC measures only the milking platform (the land area where milk production occurs).

The total estimated area used for dairying (including support) increased by approximately 6 percent from 2002 to 2009 (Figure 38), with total dairy cows per hectare increasing by 2 percent. The milking platform increased by only 4 percent between 2002 and 2009, and yet the lactating cows per hectare of the milking platform went up by about 8 percent over that time (Figure 39). Furthermore, while milk solids per total estimated dairy area increased by approximately 9 percent from 2002 to 2009, milk solids per hectare of milking platform increased by 12 percent (Figure 40).

Figure 38: Total estimated dairy land and milking platform area. **SOURCES: TOTAL ESTIMATED DAIRY LAND – MPI ESTIMATE (SEE APPENDIX), MILKING PLATFORM AREA – LIC DAIRY STATISTICS**

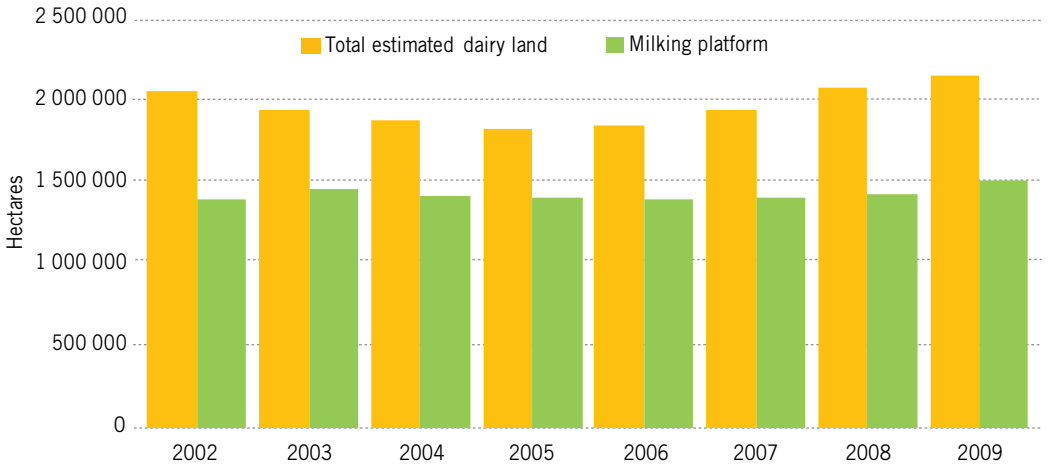


Figure 39: Cows per hectare. **SOURCES: DAIRY COWS (LIC) – LIC DAIRY STATISTICS, TOTAL DAIRY COWS – APS, MILKING PLATFORM AREA – LIC DAIRY STATISTICS, TOTAL ESTIMATED DAIRY AREA – MPI ESTIMATE (SEE APPENDIX)**

