Your Index
Your Animal Evaluation System

Contents

Everything you've always wanted to know about BWs and BVs ... and nobody's ever explained well enough. Until now!

What were you like at maths when you were at school? Remember having trouble solving equations? Remember doing simultaneous equations?

Animal Evaluation as we know it would simply not be possible without the use of statistical methods and sophisticated computerware which allow simultaneous evaluation of cows and sires using all known relationships. A mind-boggling 18,000,000 individual equations have to be solved for each of the 25 traits.

So no wonder BW is hard for an ordinary mortal to understand!

Our Animal Evaluation system is based on solving millions of complicated equations simultaneously.

Good News!

At last – BW has been taken out of the too-hard basket.

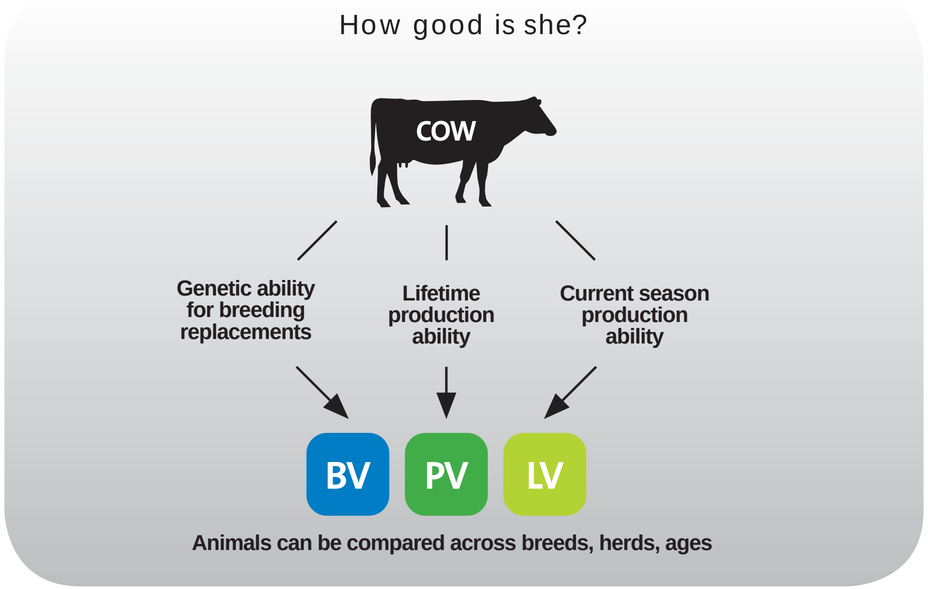
Animal Evaluation, Dexcel, Fonterra, Dairy InSight and Livestock Improvement have joined together to present this guide, Your Index, Your Animal Evaluation System: *Everything you've always wanted to know about BWs and BVs . . . and nobody's ever explained well enough – until now!*

Don't worry – you don't need to understand much maths, other than a bit of straightforward arithmetic.

In Brief

The aim of Animal Evaluation is to identify animals that are the most efficient at turning feed into profit. Animal Evaluation provides a way of comparing (or ranking) animals, no matter what herd they are in, their age, how long they have been in milk, when they calved, their breed, etc.

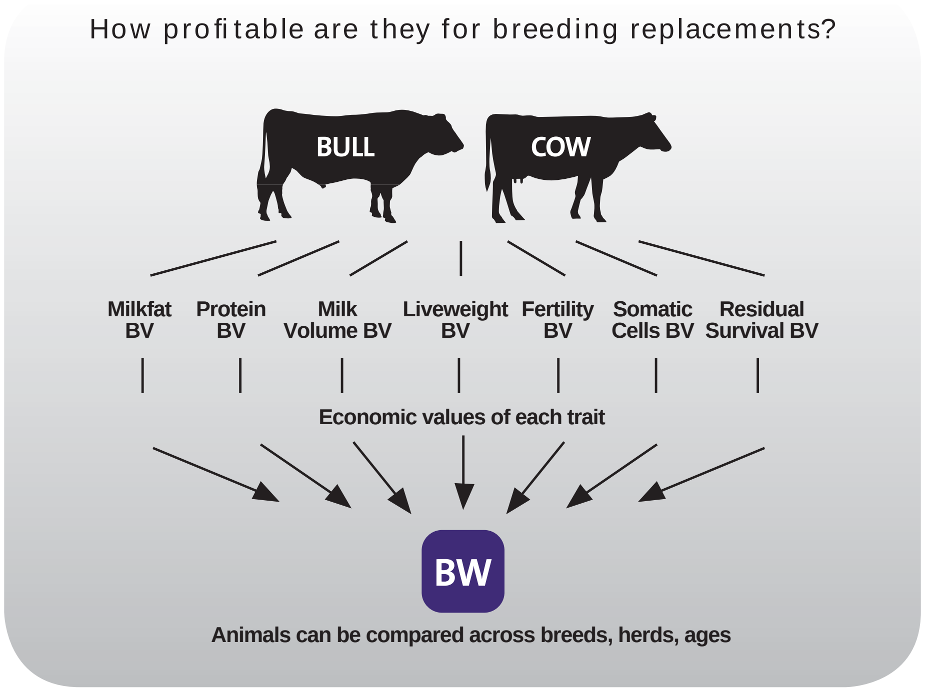
- The Breeding Value (BV) ranks male and female animals for their genetic merit for individual traits.
- The Production Value (PV) ranks female animals for their lifetime production ability.
- The Lactation Value (LV) ranks female animals for their current season production ability.



When the economic “worth” of these physical traits is taken into account, the Animal Evaluation system produces corresponding economic evaluations or indexes, called Breeding Worth (BW, for cows and bulls), Production Worth (PW, for cows) and Lactation Worth (LW, for cows).

The BW incorporates the BVs for milkfat, protein, milk volume, liveweight, fertility, somatic cells and residual survival.

The Breeding Worth (BW) therefore ranks bulls and cows on their expected ability to breed profitable and efficient replacements, since it includes the economically important traits. It is accepted and used by the dairy industry.



This book looks at all aspects of the Animal Evaluation system. In particular, it looks at the most frequently used output of the system, the BW. It explains how BW works, why it works, how it works for the dairy industry, and how you can make it work for you.

Introduction

The Breeding Worth index, or BW as we all call it, is the main output of the Animal Evaluation system. The title of this book says it all: Your Index, Your Animal Evaluation System.

Why does the BW and the Animal Evaluation system belong to you?

NZAEL is a wholly owned subsidiary of Dairy InSight, which is owned by you, the New Zealand dairy farmer. When the New Zealand Animal Evaluation Limited Board (you can call that NZAEL for short) was formed by Dairy InSight about eighteen months ago, it became the guardian of the national breeding worth index for AB sires, and was given the objective to identify animals whose progeny will be the most efficient converters of feed into profit.

The NZAEL Board decides which traits are included in the BW index, and the dollar impact of each of these traits for breeding purposes, and makes these decisions with the overall goal in mind – efficient conversion of feed into profit for New Zealand dairy farmers. Any proposed new traits for the index are adopted only after widespread consultation with users of the BW index and with scientists.

