



# Returns from training in the dairy farming industry

Part B: Modelled impact on business performance

July 2016

# Introduction

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## Context

DairyNZ, the Primary ITO, and many of the organisations that they both work with, share a goal of encouraging dairy farmers to undertake formal training. To achieve this it is important to demonstrate the benefits of training to both employers and employees.

This report forms part of a wider piece of work led by DairyNZ and Primary ITO to describe the returns from training both qualitatively and quantitatively.

## Overview

This document presents estimates the financial benefits of a range of formal training options available to the dairy farming industry. These are determined using a model that attributes the variation in dairy farming profitability to different influences, including training. As with any modelling work this approach is imperfect because, in particular, the true value of many of the key inputs is unknown. However, by undertaking sensitivity analyses it provides a way to establish the broad range of training's impact. Furthermore, the model allows the relative impact of different training courses to be evaluated. Finally the model creates a framework that can help guide empirical research.

## Structure

The first part of this document describes the modelling approach. The second part presents results from the model in a base case. The final section sets out the results of sensitivity analyses.

## Key findings and discussion

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### Formal training is an excellent investment

The return on investment (ROI) from vocational farm training for farm assistants & herd managers range between 2x and 15x. In absolute terms, the net financial benefit ranges from \$2,000 to \$6,000 per annum. In comparison, the values for the ROI from management training – either a degree or an agribusiness diploma range from 10x to 15x with net financial benefit ranging from \$10,000 to \$50,000 per annum.

### The conclusions are robust to changes in input assumptions

Work was undertaken to determine which inputs the results are most sensitive to and the conclusions of the work were tested by varying inputs over a range of plausible values. For the scenarios considered the ROI remains positive in all cases although the ROI value cover a wide range. For example, the ROI from an agribusiness diploma may be as low as 8x or as high as 26x.

### The findings are at odds with research on the effect of training on income

These findings appear at odds with research undertaken to determine the impact of training on individuals incomes. This work found that formal qualifications had limited impact on income paid to employees. It is possible that dairy farming businesses are enjoying the benefits of training without passing these onto their workers.

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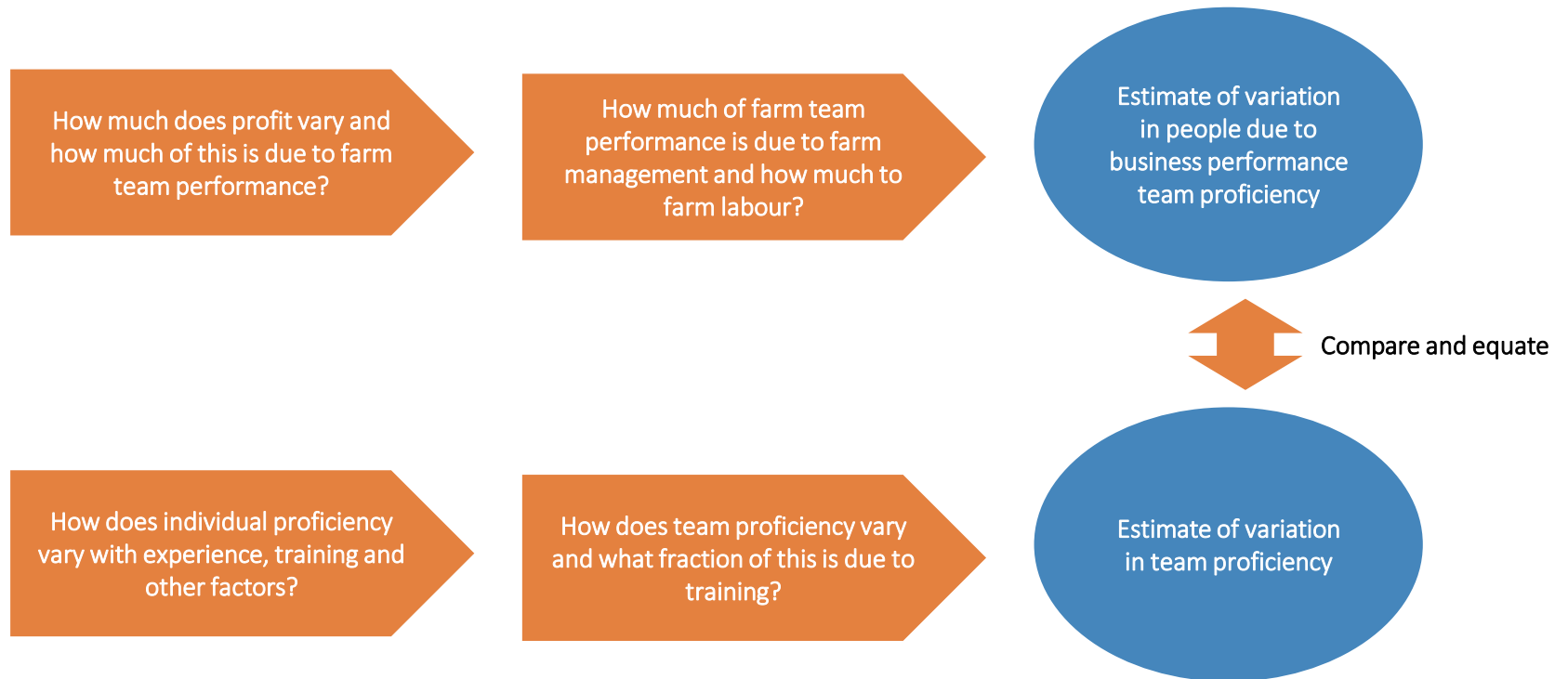
Modelling approach

Results

Sensitivity analysis

The modelling process used in this work develops and links a set of 'rules of thumb' to characterise the impact of training on farm team performance and how this impacts profitability. By comparing and equating variation in profitability with variation in farm team proficiency it is possible to put a dollar value on farm team proficiency and by working backward from this on the impact of training.

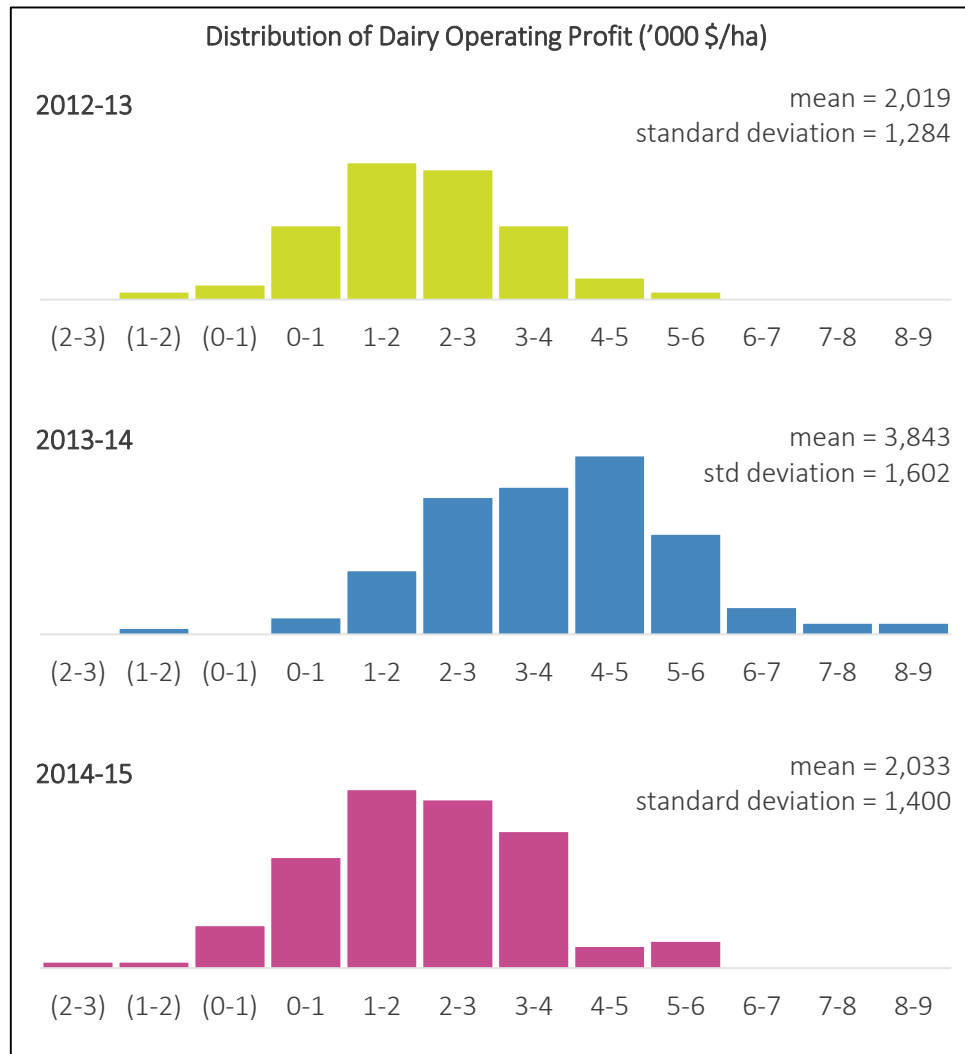
## Modelling framework



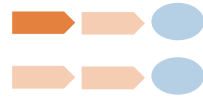
Profitability varies considerably between New Zealand dairy farming businesses. The range between the most profitable and the least profitable farms within any given season are greater than the changes in average profitability between seasons – even over a period of extreme volatility in milk prices. Some fraction of this variation can be attributed to variation in farm team performance and some fraction of the variation in farm team performance will be due to training.



## Profit variation in New Zealand dairy farming



Variation in profit is likely to be due to a range of factors. Some of these causes of variation can be reduced by averaging financial results overtime.



## Cause of profit variation in New Zealand dairy farming

Profit variation

**Farm production potential** – Soils, climate, topology and infrastructure all contribute to a farms potential. In theory these factors should be reflected in asset value and Dairy Operating Profit could be adjusted to reflect these factors. However, the correlation between Operating Profit and the book value of dairy farm assets is weak (see upcoming slide) suggesting that farm assets are not properly valued and / or that other factors play a big role in causing profit variation.

**Seasonal factors** – Seasonal farming conditions will affect different regions differently and this will cause profit to vary. However, over time the variations should average out so it should be possible to minimize this effect by averaging financial results from multiple years.

**Accounting treatments** – Differences in accounting treatments (e.g. most farms have balance dates of 31 May, but some have 31 March or 30 June) will cause variation within a year. Again, however, these effects should be reduced when multiple years of results are averaged.