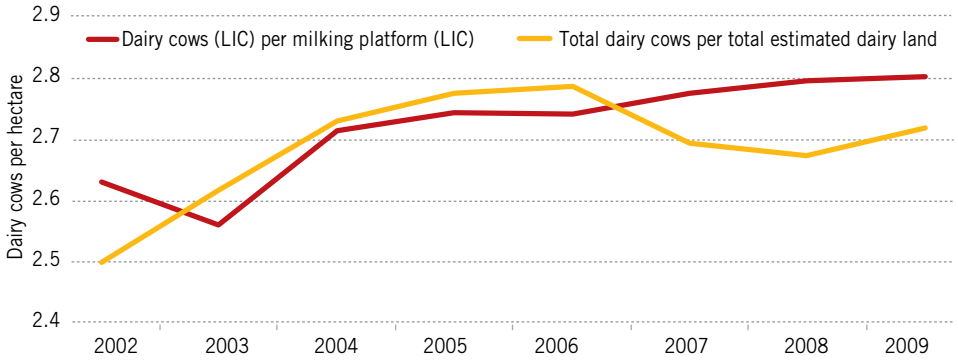
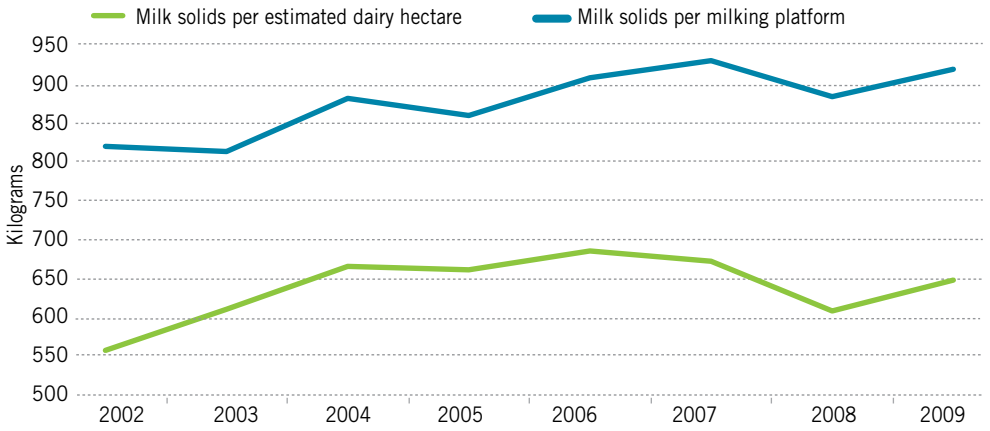


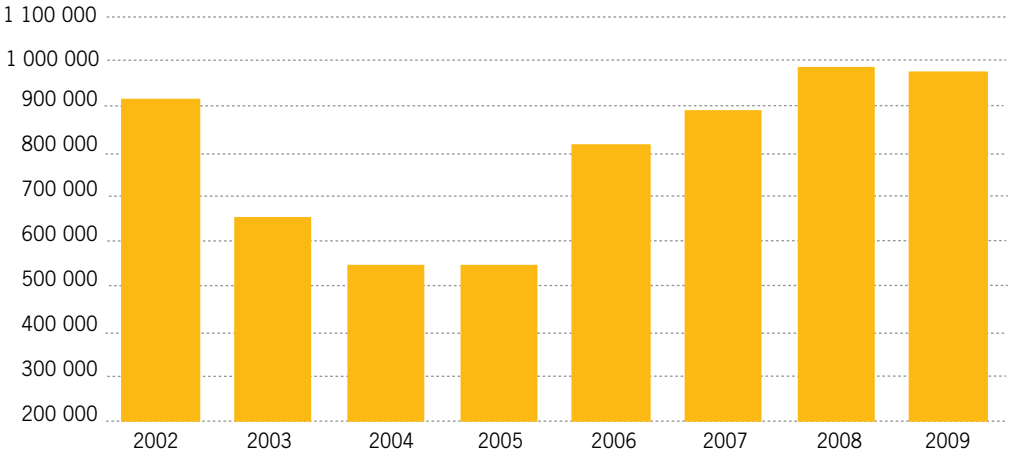
Figure 40: Milk solids per total estimated dairy area and per milking platform area. **SOURCES: MILK SOLIDS – LIC DAIRY STATISTICS, MILKING PLATFORM AREA – LIC DAIRY STATISTICS, TOTAL ESTIMATED DAIRY AREA – MPI ESTIMATE (SEE APPENDIX)**



Changing management practices on dairy farms are also having an impact on the management of sheep-beef properties, with development of dairy support activities. Although the data above indicate that the number of sheep and beef animals per hectare, labour use and fertiliser application per hectare have decreased from 2002 to 2009, sheep-beef properties have been supporting increasing numbers of dairy cows (for example, winter grazing or rearing replacement heifers), particularly from 2006.

The graph below (Figure 41) shows the increasing number of total dairy cows being run on farms classified as sheep-beef farms (including cows that belong to dairy farmers but have been brought in for grazing). Between 2002 and 2009, the number of total dairy cows being run on sheep-beef properties increased by 44 percent.