Dairy InSight appoints the NZAEL directors. At the foundation of the company it was agreed with Dairy InSight that there will always be a farmer majority on the Board. I am one of these farmer directors. The other NZAEL farmer directors are Ted Coats, John Lynskey, Philip Luscombe and Steve Ireland. Because we have a special interest in dairy cattle breeding, and in the impact of dairy cattle breeding on the businesses of our fellow farmers, we know the implications of the BW index from the practical farmer perspective. Also on the Board are people from the scientific world: Professor Hugh Blair from Massey University and Dr Bruce Thorrold from Dexcel. We also have Mark Leslie from Fonterra.

The Animal Evaluation Unit (again, you can call that AEU for short) is a division of Livestock Improvement. The AEU is the engine room that operates the national genetic evaluation system for dairy cattle on behalf of and for the good of the New Zealand dairy industry. Bill Montgomerie is the manager of that engine room. The AEU is located at Newstead, and shares the complex and facilities with Dexcel and three of the breed associations. The national database, essential to the operation of the AE system, is located there too.

What does NZAEL do for the industry?

Genetic gain is a key component of the increasing productivity of New Zealand farmers. Much of the significant improvement in average production over the last ten years is due to improved genetics, and intensely selected bulls have driven a large part of that genetic improvement. A common benchmark, or industry standard, is necessary for comparing sires.

NZAEL, as an independent industry organisation, is the ideal organisation to develop, provide and manage this industry standard for sire evaluations.

The industry standard is the BW. It has been developed to very high standards, and is governed independently by NZAEL. Other information can be used to supplement BW and provide greater or additional detail for decision making, but it is important for our industry that we have a common index system to allow comparisons and to track genetic gain.

When it comes to genetic improvement, it’s important to maintain the industry integration that has been developed over the last seventy years, because we can do much better identifying the best animals amongst the millions of dairy cattle in the national herd than we can achieve as individual farmers. The existence of NZAEL continues this integrated approach to improving genetic gain for the dairy farmers of New Zealand, and that is why its work is supported by the organisations whose logos appear on this book.

The BW is not just the industry standard, it’s *your* index.

This book will help you to understand not only the BW, but the AE system generally, so you can put your trust in it and use it to support your farming decisions, and so increase your profitability.

L.A. Satherley

Lawrence Satherley
Chairman, NZAEL

Bull Indexes

This is what the information for individual bulls looks like on the ***Ranking of Active Sires (RAS List)***, top 30 all breeds, as printed from the Animal Evaluation website:

RANKING OF ACTIVE SIRES

EVALUATION DATE 17/02/2006
BY BREEDING WORTH

Top 30 for all Breeds

Rank	Bull Code	Bull Name	Breed	Breeding Worth ($)	Breeding Values Protein (kg)	Milkfat (kg)	Milk (l)	Lwt (kg)	Fert (%)	SC (score)	Resid Surv (days)	Total Long (days)	Gene Tests	Marketer
1	501038	SCOTTS NORTHSEA	XBR	270/92	43.3	46.5	909	6.8	-2.8	-0.05	241	453	B-C-V-	LC
2	300834	OKURA MANHATTEN ET SJ3	JER	255/88	36.3	37.3	615	-22.2	0.1	0.30	203	418		Ambreed
3	301104	NOAKES NEVVY SJ2	JER	255/85	27.4	44.3	208	-41.6	4.1	0.34	13	321	V-	LC
4	300528	TAMA GROVE MAUNGA ET SJ3	JER	251/88	25.0	46.4	204	-44.8	-1.0	-0.04	156	358		Ambreed
5	101056	GLENMEAD FR RENEGADE	FRI	249/90	70.7	43.2	1896	100.8	1.4	0.22	-308	31	B-C-V+	LC
6	101140	MACFARLANES DAUNTLESS	FRI	248/86	54.6	60.5	1571	62.8	2.9	0.17	-64	333	B-C-V-	LC
7	99418	MITCHELLS LIKABULL SJ3	JER	246/91	29.1	35.6	350	-33.3	-0.1	0.02	301	494		LC
8	301025	SHEPHERDS NOONTIME	JER	245/88	29.2	45.1	357	-20.0	5.2	0.28	189	529	V-	LC
9	302010	WILLIAMS PAN LINK	JER	244/81	25.7	46.7	127	-22.3	3.1	-0.02	123	419	B-C-V-	LC
10	502031	MUDFORDS LEGENDAIRE	XBR	241/90	44.9	44.1	938	35.8	-2.0	-0.05	152	386	B-C-V-	LC
11	99495	DAYSHS LANDMARK DR	JER	241/88	27.5	45.1	445	-40.0	-0.5	-0.02	73	287	B-C-V-	LC
12	101048	GRAYS NAUTILUS S2F	FRI	238/84	47.6	50.7	1174	45.7	1.6	0.11	10	331	B-C-V-	LC
13	99441	NICKELS LIFELONG	JER	232/90	20.4	44.8	87	-46.3	-0.3	-0.10	119	321		LC
14	300515	CRESCENT FOREVER STIMULAT	JER	230/82	20.9	45.3	211	-50.3	-0.2	-0.03	187	393		Ambreed
15	301048	KINVARRA ELMO PATRICK SJ3	JER	230/84	28.7	44.1	475	-18.2	-0.2	-0.26	106	329	V-	LC
16	302003	OKURA ACE ISAAQ ET	JER	228/81	26.8	40.2	301	-30.4	-1.5	0.14	157	326		LC
17	99418	HANCOCKS LADYSMAN SJ2	JER	228/90	21.5	34.1	25	-42.0	-1.3	-0.18	236	383	B-C-V-	LC
18	101062	MITCHELLS NOTEWORTHY	FRI	228/85	47.9	48.2	1141	62.2	2.3	0.23	227	562	B-C-V-	LC
19	102049	SRC LAKESIDE OG MAGIC	FRI	228/78	58.4	54.0	1747	86.8	-1.5	-0.01	-8	278	B-C-V-	LC
20	300011	WILLIAMS MINSTREL	JER	227/88	26.7	47.4	181	-18.8	-0.1	0.51	138	386	V-	LC
21	100114	KINGSMILL R E LANCER	FRI	226/87	52.1	36.4	1318	57.8	1.7	0.05	-46	238	B-C-V+	LC
22	302614	CRESCENT GSF STANZA ET	JER	226/76	26.1	48.4	484	-47.7	-4.0	0.48	125	258		Ambreed
23	99448	KURIGERS LASSOO LOUIS	JER	223/90	27.6	31.1	348	-31.2	0.4	0.36	321	500	B-C-V-	LC
24	102090	SRB NIELSENS STORMLINE	FRI	222/78	52.1	58.3	1464	77.8	0.2	0.31	150	469	B-C-V-	LC
25	302086	FOXTON BONANZA	JER	220/79	25.7	41.3	406	-35.0	0.2	0.27	162	368		LC
26	300047	MAGHERACANON DODDY GR	JER	219/87	26.4	40.9	186	-9.3	-0.8	-0.02	169	387	V-	LC
27	301014	BOURKES NIMROD	JER	219/85	26.3	47.7	404	-14.6	4.9	0.17	75	411	V-	LC
28	500580	MARQUIS	XBR	218/89	26.3	44.9	330	-14.7	-3.3	-0.04	257	402	B-V-	Ambreed
29	99404	ERRLYN SS PRICE DR	JER	218/89	25.2	57.6	538	-21.9	-0.2	0.35	243	482		LC
30	102077	SRC GLENMEAD ROCKFEST	FRI	218/81	52.4	61.3	1369	90.8	0.6	0.44	41	377	B-C-V-	LC

To work through the explanation of the BW, let's look first at what information is shown on the *RAS List* about a bull's proof. The BW comes first, with its accompanying reliability figure. (We will discuss reliability later.)