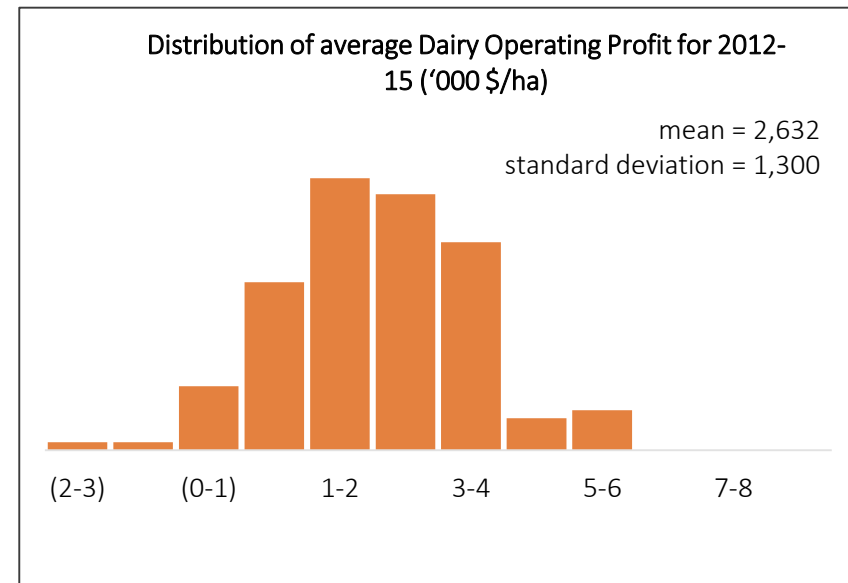
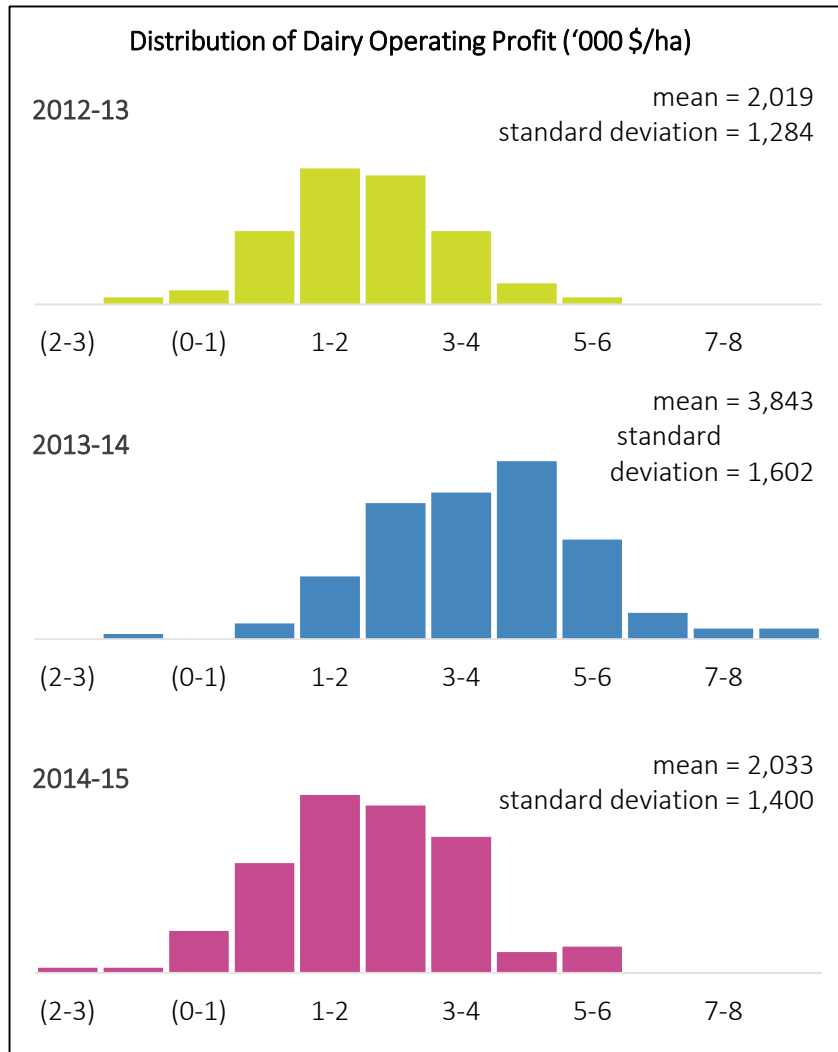
**Owner discretion** – As most farms are family operated, the lines between personal expenditure and business expenditure can be blurred. For example, a farming couple could invest in farm maintenance that doesn't contribute to farm productivity but does make the family home a nicer place to live.

**Farm team performance** – The decisions and actions made by the farm team are likely to be a leading cause of variation in profit.

Averaging three years of profitability results for dairy farming doesn't significantly change the spread of profitability. This suggests that neither seasonal factors, nor accounting treatments are dominant causes of variation in farm profits.



## Average profit over time



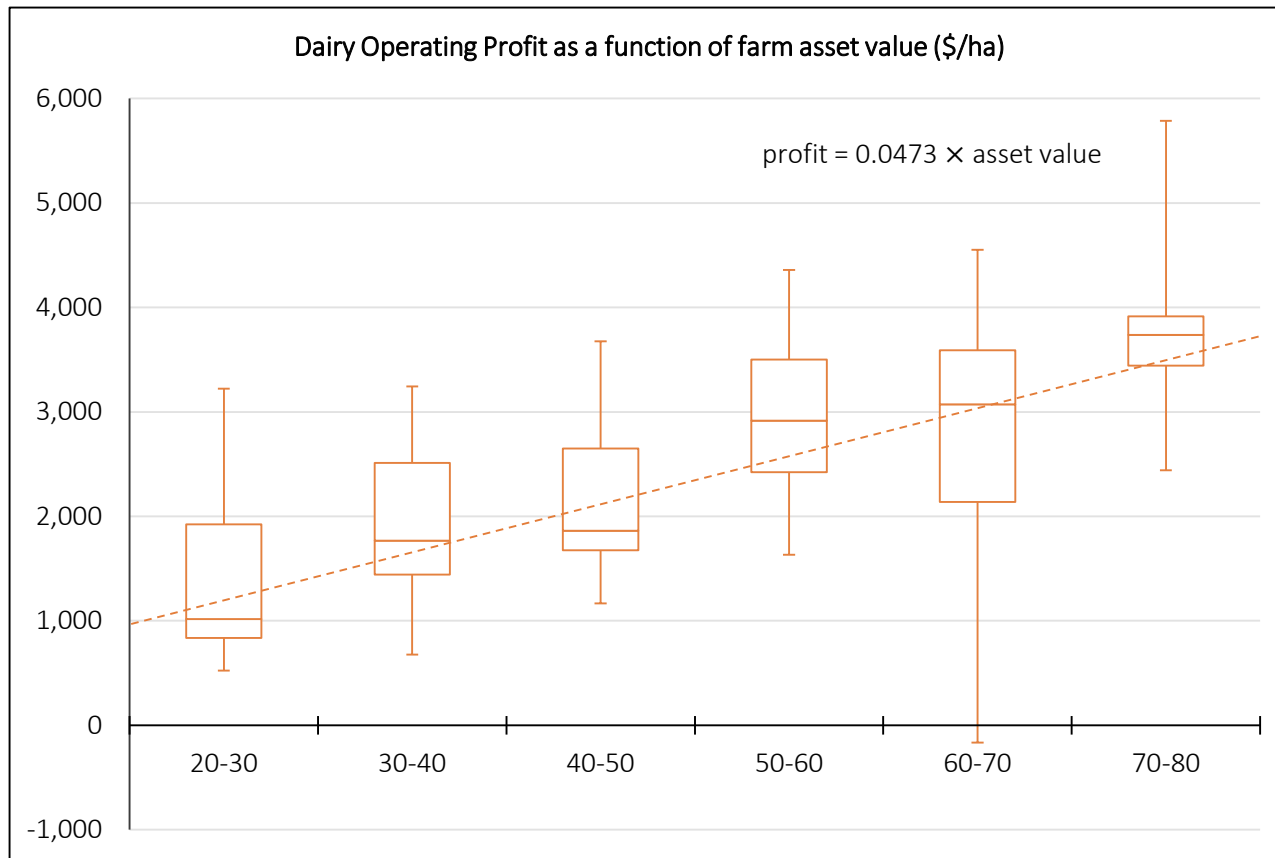
The variation for the three years is not much different to the variation for individual years. This suggests the relative profitability of farms doesn't change much from year to year.



Average profits per hectare are higher for farms with higher asset values; the slope of the best fit curve was about 5% in 2012-15 which appears a reasonable rate of return for a dairy farm asset. However, the spread of performance around this trend line is very high suggesting that differences in soils, climate, topology and infrastructure are not the dominant cause of variation in farm profits.



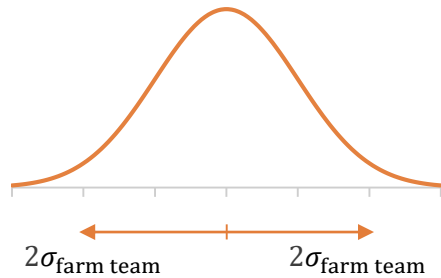
## Impact of asset values on dairy operating profit



We estimate the variation of farm team performance by modelling each of the influences of farm profit variation as independent variables. By weighting the relative contribution that each of these influences it is possible to arrive at a quantitative measure for the variation in farm team performance. In our base case farm team performance is assumed to be responsible for 35% of variation in overall profitability.



## The value of farm team performance



Variation in farm team performance is  $4\sigma_{\text{farm team}}$  where variation captures 95% of farms.

$$\sigma_{\text{profit}}^2 = \sigma_{\text{production potential}}^2 + \sigma_{\text{seasonal}}^2 + \sigma_{\text{accounting}}^2 + \sigma_{\text{owner discretion}}^2 + \sigma_{\text{farm team}}^2$$

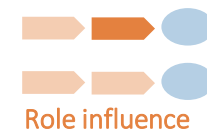
Say:  $100\% = 30\% + 5\% + 10\% + 20\% + 35\%$

$$\sigma_{\text{farm team}}^2 = 0.35 \sigma_{\text{profit}}^2$$

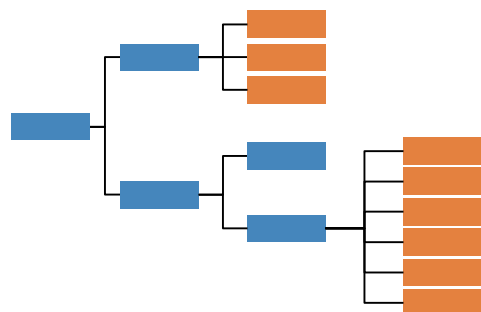
$$\sigma_{\text{farm team}} = \sqrt{0.35} \sigma_{\text{profit}}$$

variation in farm team performance =  $4\sqrt{0.35} \sigma_{\text{profit}}$

Farm team performance can be thought of in two parts – farm labour performance and farm management performance. To understand the weighting of different roles on farm (see later slide) we need to breakdown the causes of variation in profit and understand the importance of labour and management to these.