Figure 41: Total dairy cattle on sheep–beef farms. **SOURCE: APS**



In addition, some land on sheep-beef properties is used for growing silage crops used by the dairy industry. All of this together suggests an increasing sophistication of management of both dairy and sheep and beef farms.

Are the dairy, sheep and beef industries becoming more productive?

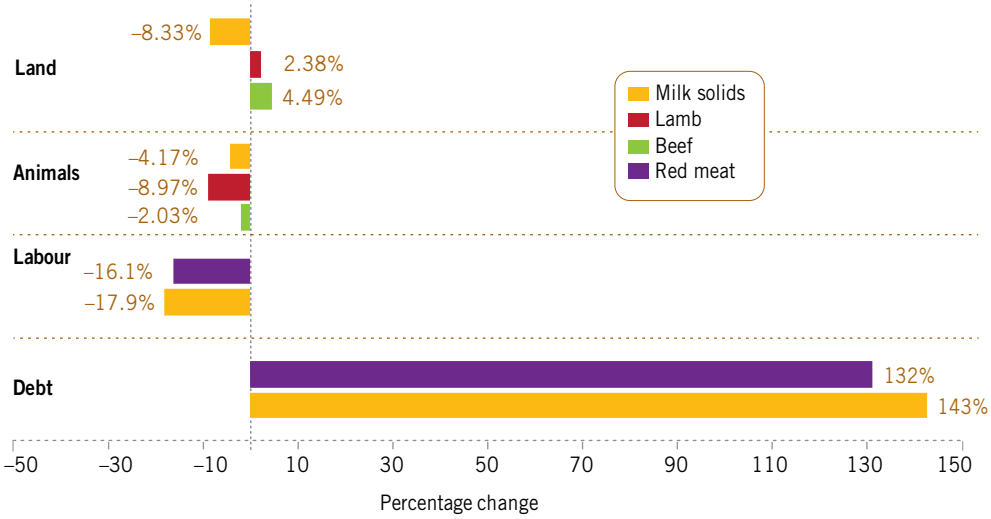
The companion question to intensification is productivity. In all cases (Figure 42), it took fewer animals and less labour to produce one kilogram of milk, beef or lamb.

Although the overall amount of land used for beef and lamb production went down over this period, the production of beef and lamb decreased even faster over this period, so that on a per-kilogram basis, beef and lamb production required more land.

And for dairy and sheep-beef farming, the amount of debt farmers have entered has climbed dramatically.

It is important to remember, however, that extreme weather over this period, and particularly the 2008 nationwide drought, led to reductions in stock numbers – including in some cases loss of significant strategic stock such as breeding animals – and also production. This has affected the overall trends from 2002 to 2009, particularly due to the short length of the time series. (Note that the debt figures are from 2003–2009.)

Figure 42: Summary – Changes in inputs to production.



On the dairy side, an eight percent overall reduction in the area of land that it takes to produce one kilogram of milk solids is significant. We expect the reduction has been achieved through a combination of improved animal and forage genetics, better pasture management and animal health, and through irrigation and supplementary feed. However, speculating about the relative significance of these factors and other factors that may be at play is outside the scope of this work.

The debt trends for both dairy and sheep-beef farming are concerning. There are likely to be different causes in different sub-sectors. In dairying, which has performed strongly over this period, factors such as the price of land, Fonterra's share price and expectations of future product prices have influenced farmer debt. Investment in other forms of capital (buildings, automation, and other technologies) is also likely to have had an impact. Moreover, the increase in land area under dairying indicates a higher level of conversion of properties to dairy farming, which typically requires significant investment that would have influenced the strong dairy debt figures.

The sheep and beef sectors have had a difficult spell over this time: their debt figures reflect low returns and the need to borrow on equity to stay in business, usually off the back of historically strong balance sheets.

4 CONCLUSIONS

The available data meant that it was possible only to generate trends over a period of eight years, which is not a very long time series. Furthermore, these data cannot tell us much about why these trends have occurred and where they are likely to go in the future. We have little evidence about the quality of the inputs going into pastoral farms and of the management of these inputs, so all we can do is speculate based on use and output trends.