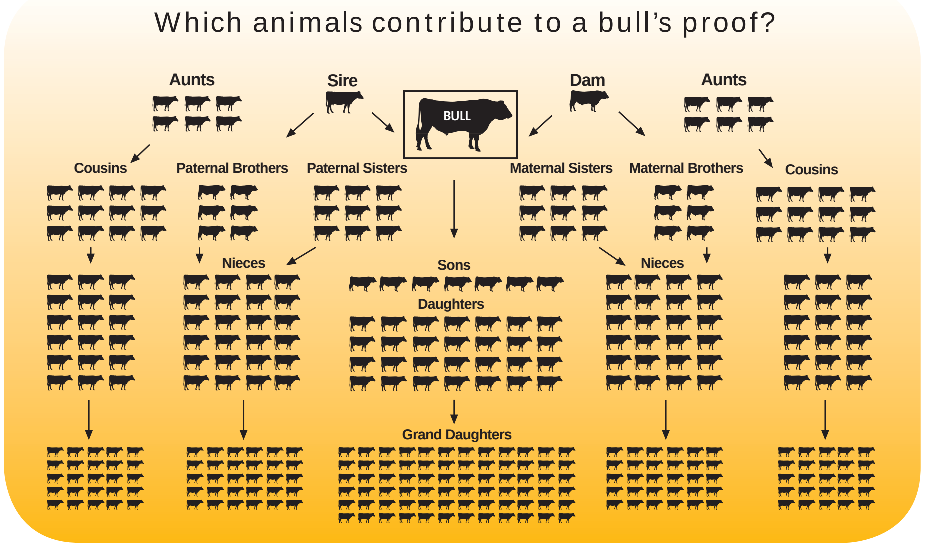
After the BW column come Breeding Values (BVs) for seven traits:

- Protein
- Milkfat
- Milk (volume)
- Liveweight
- Fertility
- Somatic Cell
- Residual Survival

You will notice a line separating those figures from the Total Longevity information; the line separates the seven traits that are included in the BW from the trait (Total Longevity) that's not included in the BW. Where do the figures in these columns come from?

Information contributing to a bull's proof

Of course, a bull does not produce milk, so all the information about production and other traits that he can pass on must come from his female relations – his dam, maternal and paternal sisters, cousins and aunts, and his own progeny – in other words, all his close female relations.



Which animals contribute to a bull's proof?

Every bull on the RAS List has many relations contributing to his proof.

All production information (protein, milkfat, milk, and somatic cell) on these females comes from herd test data, which is why Herd Testing is so important for individual farmers and the industry. Liveweight data is derived from physical weighing. Fertility and longevity data are derived from mating and calving records.

Every female relative is compared with her herdmates, and to make comparisons fair, she is looked at in her contemporary group. That is, she is compared with animals of the same age, in the same season of calving, and in the same herd. In this way, the system finds out how much better (or worse) the related females of a particular bull are on average than their contemporaries.

Because of all the variables involved, the precise effect of a bull on his daughters cannot be predicted or calculated, ie. we cannot ever say that this animal's daughters are expected to produce this number of litres of milk, be this weight, or live this long. We can say that his daughters are expected to produce this many ***more or less*** litres of milk, be this many kg ***heavier or lighter,*** or last this many days ***longer or not so long*** in a herd than another bull's daughters in the same situation. That is, we can calculate the expected differences between any animals for any trait or combination of traits we wish to consider. For ease of comparison, we establish a genetic base.

Base cow

A genetic base is set arbitrarily. In the case of AE at present, the base is set to the average of a group of 1985-born cows, usually called the base cow. At each Animal Evaluation run, the average current breeding value for these nearly 30,000 1985-born cows is set to zero for all traits to form a reference point for comparison.

Breeding Values

Once this has been done, the figure for every bull can be compared with this reference point to produce the bull Breeding Value (BV) for that trait.

The BVs for each trait are shown on the *RAS List* in the seven columns labelled Breeding Values. (Breeding Values are also calculated in a similar way for each TOP trait, but these are not shown on the *RAS List*.)

Breeding Worth

The whole aim of the BW system is to identify animals whose progeny will be the most efficient converters of feed into farmer profit.

And so NZAEL has to decide which traits are the important contributors to an animal's profitability and, for those traits, what is the relative importance of each one. And then it develops the BW which considers all those traits. The BW therefore indicates how efficiently an animal's progeny is expected to convert feed into profit.

The BW currently includes seven traits: Protein, Milkfat, Milk (volume), Liveweight, (cow) Fertility, Somatic Cell, and Residual Survival.

In order to identify the most profitable bulls, we need to know how important each trait is economically. In other words, how much extra profit is an animal expected to produce for every extra unit of BV it has for that trait?

Economic Values

Economic Values (EVs) are calculated using farm economic models which take into account milk production, income from cull cows and bobby calf sales, costs in generating and rearing replacements and dairy cash expenses. And they are based on a base unit of feed of 4500kg (4.5t) dry matter per year. They are also based on expected payouts for milk components in the future.

EVs are updated every 12 months (in February). As at 16 February 2006, the current EVs ($ per BV unit) are:

Protein EV	$6.328	Milkfat EV	$1.251
Milk EV	-$0.070	Liveweight EV	-$0.987
Fertility EV	$1.638	Somatic Cell EV	-$21.744
Residual Survival EV	$0.033		

Three of the BW traits – Milk, Liveweight and Somatic Cell – have a negative value.

Combining all the information into one index

Now it's a simple matter to combine all this information to get one all-embracing index for profitability – and this is the simplest piece of mathematics in the whole BW process! Just simple arithmetic, thus:

HOW IS BW CALCULATED?

Protein BV	×	$6.328
Milkfat BV	×	$1.251
Milk BV	×	−$0.070
Liveweight BV	×	−$0.987
Fertility BV	×	$1.638
Somatic Cell BV	×	−$21.744
Residual Survival BV	×	$0.033
		ADD

Add (combine) all these together. The resulting figure is the BW.