## Steps to determine labour and management contribution to farm team performance



Step 1: Identify profit driver

**Days in milk per cow (days)**  
Mating and calving performance  
Management of cow condition  
Management of feed supply/demand  
Animal health

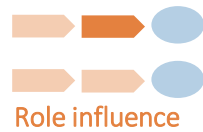
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Step 2: Identify farm attributes that affect profit drivers

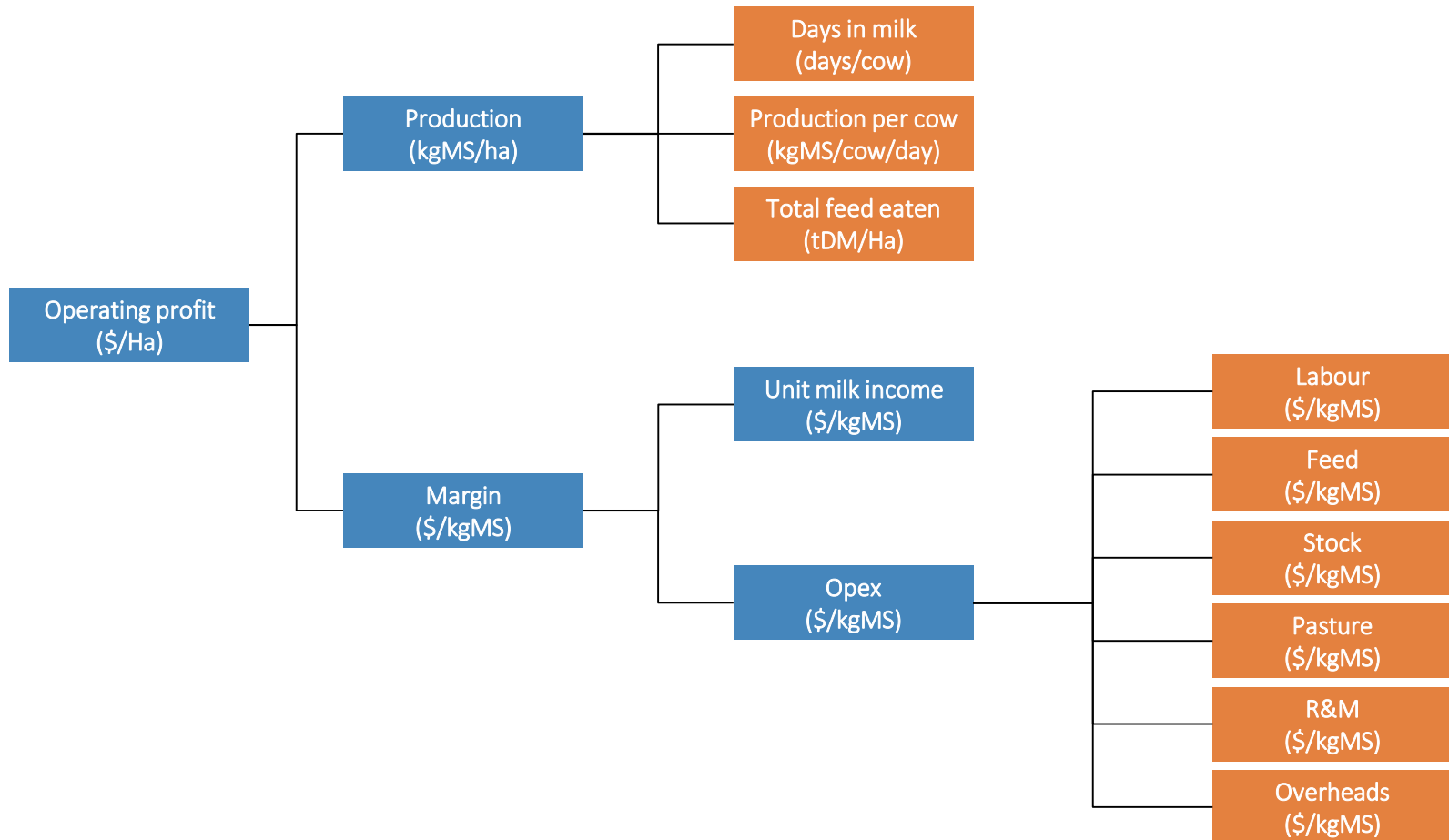


Step 3: Estimate the relative importance of farm management and farm labour to farm attributes

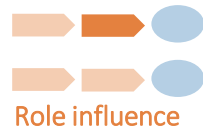
We use a profit tree to identify a set of nine KPIs (or 'profit drivers') that characterise dairy farm business. These profit drivers are mathematically related to farm profit.



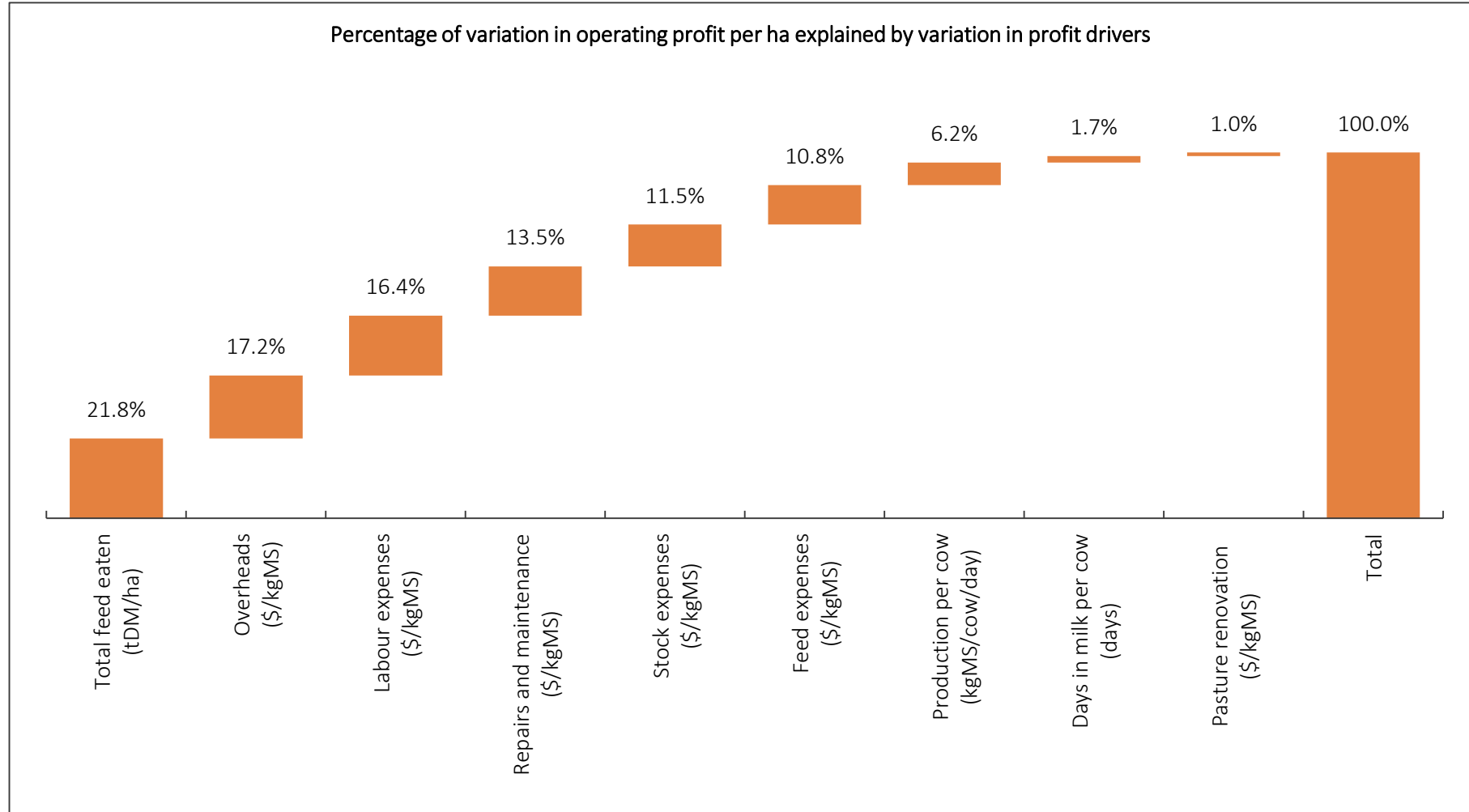
## Decomposition of operating profit into profit drivers



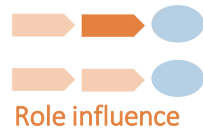
An approximate gauge of the relative importance of each profit driver in causing variation in profit is derived using a regression analysis. We acknowledge that these profit drivers are not fully independent variables but the error introduced is acceptable given the 'rule of thumb' approach being taken.



## Relative importance of profit drivers



Farm attributes that influence profit drivers were identified and each given an indicative weighting



## Farm attributes that impact on profit drivers

Farm business attributes	Weighting of attribute within value driver
<b>Days in milk per cow (days)</b>	
Mating and calving performance (calving date & spread)	40%
Management of cow condition	20%
Management of feed supply/demand (dry off date)	30%
Animal health (lameness/matistis) deaths/culls	10%
	<b>100%</b>
<b>Production per cow (kgMS/cow/day)</b>	
Genetics management	10%
Feeding (quantity & quality)	30%
Pasture management	30%
Cow condition	20%
Animal health (prevention and mgmt lameness/matistis)	5%
Age of herd (wastage/replacements, expansion of herd)	5%
	<b>100%</b>
<b>Total feed eaten (tDM/ha)</b>	
...	

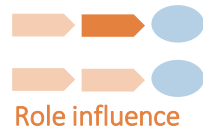
Farms attributes were then characterized as being influenced by farm labour and/or farm management to greater or lesser extent.