It is clear that the pastoral landscape is becoming more dynamic, with animals moving more between property types so the boundaries between sheep-beef and dairy farms are becoming increasingly blurred. The question is how we can monitor the trends and progress of these sectors in the future.

We hope this paper stimulates debate not only about how to interpret the data we have, but also how to build a richer bank of information to help us understand the performance and the potential of the pastoral sectors in years to come.

MPI will continue to work in partnership with the pastoral sector and associated industries, as well as the research community in order to address the knowledge and data gaps and thereby improve national capability to understand what drives performance of our most important industries.

APPENDIX

DATA SOURCES

Agricultural Production Survey (Statistics New Zealand)

The Agricultural Production Survey (APS) is a periodic survey to produce statistics on agriculture, horticulture and forestry activity. The survey is annual, with a full census every five years. The total population of the survey covers approximately 80 000 businesses involved in agricultural, horticultural or forestry production, around 30 000 of which are surveyed in a sample year. Census years cover the entire population of 80 000 businesses. The APS time series (2002–2009) that we have used in this work covered two censuses, in 2002 and 2007. The mix of sample years and census years in the time series covered by this study is likely to have led to some noise in the data.

The data from the survey are organised according to the Australian and New Zealand Standard Industrial Classification (ANZSIC). This study was particularly concerned with data classified as relating to dairy farming or sheep-beef farming. However, within the time series of this work (2002–2009), the ANZSIC classifications changed. Farming and forestry units included in agricultural production censuses and surveys from 2002 have given both ANZSIC 1996 and ANZSIC 2006 codes which might have affected how farming categories have been coded.

This study used ANZSIC 2006 coding. The farm types in the ANZSIC coding are based on the "Estimated Value of Agricultural Operations (EVAO)".[6] APS provides the base data for this study, including agricultural and forestry land use; numbers of dairy cows, sheep and beef cattle; and fertiliser use by farm class.

New Zealand Dairy Statistics (DairyNZ and Livestock Improvement Incorporation)

The New Zealand Dairy Statistics provide statistical information related to dairy industry production, animal population, herd production and herd improvement statistics, for the New Zealand Dairy Industry. Data are sourced from the Livestock Improvement Corporation (LIC) National Database, dairy companies, Animal Evaluation database, Animal Health Board Annual Report, Quotable Value New Zealand Rural Property Sales Statistics, and Statistics New Zealand.

Statistics from DairyNZ relate to the whole dairy industry, while LIC's dairy statistics relate specifically to the milking platform.

This study uses data about milk solids production, numbers of milking cows, and land area of the milking platform.

MPI Livestock Slaughter Data

The Livestock Slaughter comes from MPI pastoral statistics. It is collected from meat suppliers each month to provide a range of data related to livestock numbers and New Zealand meat production.

Fertiliser Industry Data (Fert Research)

Fert Research represents the New Zealand fertiliser industry. Virtually all the fertiliser sold in New Zealand is through two nationally operating farmer co-operatives. Both are members of Fert Research. Fert Research collects and incorporates the fertiliser sales of Ballance Agri-Nutrients and Ravensdown Fertiliser Co-operative to produce annual data on the agricultural consumption of Nitrogen (N), Phosphate (P), and Potassium (K) at the national level. Fert Research N-P-K consumption data goes back to 1961.

6 For a detailed explanation of EVAO and the coding method in ANZSIC 1996 and 2006, see: *Farm Types Used in Agricultural Production Statistics: A Comparison between ANZSIC96 and ANZSIC06 Classifications* accessed at http://www.stats.govt.nz/browse_for_stats/industry_sectors/anzsic06-industry-classification/farm-types-used-in-ag-prod-stats.aspx (accessed on 10th April 2012).

This study used Fert Research fertiliser sales data in conjunction with the farm class APS fertiliser data, in order to produce "national level" fertiliser use trends by farm class. This is detailed in the **Methods** section below.