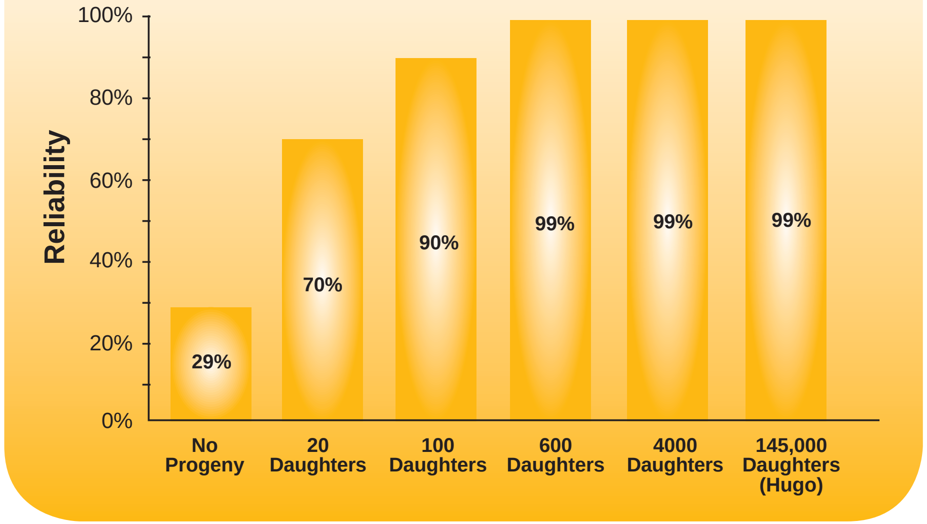
Reliability

Reliability, which is shown as a number on a scale of 0 to 99, measures how much information has contributed to the trait evaluation for the animal, and so it indicates how confident we can be that the BV is a good indication of the animal's true merit.

If the Reliability is high (in the nineties) the index is not likely to change greatly as further information is included in its evaluation. (It still can change greatly, but the chances of it changing greatly are small.) The lower the Reliability, the more likely it could change greatly.

The more information (ie. daughters and lactations) included in the evaluation, the higher the Reliability. If we know absolutely nothing about the bull or any of his relations (which would probably only be the case if we did not know his identity), he would have a Reliability of 0.

How does the number of progeny affect a bull's BW reliability?



It's important to realise that the Reliability says nothing about the bull – it refers to the amount of information we have about the bull's relations in general, and daughters in particular. We might say, "This bull has a low Reliability", but we really mean that the bull's evaluation is based on the performance records of only a small sample of daughters.

To get on the *RAS List* a bull must, among other things, have a BW Reliability of 75 or more. But, in fact, all bulls can be evaluated, no matter what their reliability.

Study of an individual bull

Bulls can achieve high BW with different trait combinations.

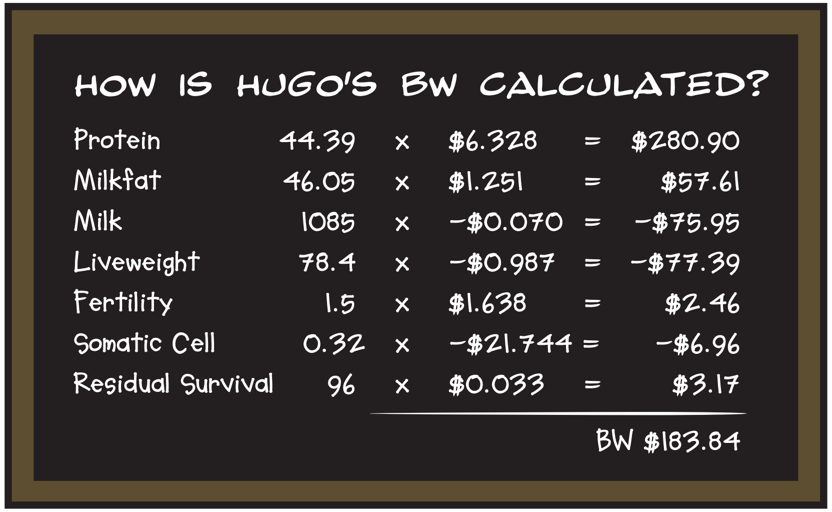
Let's now study in detail the AE information provided for a particular bull. With 149,640 daughters, SRB Collins Royal Hugo is the most heavily used bull ever in the history of New Zealand dairying.

This is what his production BVs are on the AEU website (as at 20/2/06):

BW	184/99	Protein	44.39kg
Milkfat	46.05kg	Milk	1085 litres
Liveweight	78.4kg	Fertility	1.5%
Somatic Cells	0.32	Residual Survival	96 days

His BW

Hugo's BW is 184/99 (99 is the Reliability figure.) Combining all Hugo's BVs as shown on the previous page, we get:



HOW IS HUGO'S BW CALCULATED?

Protein	44.39	x	$6.328	=	$280.90
Milkfat	46.05	x	$1.251	=	$57.61
Milk	1085	x	-$0.070	=	-$75.95
Liveweight	78.4	x	-$0.987	=	-$77.39
Fertility	1.5	x	$1.638	=	$2.46
Somatic Cell	0.32	x	-$21.744	=	-$6.96
Residual Survival	96	x	$0.033	=	$3.17
					BW $183.84

Hugo's BW is 183.84, or 184 in round figures.

The figures making up the BW are very interesting in themselves. Take a moment to look at the total for each one. For perhaps the first time you can get an appreciation of how much each trait contributes to the overall profitability index.

As we study all the figures for Hugo, it's important to remember that a bull – or a dam, for that matter – passes (transmits) half of its genetic merit, on average, to immediate offspring. You can look at the BW in a short-term context, or in a long-term context.

In a short-term context, you can conclude: Hugo's daughters are, on average, expected to generate $92 (half of $184) more profit per 4.5t DM, per year, than the daughters of a bull with a BW of 0.

Or, in a long-term context, you can conclude: using Hugo to breed a replacement is expected to generate $184 more profit per 4.5t DM, per year, than using a bull with a BW of 0. Half of this extra profit comes from the replacement herself, and the rest from her descendants being more profitable than the descendants of the bull with a BW of 0.

Remember the BW is given in terms of today's dollar, so you can get a really good idea of how much better (or worse) one bull is compared to another. Or you can compare this bull to the average Holstein-Friesian bull. The Reliability for Hugo's BW is 99, which indicates that there is a large amount of information in his proof, and therefore that his BW is not expected to change greatly as more information is included in his evaluation.

Let's now look at the rest of the *RAS List* information shown for Hugo.

His Protein, Milkfat and Milk BVs

Hugo's Protein BV of 44.39 indicates he is expected to transmit 22.20kg (half of 44.39) more protein per lactation than a bull with a Protein BV of 0 will transmit.

Likewise, his Milkfat BV of 46.05 indicates he is expected to transmit 23.03kg more milkfat per lactation than a bull with a Milkfat BV of 0, etc.

Note that the Milk BV is more correctly Milk Volume BV, and is measured in litres.

His Fertility BV

The Fertility Breeding Value, or more correctly, the Cow Fertility BV, refers to the % extra likelihood of a bull's daughters calving in the first 42 days of the herd's calving period.

Hugo's Fertility BV of 1.5% indicates that 0.75% more of his daughters are expected to calve in the first 42 days of the herd's calving period compared to the daughters of a bull with a Fertility BV of 0%.

Notice the Fertility BV does not refer to the bull's fertility. Neither does it refer to the likelihood of the bull's offspring being born in the first 42 days of the calving period, but to the likelihood of them giving birth within that time when it is their turn to calve.

His Somatic Cell BV

SC BV indicates the merit of a bull for somatic cell counts (SCC) measured as a "score".

Unfortunately, Somatic Cell (SC) score is not so easy to interpret as the BVs we've already looked at. However, it's easy to grasp that the lower the SC score, the better. Negative is good!

A good benchmark or rule of thumb is that a BV score of 1 equates to approximately 75,000 extra SCC transmitted to daughters than a bull with a score of 0 would transmit.