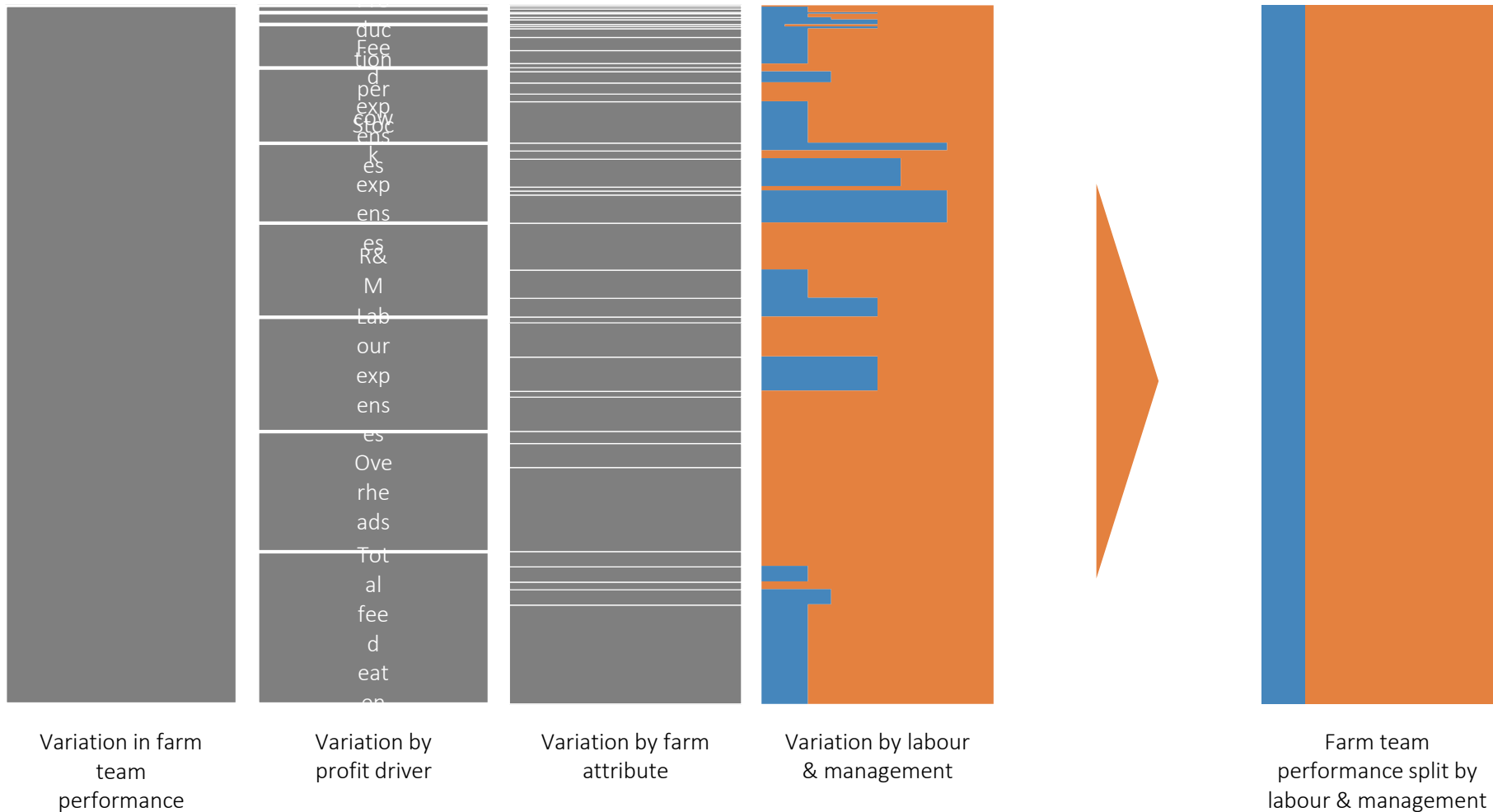
## Influence of labour and management

Farm business attributes	Labour	Management
<b>Days in milk per cow (days)</b>		
Mating and calving performance (calving date & spread)	50%	50%
Management of cow condition	30%	70%
Management of feed supply/demand (dry off date)	20%	80%
Animal health (lameness/matistis) deaths/culls	50%	50%
<b>Production per cow (kgMS/cow/day)</b>		
Genetics management	0%	100%
Feeding (quantity & quality)	20%	80%
Pasture management	20%	80%
Cow condition	20%	80%
Animal health (prevention and mgmt lameness/matistis)	50%	50%
Age of herd (wastage/replacements, expansion of herd)	10%	90%
<b>Total feed eaten (tDM/ha)</b>		
...		

By combining the weightings for profit drivers, farm attributes and the labour / management split we can arrive at a 'rule of thumb' to allocate variation in farm team performance between farm labour and farm management. In our base case this split is approximately 20% farm labour and 80% farm management.



## Attributing profit variation between farm management and farm labour





The basis for our model of a worker's individual performance is a 'proficiency curve'. We model assume that a new worker has no proficiency when they start work in the industry for the first time but gains proficiency with work experience. Over time the rate of gain flattens and eventually the worker's labour proficiency reaches a plateau.



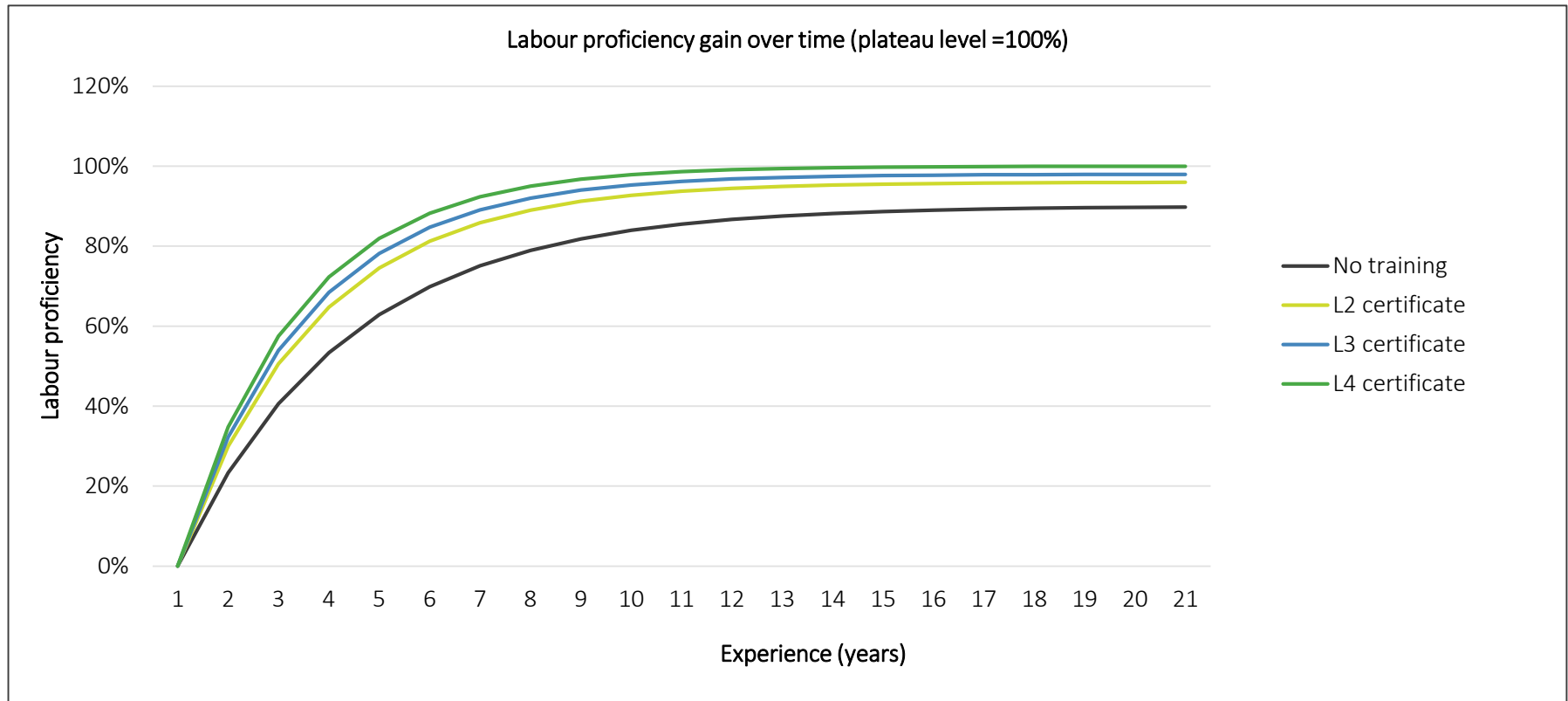
## Labour proficiency curve for a farm worker



We model the impact of training by assuming that training can either accelerate the rate of proficiency gain, raise a worker's plateau level of proficiency or both. In our base case we assume that dairy farm industry training does not raise the plateau of labour proficiency but that different levels of training accelerate the rate of labour proficiency gain to different extents.