World Trade Atlas (Statistics New Zealand)

World Trade Atlas is a data system that holds world's merchandise statistics. It contains the merchandise export and import trade data of each reporting country (more than 80 countries official statistics) from the most general to the most detailed level.

Linked Employer-Employee Data (Department of Labour)

Linked Employer-Employee Data (LEED) is a longitudinal database that has been developed by Statistics New Zealand. LEED provides statistics on filled jobs, job flows, worker flows, mean and median earnings for continuing jobs and new hires, and total earnings. LEED uses existing administrative data drawn from the taxation system (monthly data on employee earnings), together with business data from Statistics New Zealand's Business Frame (data on employers and firms). LEED data are available for the tax year 2000 through 2009 (the tax year is the year ending at 31 March). LEED data from 2002 to 2009 by farm class are used in this study.

Annual Agriculture Credit Series (Reserve Bank of New Zealand)

The "Annual agricultural credit series" was introduced for the first time in June 2002 by the Reserve Bank of New Zealand (RBNZ). It is a long-run series of loans outstanding to the agriculture sector. Beginning with 2003, the series came in by farm class (dairy and sheep, beef and grain) and in 2004 with a further break down in sheep-beef category (such as sheep, beef, sheep-beef). RBNZ "total lending to agriculture" data from 2003 to 2009 by farm class are used in this study.

METHODS

Estimated Pasture Areas

Estimating the total pasture area actually used for dairy farming, sheep farming and beef farming is difficult. The APS classifies whole farms according to the activity responsible for the majority of their income. This means that the APS will not report specific land area data for any portions of a farm used for minority activities. For example, APS would report the entire land area of a beef property that also supports some dairy grazing as beef, not as some beef and some dairy.

The following steps were taken to estimate the land area actually being used for dairy, sheep and beef farming:

- Subtract the LIC milking platform area from the APS total pasture area. The LIC milking platform area is allocated entirely to dairy. The remaining area needs to be split proportionally between other activities.
- Estimate the total megajoules of metabolisable energy (MJME) consumed by dairy grazing (not milking cows), beef cattle, sheep and deer. Multiply the MJME requirements per head of each type of animal (derived from the National Agricultural Inventory) by the total population sizes of those animals. The National Agricultural Inventory is a model to calculate methane emissions and nitrogen excreted from dairy, beef, sheep, and deer.
- Use each population's energy requirements to estimate the proportion of remaining pasture (non-milking platform) used for that farming activity. Divide each population's estimated MJME requirements by the total combined MJME estimate, and multiply this proportion by the remaining pasture area. This is the estimated pasture area used for each type of farming activity. For the estimated sheep farming area and estimated beef farming area, this is the last step.

≈ Add the dairy grazing estimate to the LIC's milking platform area to get the total estimated dairy area.

Fertiliser

Fert Research collects total fertiliser (N-P-K) sale data, but these data are not split by farm class. APS fertiliser data are split by farm class, but the fertiliser questions in the APS changed a number of times between 2002 and 2009, which made it difficult to ascertain the total application of nitrogen (N), phosphorous (P) and potassium (K) from year to year. Furthermore, in most years, the APS data were based on a sample of 30 000 farms, so these fertiliser data were not considered to be as complete as the Fert Research data. The approach taken in this study was to estimate, based on APS data, the percentage of elemental N, P and K applied per farm class and use these percentages to apportion the Fert Research total fertiliser by farm class.

Pastoral Farm Assets (Beef+Lamb New Zealand Economic Service, DairyNZ Economic Survey)

Total asset data by farm class were sought to provide context around the total debt data for dairy farms and sheep-beef farms. However, these data are not available.

The Beef+Lamb New Zealand Economic Service estimates annually the average sheep-beef farm's assets, and the DairyNZ Economic Survey does the same for the average dairy herd's assets. Multiplying the Beef+Lamb New Zealand estimate by the total number of sheep-beef farms, and multiplying the DairyNZ estimate by the total number of dairy herds, provided a reasonable estimate of the total assets for sheep-beef farms and dairy farms, respectively.