The AEU gives a useful guide: bulls with SC BVs greater than 0.7 are among the worst 10% of sires for increasing SCC; while bulls with SC BVs less than -0.2 are among the best 10% of sires for reducing SCC.

Hugo's SC BV of 0.32 indicates that he is in the middle 80% – neither exceptionally good nor exceptionally bad in this respect.

Ancestry and performance records

Before a sire has any daughters of his own, his BW is calculated using ancestry information only. As data from his own progeny comes to hand, his BW starts to reflect his progeny data more and more, and his ancestry data less and less. In other words, a weighting is applied to the ancestry and progeny records.

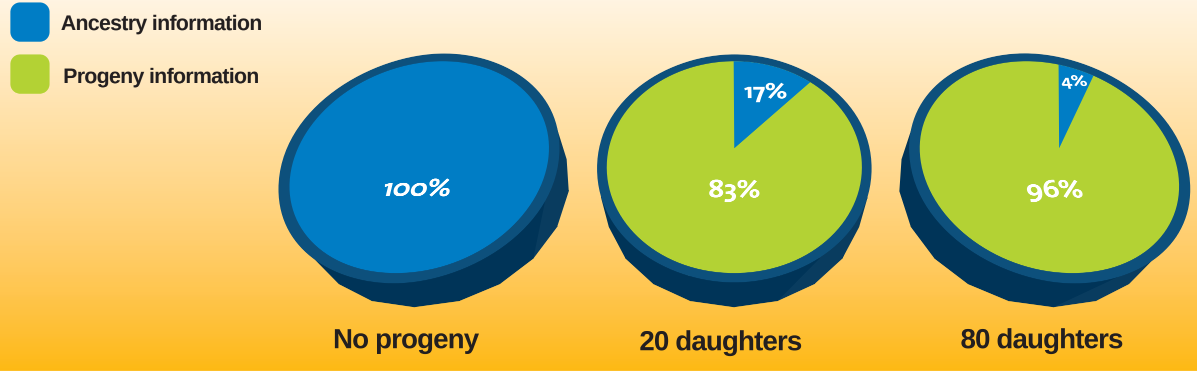
The illustration below shows typical cases of the relative importance or weighting of ancestry and progeny records in determining a bull's BVs and BW.

Bulls not on the ***RAS List***

Not all bulls appear on a *RAS List*. However, the evaluations of those that don't are available through the AEU website. They are also published annually in the *New Zealand Dairy Sire Summary,* available from AEU about May of each year.

A bull can have an evaluation even if he has no daughters, or no daughters yet herd tested. Such a bull is called an unproven bull.

How is ancestry/progeny information weighted in a bull's BW?



(Approx guide only)

Traits not shown on the ***RAS List***

So far, we have only looked at the traits commonly grouped together and headed up "Breeding Values" on the *RAS List.* Animal Evaluation also produces indexes for Milkfat % and Protein %, Calving Difficulty, Body Condition Score, and all the 16 traits commonly known as Traits Other than Production (TOP), all of which are available on the AEU website.

Calving Difficulty

Animal Evaluation calculates Calving Difficulty BVs to help AB organisations assess the suitability of bulls for mating with yearling heifers, and so that farmers can tell which bulls cause higher than usual rates of calving assistance when mated to their cows and heifers.

Calving Difficulty refers to the degree of difficulty a cow has when giving birth to calves sired by the bull in question. It does not refer to the difficulty with which the bull's daughters will calve.

A sire's Calving Difficulty Breeding Value (BV) predicts the percentage of assisted calvings expected when he is mated to yearling heifers. The higher the BV, the higher the expected percentage of assisted calvings. Since this is a bull's own trait that is exhibited when his calf is being born, not a cow trait, the base for this trait is not the 1985-born cow, but the average BV of sires born in 1985.

Cows mated to a sire with a Calving Difficulty BV of 10% are expected to have, on average, five more assisted births per 100 compared with cows mated to a sire with a Calving Difficulty of 0. (A bull transmits half his BV to his immediate offspring, which is the animal being born and causing the possible difficulty.)

Although Calving Difficulty information is based on assisted births in ***first calvers,*** the BV can also be used to identify bulls that are expected to increase the rate of calving assistance for ***cows*** carrying the bull's calves.

Body Condition Score

Body Condition Score (BCS) is commonly used as a method to assess body energy reserves. BCS is included in the Fertility BV because there is a high correlation between BCS and fertility. The inclusion of BCS in the Fertility index has improved the evaluation of the fertility trait – and it's expected that this will improve both traits in the long run.

TOP traits

The 16 TOP traits evaluated are:

• adaptability to milking	All scored by the farmer
• shed temperament	
• milking speed	
• overall opinion	
• stature	All scored by qualified inspectors
• body capacity	
• rump angle	
• rump width	
• legs	
• udder support	
• front udder	
• rear udder	
• front teat placement	
• rear teat placement	
• udder overall	
• dairy conformation	

As two-year-olds, daughters of bulls are evaluated for TOP traits using a scale from 1 to 9, where 1 and 9 represent the biological extremes.

As with the production BVs, the scores of all female relatives of the bull are used to produce a BV for each TOP trait.

The interpretation of TOP BVs is no different from the interpretation of production BVs, ie. a bull passes half its genetic merit on average to his offspring. So you can calculate the difference a bull is likely to make when mated to a base cow, and see whether he is better (or worse) than another for a specific trait. With most of these traits, since the BVs don't have as big a range as the production traits do, we are dealing with much smaller numbers and with much smaller variations from the base.

What's good, what's bad

Because TOP scoring uses a scale from 1-9 where 1 and 9 represent the biological extremes, we cannot generalise and say that a positive score is better than a negative one. And even if it is, we can't say that the bigger the score, the better. In many cases, one extreme is as bad as the other.

You should always look at what the BV figures mean when they are used to score a trait. (See example below.)

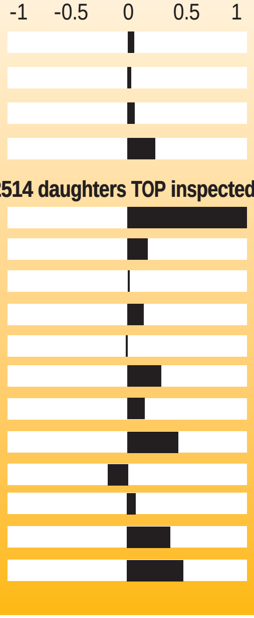
Hugo's Traits Other than Production (TOP), as taken from the AEU website

TOP Breeding Values

MANAGEMENT	**BV/Rel**		
Adaptability to milking	0.07/98.9	slowly	quickly
Shed temperament	0.05/98.9	nervous	placid
Milking speed	0.08/99.0	slow	fast
Overall farmer opinion	0.34/98.9	undesirable	desirable

2514 daughters TOP inspected

CONFORMATION			
Stature	1.25/99.0	small	tall
Dairy capacity	0.25/99.0	frail	capacious
Rump angle	0.02/99.0	high pins	sloping
Rump width	0.23/99.0	narrow	wide
Legs	-0.01/98.2	straight	curved
Udder support	0.38/99.0	weak	strong
Front udder	0.21/99.0	loose	strong
Rear udder	0.40/99.0	low	high
Front teat	-0.22/99.0	wide	close
Rear teat	0.11/99.0	wide	close
Udder overall	0.38/99.0	undesirable	desirable
Dairy conformation	0.44/99.0	undesirable	desirable



From the Animal Evaluation run on 18 February 2006

Changes to a bull's indexes

Information about an individual bull is growing by the minute, as more information about his female relations is recorded on the database.