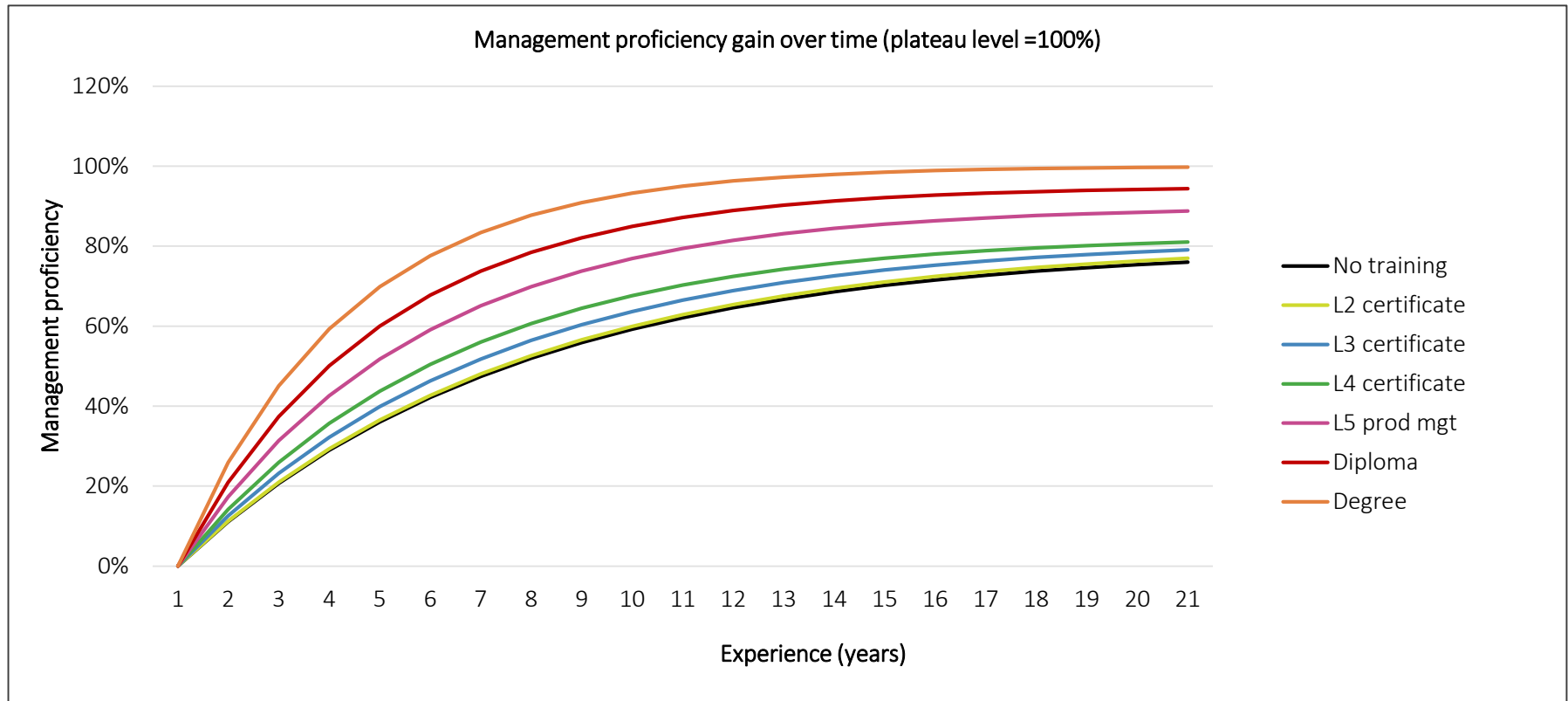
## Labour proficiency curves for a farm worker with training



Management proficiency is also modelled using proficiency curves. In our case we model the effect of training as both raising the plateau level of management proficiency and accelerating the rate of proficiency gain.



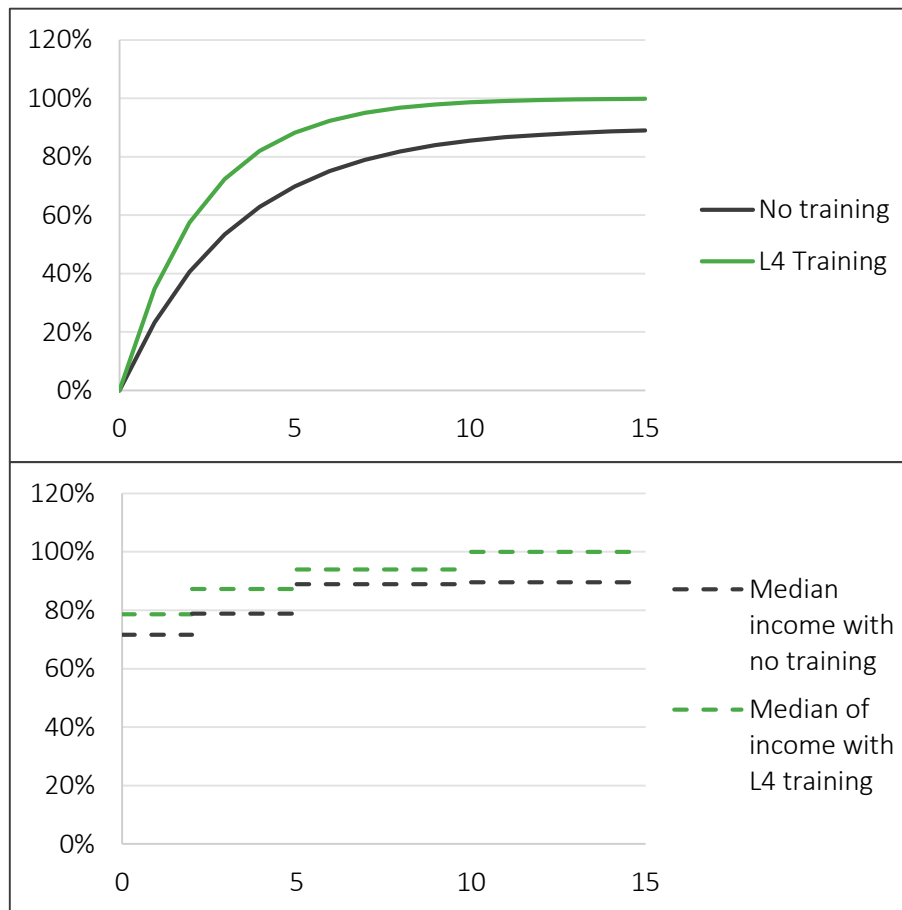
## Management proficiency curves for a farm worker with training



We compare the proposed labour proficiency curve with the medians of income for employees in the dairy industry. In both cases, training is correlated with a ~10% improvement. Gaps in data make a similar comparison analysis between management proficiency curve and income hard. Within reasons, however, we can argue that management training will have a better impact on proficiency. A sensitivity analysis on management proficiency curve (and also labour) is also presented (see later) to address the model uncertainty.



## Labour proficiency vs. employee income curves

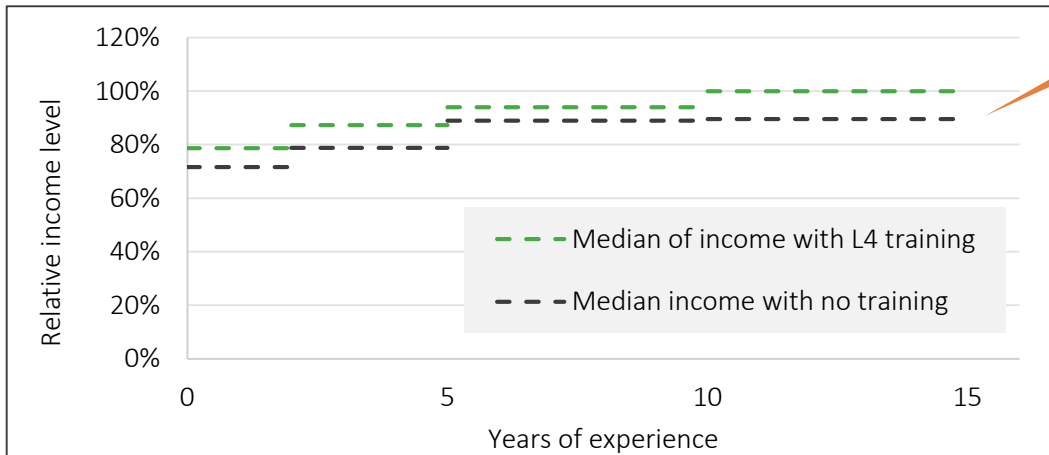
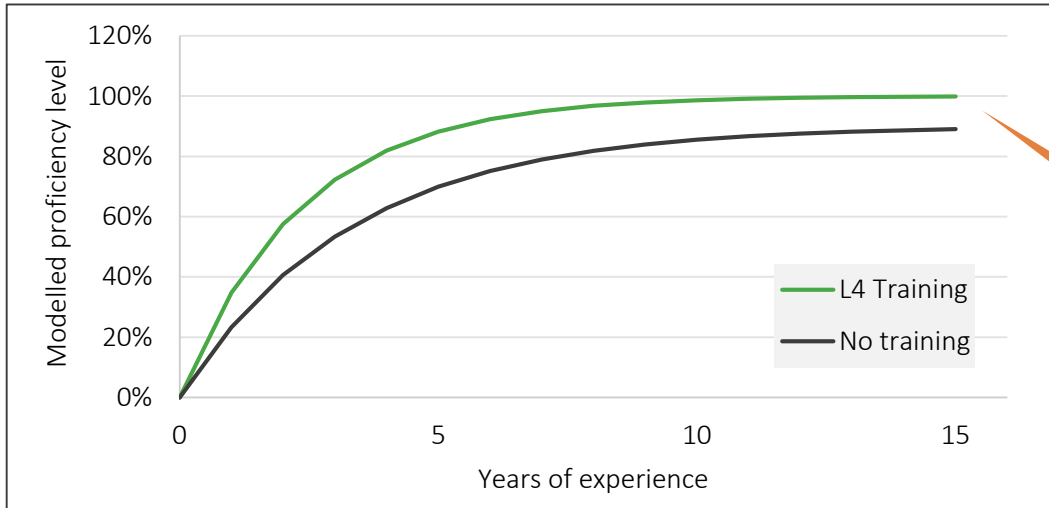


Gaps of proficiency and income are relatively consistent

We compare the proposed labour proficiency curve with the medians of income for employees in the dairy industry. In both cases, training is correlated with a ~10% improvement. Gaps in data make a similar comparison analysis between management proficiency curve and income harder. Within reasons, however, we can argue that management training will have a better impact on proficiency. A sensitivity analysis on management proficiency curve (and also labour) is also presented (see later) to address the model uncertainty.



## Labour proficiency vs. employee income curves

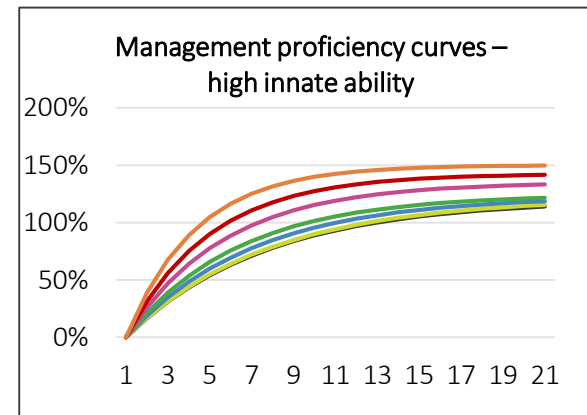
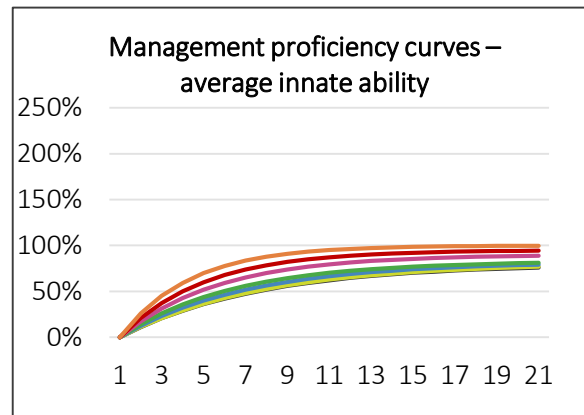
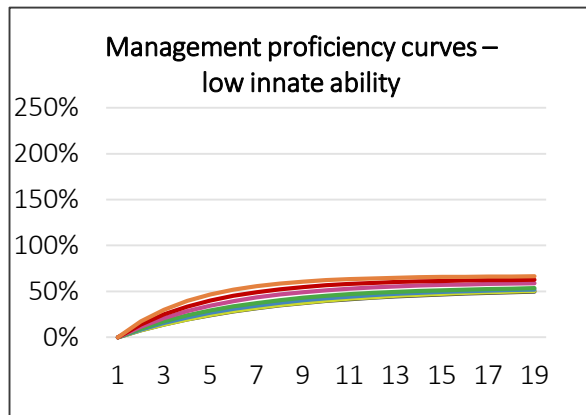
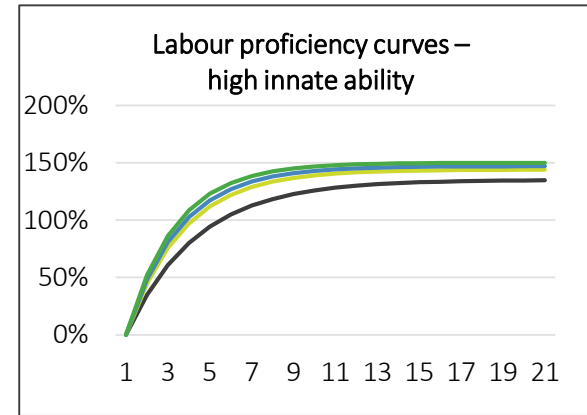
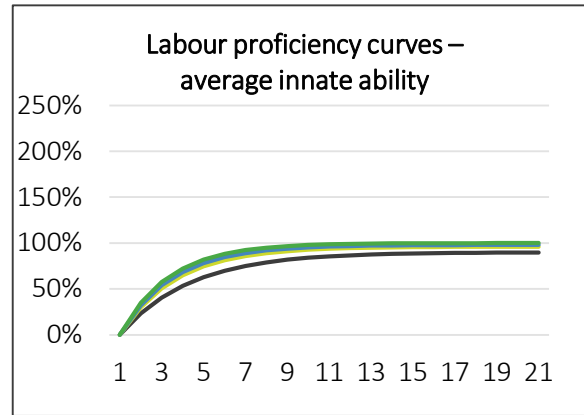
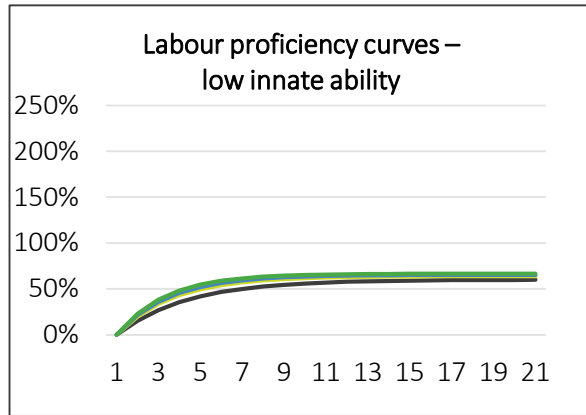


Gaps of proficiency and income are of a similar order

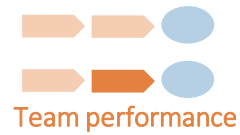
Experience and training are not the only determinants of farm worker performance. Other factors like a farm worker's work ethic, cognitive ability & communication skills are also important. To characterise how important we define an attribute for each worker that we call innate ability. We assume that innate ability raises or lowers an individual worker's plateau labour and management proficiency. The extent to which this occurs sets the relative importance of innate ability and training in our model. We illustrate this by considering the proficiency curves for workers with innate ability in the top 1/3, middle 1/3 and bottom 1/3 of all workers.



## Impact of innate ability



Individual worker performance attributes are aggregated to create a team performance value. The starting point for this is the model farm team described in the table below. This model farm team works on a model farm of 100 hectares.



## Model farm team

Role	Workforce breakdown	Number per farm	Typical experience (years)	Labour contribution	Management contribution
Business manager	12,000	1.00	22.0	20%	80%
Farm manager	3,000	0.25	11.0	30%	70%
Production manager	3,000	0.25	6.5	50%	50%
Herd manager	6,000	0.50	3.5	80%	20%
Farm assistant	9,000	0.75	1.0	100%	0%
	<b>33,000</b>	<b>2.75</b>			

The range of farm team performance is modelled by assembling modelled farm teams with different mixes of innate ability, experience and training.



## Assumptions for the range in farm team performance

	High performing farm team	Base case farm team	Trained farm team	Low performing farm team
<b>Innate ability</b> - Farm team attract people with different innate ability such that the team mix is:	70% in top 1/3 23% in middle 1/3 7% in bottom 1/3	23% in top 1/3 54% in middle 1/3 23% in bottom 1/3		7% in top 1/3 23% in middle 1/3 70% in bottom 1/3
<b>Experience</b>	All team members have 20% more years of experience than the model team	Experience as per model team (see previous slide)		All team members have 20% less years of experience than the model team
<b>Training</b>	Business manager – degree Farm manager – L5 prod mgt Production mgr – L4 NCA Herd manager – L3 NCA Farm assistant – L2 NCA	No training	[various by scenario]	No training



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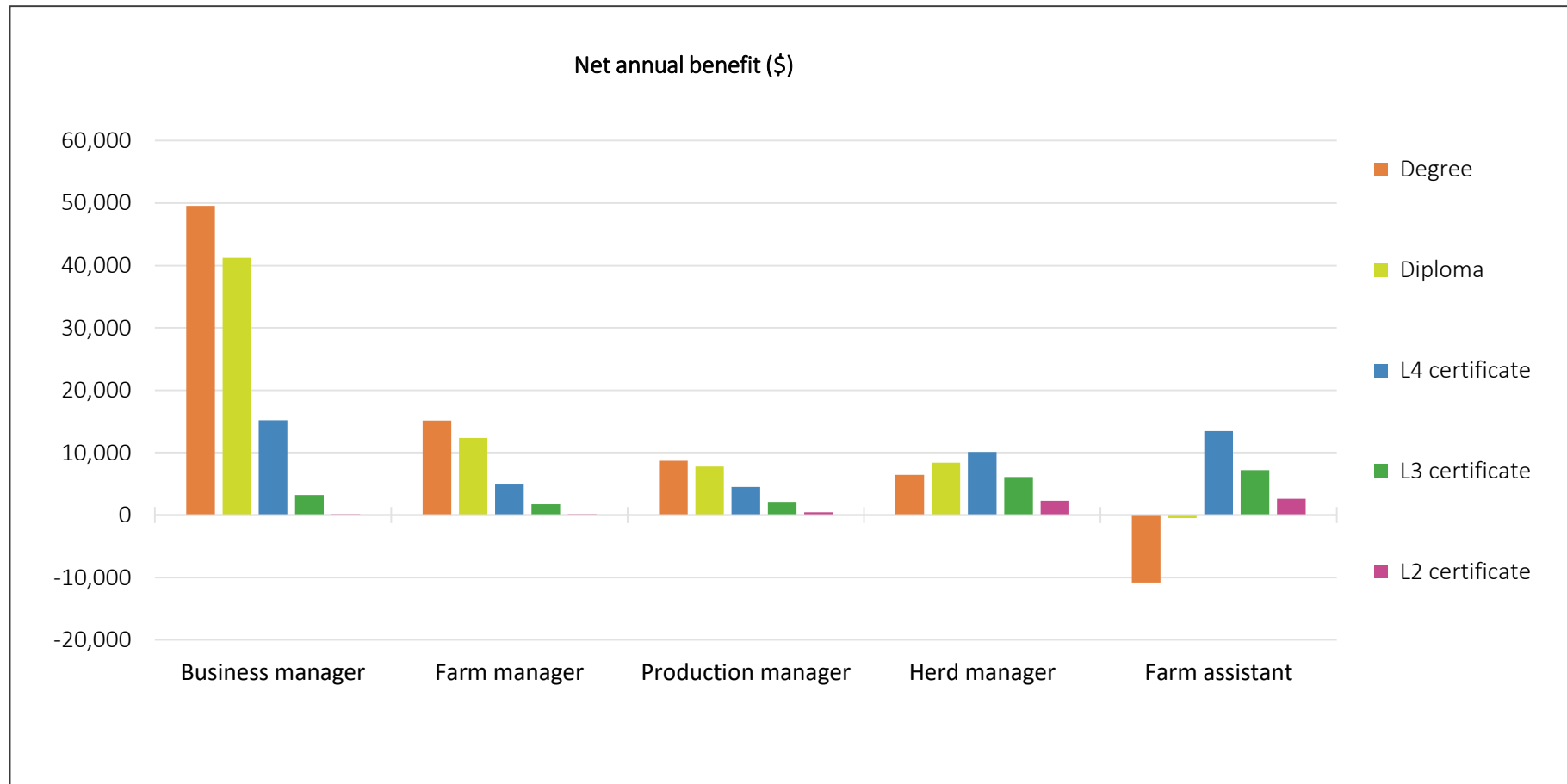
Modelling approach