So, theoretically, the estimates of BW could change by the minute, and if the computer power were available, the indexes could be updated on an instantaneous basis. (This could happen in the future – who knows!) In the beginning, indexes were updated once a year, now they are updated approximately every 3-5 weeks. This is called an Animal Evaluation "run".

Two sorts of updating take place during a run:

- The usual, run-of-the-mill updates to include the new data (production and TOP) that has come in about a bull's female relations since the last update.
- Occasional updates to incorporate changed inputs into the system. These changes could be regular changes necessitated by updates of the Economic Values (currently once a year), or Interbull information (currently four times a year the latest international information is brought into the system), or changes to the Animal Evaluation system brought about by changes in the way indexes are calculated or by the addition of new breeding values to the index.

Sometimes these occasional changes bring about some significant changes in bull (and cow) indexes, which is why you can only ever compare indexes from the same Animal Evaluation run. When this happens, the Animal Evaluation unit publicises the reasons for the changes – on its website, in the dairy industry publications, and in media releases.

The AE system is a "living" system that can be changed and adapted to cope with changes or to meet new requirements of the dairy industry. For example, the information included in an evaluation might change (as it has done in the past); economic values might change (as they do every year); the method of calculating a BV might change (as it does when statistical methods are developed and computer capabilities improved); and the industry might consider it desirable to change the base cow (to a current national herd average, for example).

In some of the above scenarios, BWs and BVs could change in appearance, perhaps dramatically. But mostly, the dramatic changes are merely changes in the way we "label" or describe the merit of our animals.

It's important to understand that a leopard doesn't change its spots, ie. a bull himself does not change. His genetic merit is the same all his life, no matter what his current indexes are. At the end of the day, a BW, BV or any other evaluation, is only an estimate of a bull's genetic merit. Long-term, as the Animal Evaluation system collects more and more authentic information about the bull's daughters, his index should become a better and better (closer and closer) approximation of his true genetic merit.

Cow Indexes

So far, we have discussed only bull indexes. Bulls have an enormous part to play in genetic improvement of the national herd because one bull can sire a huge number of cows. However, even though dams have limited numbers of progeny, they also have an important role to play in genetic progress.

Just as bull indexes are the tools for finding the best bulls to breed from, cow indexes facilitate the breeding decisions on-farm. Secondly, they provide additional information to facilitate efficient and profitable farm management.

There is a third use for cow indexes, an industry use – the national averages show whether the NZAEL is achieving its task of identifying bulls whose progeny are the most efficient converters of feed into farmer profit.

This section looks at the indexes that come out of the Animal Evaluation system relating to cows – BW, PW and LW; and BVs and PVs. These cow indexes are provided by Livestock Improvement (LIC), and are available to farmers through the LIC MINDA service, or can be purchased from Livestock Improvement by other herd record or herd testing suppliers.

We recommend that you read the section on bull indexes before reading this section on cow indexes, since explanations given there are not repeated here.

Cow BWs, PWs and LWs are widely used and widely accepted as the industry standard. Even farmers who do not get BW and other indexes for their own cows use them as a guide when they are buying in animals for their herd, as the BW can be used to compare cows across all herds, ages and breeds.

Various cow indexes appear on MINDA reports, depending on the management purpose of the report. This section will look at all indexes.

Information contributing to a cow's evaluation

Cows differ from bulls in that their own performance can be measured and be part of their evaluation. So a cow's BVs consider:

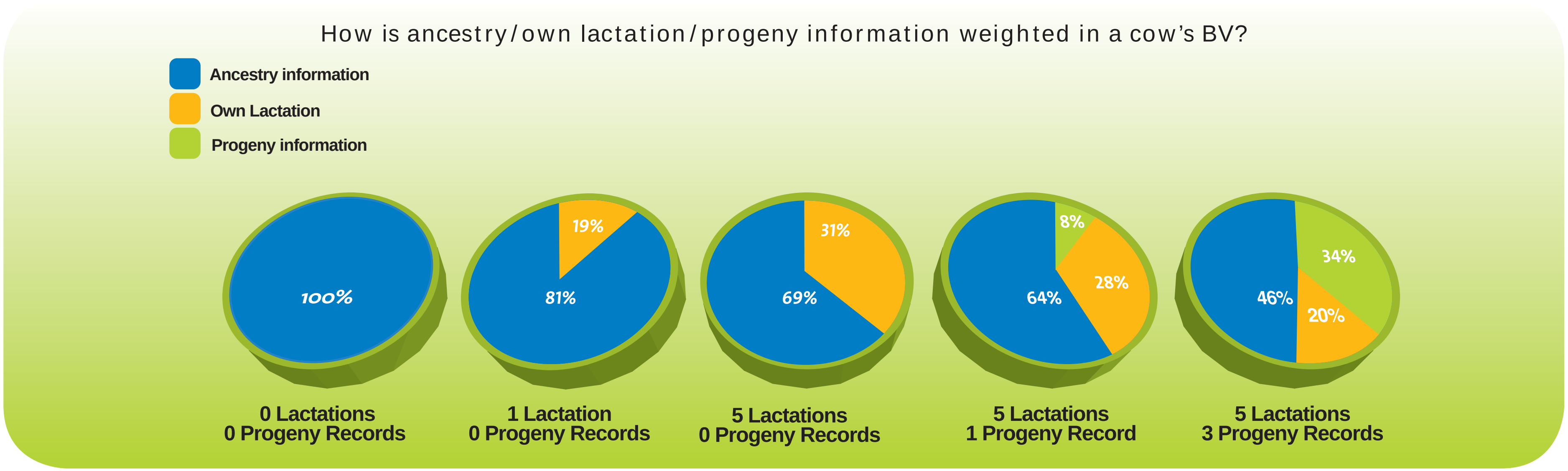
- ancestry (which includes all female relatives related through ancestry, ie. sisters, nieces, etc) – this information is used when she is a calf
- her own performance – this information is included once she is milking
- the performance of her offspring (or direct descendants) – this information is included once she has herd-tested daughters

The evaluation of an untested cow is based solely on ancestry records. As a cow increases her number of lactations and therefore her number of herd tests, the weighting on her own records increases and the weighting on the ancestry information decreases.

If she has progeny (daughters or daughters of sons) with records, these will also contribute to her evaluation. The weightings used for the BV and BW calculations are different from the weightings used for PV and PW calculations.

The weighting system is applied to all traits individually. So, for example, a cow might have no liveweight information of her own (in which case, her Liveweight BV would be based entirely on ancestry information), but have records of several lactations (in which case, her Production BVs would be based on her own performance).

The diagram on the next page shows the weightings for a cow's BVs at different stages of her herd life. The corresponding diagram for PVs is shown on page 15.



How is ancestry/own lactation/progeny information weighted in a cow's BV?