Results

Sensitivity analysis

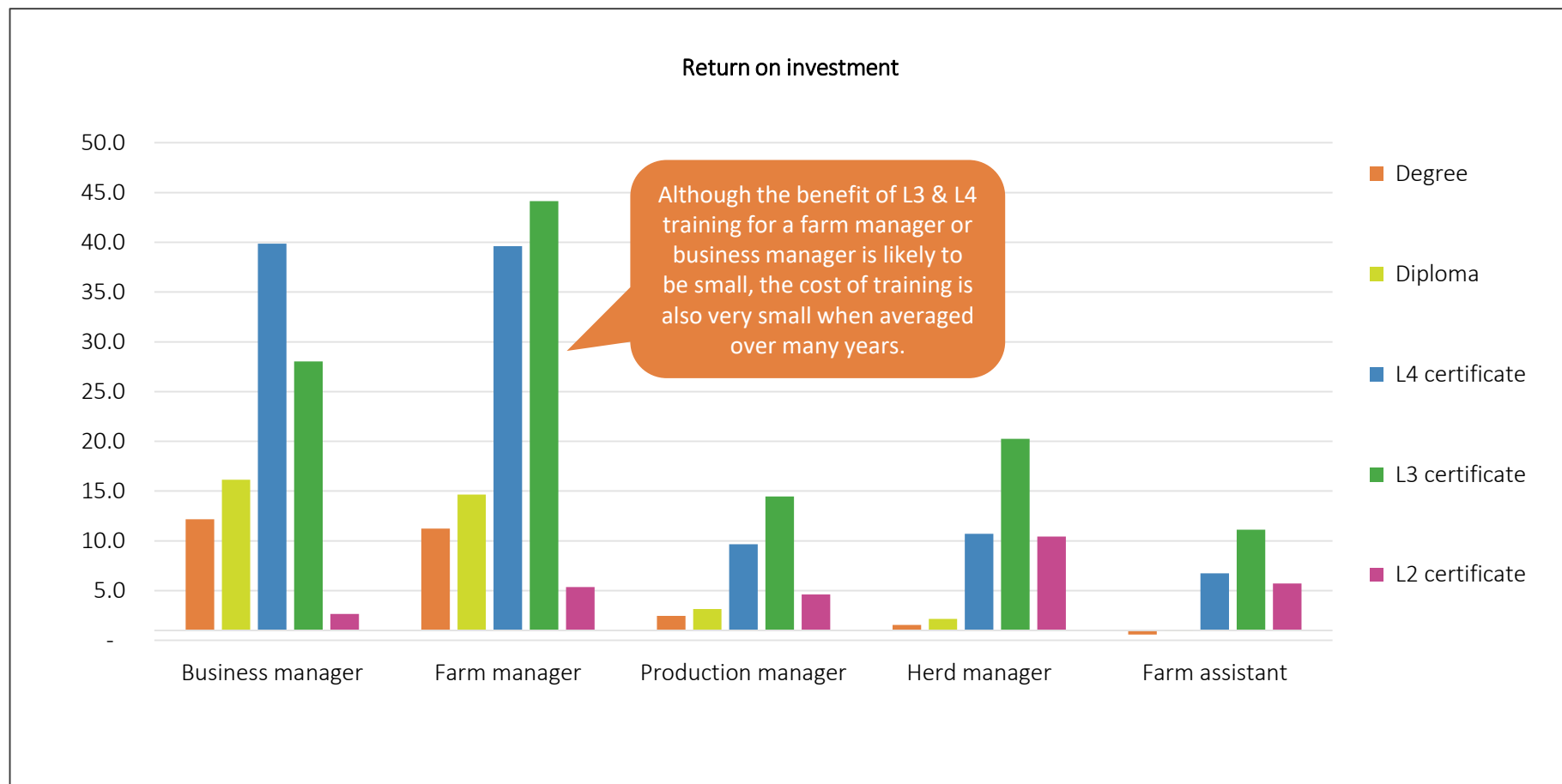
The net annual benefit of training is calculated for each role and for each of the qualifications modelled.

## Financial benefit from training



The return on training is calculated for each role and for each of the qualifications modelled. Here return on investment is defined as the annual financial benefit divided by the annualised cost of training.

## Return on investment



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Modelling approach

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Sensitivity analysis

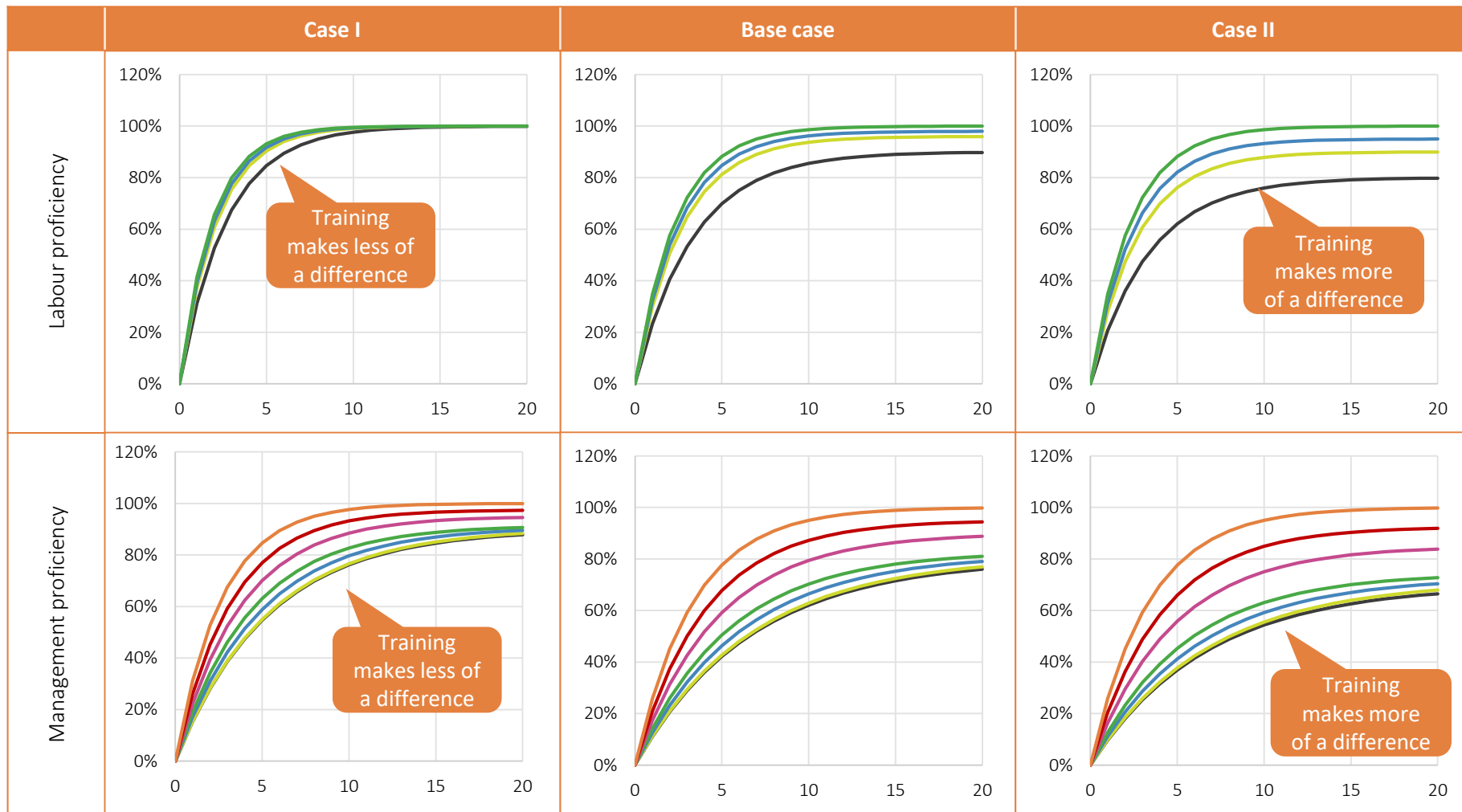
We carried out the sensitivity analysis by modifying five parameters, listed on the table below, with respect to three different cases. Case I and Case II are designed to decrease and increase the financial benefit from training and Rol (in most cases – an exception to this is the parameter ‘% Total contribution of labour : management to value drivers – see later slides for explanations), respectively. The base case is used as the point of reference.

## Sensitivity parameters A

Parameter	Case I	Base case	Case II
% Variation in profit due to variation in farm team	20%	35%	70%
% Total contribution of labour : management to value drivers	10% : 90%	20% : 80%	40% : 60%
Impact of people management	High performing teams have 90% of staff with high innate ability and 40% longer tenure than an average team	Good management firms have 70% staff with high innate ability and 20% longer tenure	Good management firms have 50% staff with high innate ability and 10% longer tenure
Impact of training on proficiency	[See later slides]		
Impact of innate ability on proficiency			

The sensitivity to the impact of training on proficiency is tested by changing the time to full proficiency and / or the gap in proficiency due to qualifications. The changes are illustrated by the figures below.

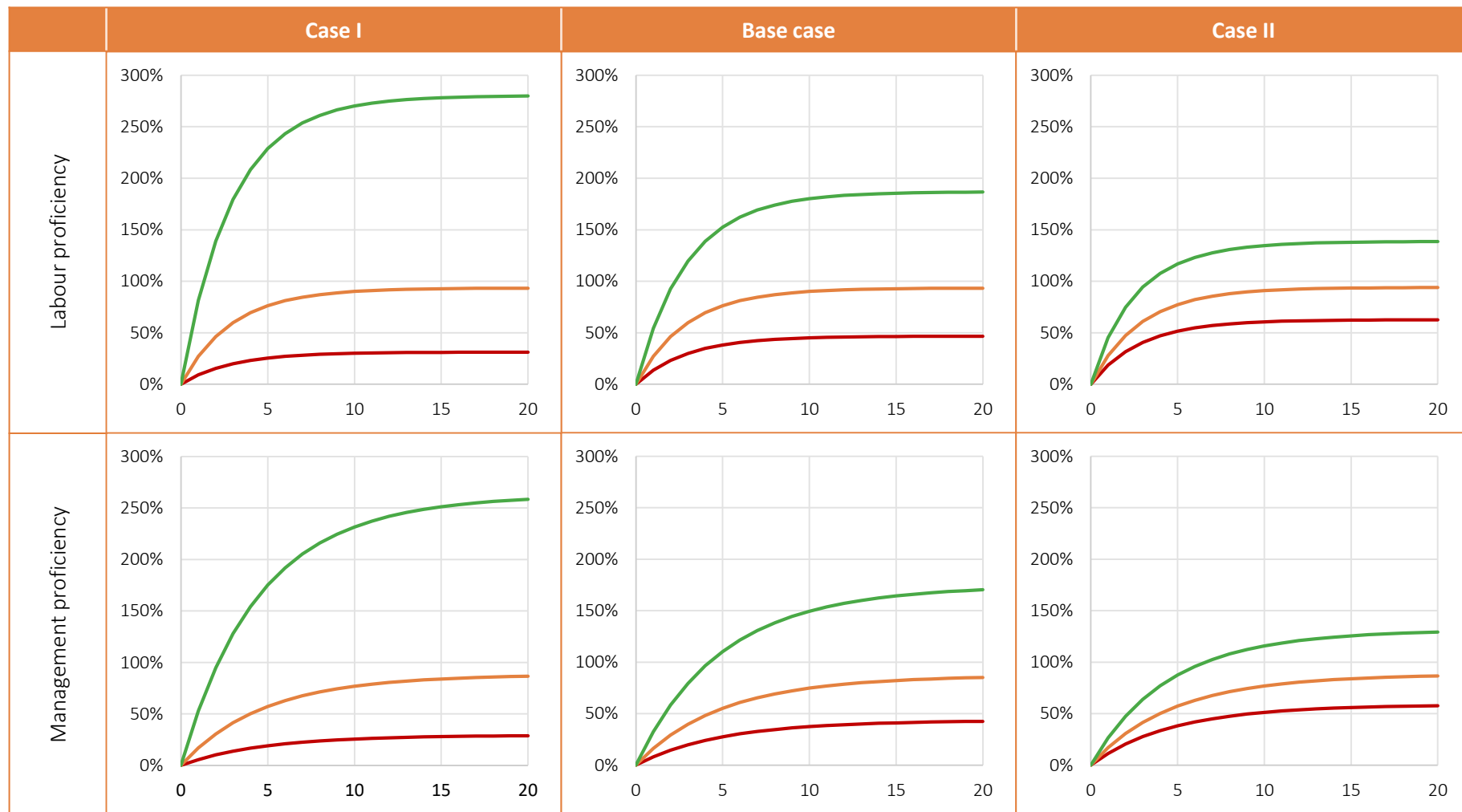
## Sensitivity parameters B – Impact of training



Different colours for different qualifications – see slide ‘Management proficiency curves for a farm worker with training’ for legend.

Similarly, the sensitivity to the impact of innate ability on proficiency is tested by changing the plateau level caused by the variation in innate ability.

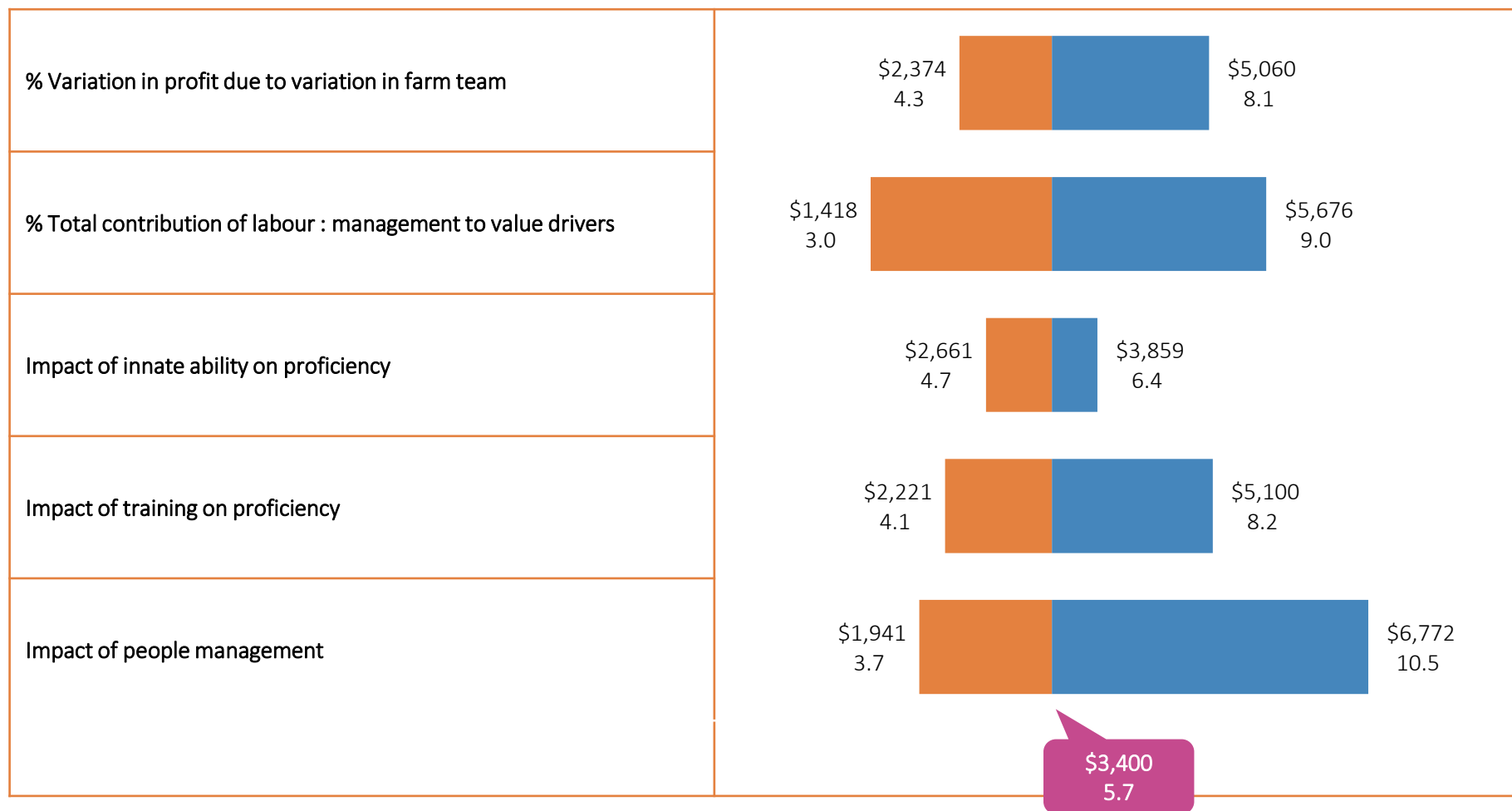
## Sensitivity parameters C – Impact of innate ability



Average of proficiency, across qualifications, with: ( ■ Low ■ Average ■ High) innate ability

We tested the sensitivity to the changes in the five chosen variables by evaluating the resulting net annual benefit and RoI of L3 training for farm assistants. In all cases, the benefit is positive (RoI > 1.0). If we believe that labour contributes more to farm profitability, the benefit and RoI will improve significantly.

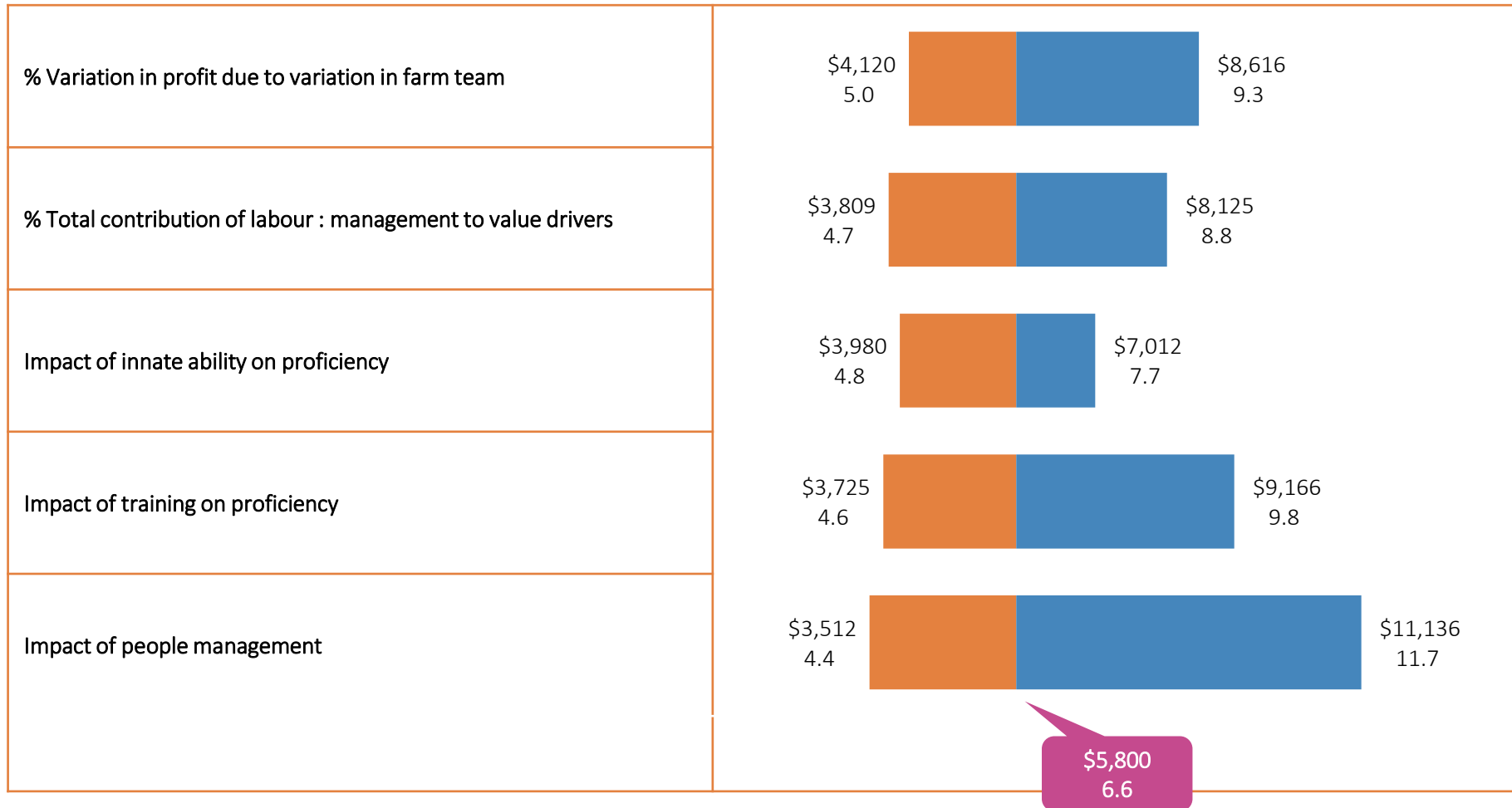
## Net annual benefit & RoI of L3 training for farm assistants





The same test was also carried out on L4 training for herd managers and the same conclusion holds. The net annual benefit and RoI remains positive in all cases.

## Net annual benefit & RoI of L4 training for herd managers



Finally, the same test was carried out on Diploma training for business managers. Here, we observe that the impact of ‘% Total contribution of labour : management to value drivers’ is the opposite of it on the other roles. This is because the business managers are responsible for the overall management proficiency of the team. Therefore, if we believe that the profitability is more sensitive to management (which is described in Case I), it follows that management training that increases management proficiency, will improve the net benefit and RoI. It is also important to note that the net benefit and RoI of diploma training for business managers are significantly higher than vocational training for labour-focused roles in each different case.

## Net annual benefit & RoI of Diploma training for business managers