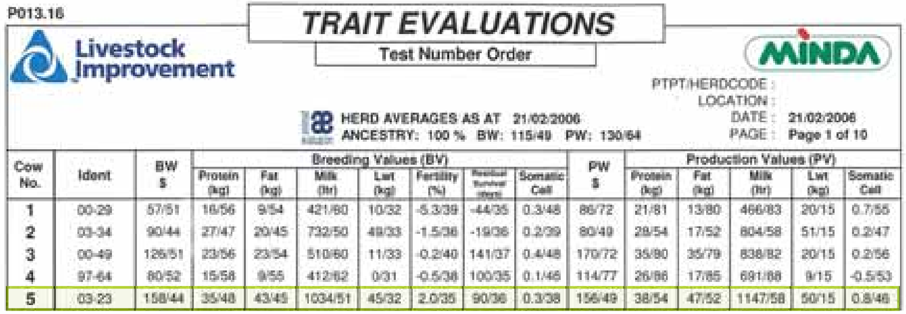
(Approximate guide only)

Cow Breeding Worth

The BW index is widely used for cows. Like the bull BW, it ranks animals on their expected ability to breed profitable and efficient replacements.

The same seven trait BVs contribute to a cow's BW as to a bull's BW, ie. Protein, Milkfat, Milk, Liveweight, Fertility, Somatic Cell and Residual Survival. The cow BW is calculated in the same way as the bull BW, and the same economic values apply.

Cow BVs are shown on a *Trait Evaluations* report like the one below:



P013.16

TRAIT EVALUATIONS

Test Number Order

Livestock Improvement

MINDA

PTPT/HERDCODE :
LOCATION :
DATE : 21/02/2006
PAGE : Page 1 of 10

HERD AVERAGES AS AT 21/02/2006
ANCESTRY: 100 % BW: 115/49 PW: 130/64

Cow No.	Ident	BW $	Breeding Values (BV)							PW $	Production Values (PV)				
			Protein (kg)	Fat (kg)	Milk (ltr)	Lwt (kg)	Fertility (%)	Residual Survival (days)	Somatic Cell		Protein (kg)	Fat (kg)	Milk (ltr)	Lwt (kg)	Somatic Cell
1	00-29	57/51	16/56	9/54	421/60	10/32	-5.3/39	-44/35	0.3/48	86/72	21/81	13/80	466/83	20/15	0.7/55
2	03-34	90/44	27/47	20/45	732/50	49/33	-1.5/36	-19/36	0.2/39	80/49	28/54	17/52	804/58	51/15	0.2/47
3	00-49	126/51	23/56	23/54	510/60	11/33	-0.2/40	141/37	0.4/48	170/72	35/80	35/79	838/82	20/15	0.2/56
4	97-64	80/52	15/58	9/55	412/62	0/31	-0.5/38	100/35	0.1/46	114/77	26/86	17/85	691/88	9/15	-0.5/53
5	03-23	158/44	35/48	43/45	1034/51	45/32	2.0/35	90/36	0.3/38	156/49	38/54	47/52	1147/58	50/15	0.8/46

You can use the same formula and the same Economic BVs as for calculating the bull BW on page 10 to calculate Cow No. 5's BW.

HOW IS COW NO. 5's BW CALCULATED?

Protein	35	x	$6.328	=	$221.48
Milkfat	43	x	$1.251	=	$53.79
Milk	1034	x	-$0.070	=	-$72.38
Liveweight	45	x	-$0.987	=	-$44.42
Fertility	2.0	x	$1.638	=	$3.28
Residual Survival	90	x	0.033	=	$2.97
Somatic Cell	0.3	x	-$21.744	=	-$6.52
					$158.2

Using a calculator once again, we get the animal's BW, 158.2.

(Because each BV on the *Trait Evaluations* report is rounded to the nearest whole number or to one decimal place, your calculations may result in a BW figure 1-3 units away from the official figure shown on the report.)

This BW of 158 indicates Cow No. 5 is expected to generate an extra $79 profit per year, per unit of feed, through breeding daughters which are more efficient producers than the daughters of a cow with BW 0.

If you are thinking in terms of breeding, remember this cow is expected to pass, on average, half of her merit to offspring. So her son or daughter can be expected to have a BW made up of half her BW and half the sire's BW.

If you are thinking in terms of the value of this cow herself, her use as a dam of replacements is expected to generate an extra $158 profit per year for you, than a cow with a BW of 0. Half of this extra profit comes from the immediate daughter, and the rest from her descendants.

The BW is comparable across all herds, ages and breeds, so it can be used for making breeding, culling or buying decisions.

The Breeding Worth ranks a cow on her expected ability to breed profitable and efficient replacements, but does not say so much about her own ability to be a profitable and efficient lifetime producer. The Production Worth (PW) is the index that has been developed specifically for that purpose.

Basically, the BW is mostly about her family, and the PW is mostly about the cow herself.

Production Worth (PW) for cows

Like the cow BW, the PW is also based on ancestry, individual and progeny records.

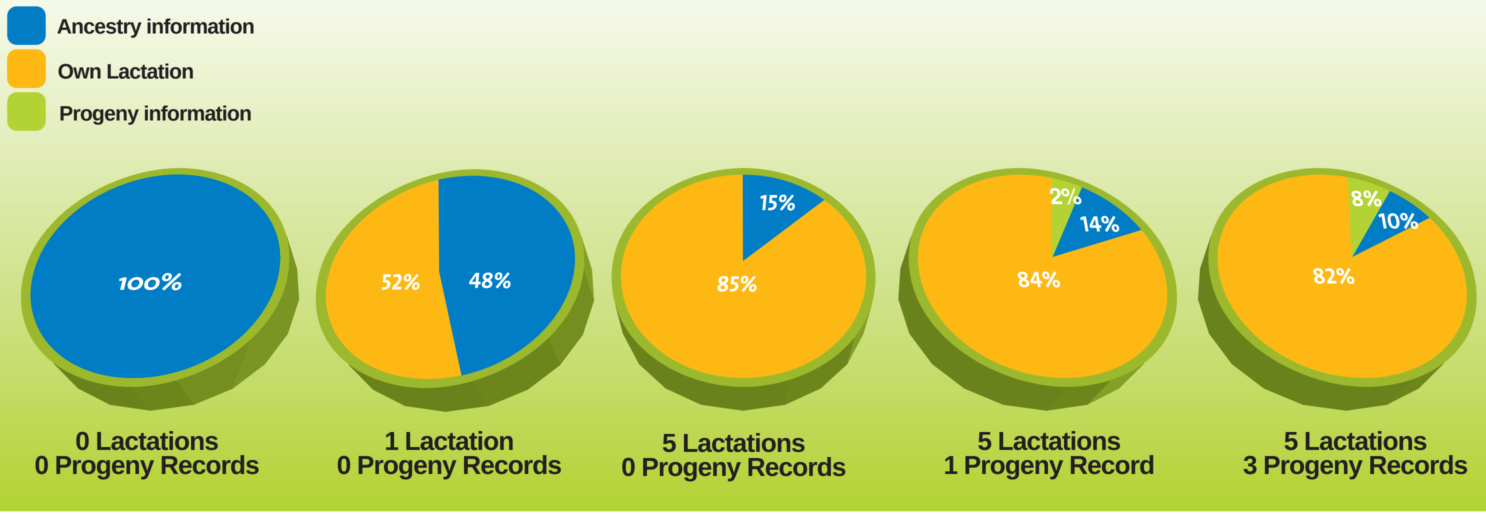
Cows are given Production Values for the four individual traits of Milkfat, Protein, Volume, and Liveweight, and these are then combined into a PW using Economic Values (EVs).

The PVs basically use the same information about the cow's ancestry, female relations and her own production as her BVs do, but combine the information in a different weighting that reflects high repeatability of production performance from one season to the next. The weighting placed on a cow's own records is much greater than those for ancestry and progeny when calculating PVs. (See the diagram below.) This is because the PVs/PW measure the lifetime producing ability of the cow herself, not what she is expected to pass on to offspring.

The EVs used for the PW are different from the EVs used for BW because their purposes are different, and they are looking at a different time-frame.

The nature of a BW demands that its EVs be calculated on a long-term basis (looking forward 20 years), whereas the PW has EVs that are calculated over the lifetime of a cow (10 years).

How is ancestry/own lactation/progeny information weighted in a cow's PVs?



(Approximate guide only)

As at 20 February 2006, the current EVs used for calculating the PW are:

Protein EV	$5.709
Milkfat EV	$1.266
Milk EV	-$0.067
Liveweight EV	-$0.901

Once again, it's a simple matter to combine all this information to get one all-embracing PW index for Cow No. 5 by adding the four components. (Her PVs are shown in the report on page 14.)

HOW IS COW NO. 5'S PW CALCULATED?

Protein	38	X	$5.709	=	$216.94
Milkfat	47	X	$1.266	=	$59.50
Milk	1147	X	-$0.067	=	-$76.85
Liveweight	50	X	-$0.901	=	-$45.05
					154.54

And the total is 154.54. (Because each PV on the *Trait Evaluations* report is rounded to the nearest whole number, or to one decimal place, your calculations may result in a PW figure 1-3 units away from the official figure shown on the report, as in this example.)

The official PW of 156 indicates this Cow No. 5 is expected to generate an extra $156 profit per year, per unit of feed, on average over her lifetime, more than a cow with a PW of 0.

The PW is comparable across all herds, ages and breeds, so it can be used as a guide for culling and buying decisions.

Lactation Worth for cows (LW)

Lactation Worth ranks cows on their expected ability to be profitable and efficient producers within the current season only.

A cow's LW is a combination of her current-season producing ability for Milkfat, Protein, Milk volume and Liveweight. It is based on her own herd test records, as well as liveweight. A cow's LVs are calculated for each of the four traits and combined into a Lactation Worth using EVs that differ from the EVs used for BW and PW. (Cow LVs do not feature on any reports because they are of limited use, but they are calculated by the AE system because they are needed for calculating the LW.)

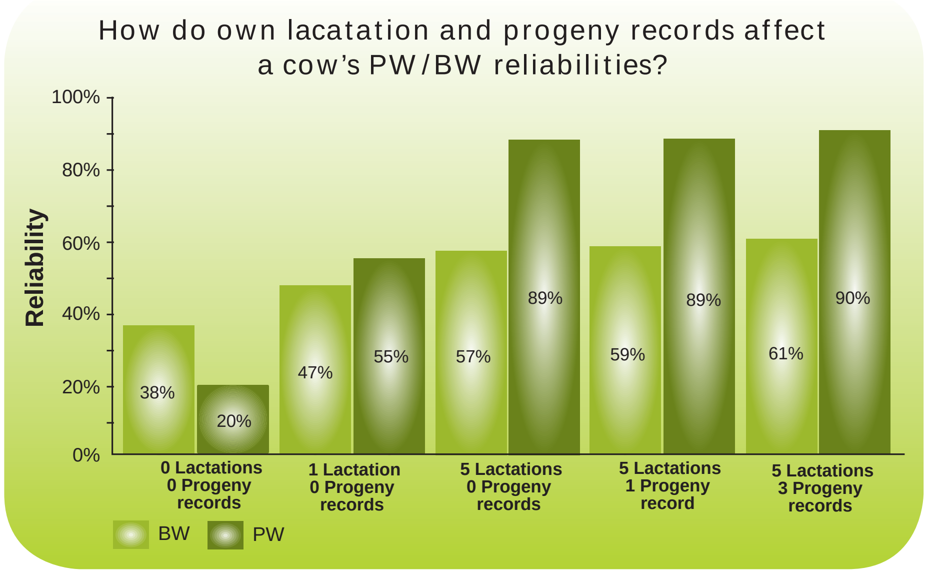
An LW of 200 for example, indicates a cow is expected to generate an extra $200 profit per unit of feed in the current season more than a cow with a LW of 0.

The LW is comparable across all herds, ages and breeds. However, since LVs and LWs provide only a current season ranking of a cow's profit and efficiency (rather than a lifetime ranking), they are of limited use for long-term decision-making.

Reliability of BW and PW

Reliability is a measure of the amount of information which has contributed to an evaluation. The more ancestry records, herd tests, and progeny information included in the evaluation, the higher the confidence we can have in the figure, and the less likely it is to change significantly with additional records.

The following diagram shows the reliabilities for a cow's PW and BW at different stages of her herd life.


How do own lacatation and progeny records affect a cow's PW/BW reliabilities?

(Approximate guide only)

BW, PW and LW at a glance

A cow's performance is affected by all these factors:

- herd/year/season/age (age at calving, period of calving)
- genetic merit
- permanent factors (hybrid vigour, permanent environment)
- temporary factors (management, temporary environment)

Her actual performance can be represented by the diagram below.

And so the BW is a measure of the cow's expected profitability based on genetically transmitted factors, the PW is a measure of her profitability based on genetics and other permanent factors, and the LW is a measure of her current performance and her expected profitability based on her genetics and permanent factors and temporary factors.

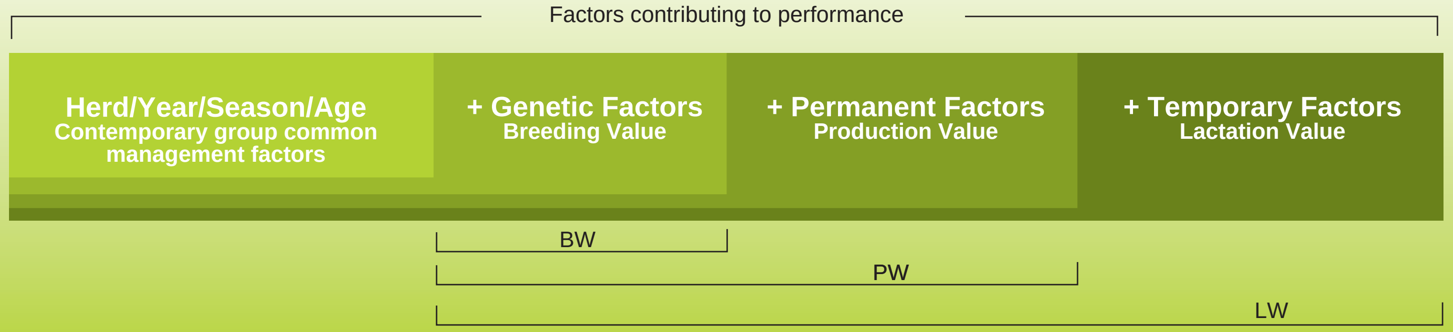
Changes to a cow's indexes

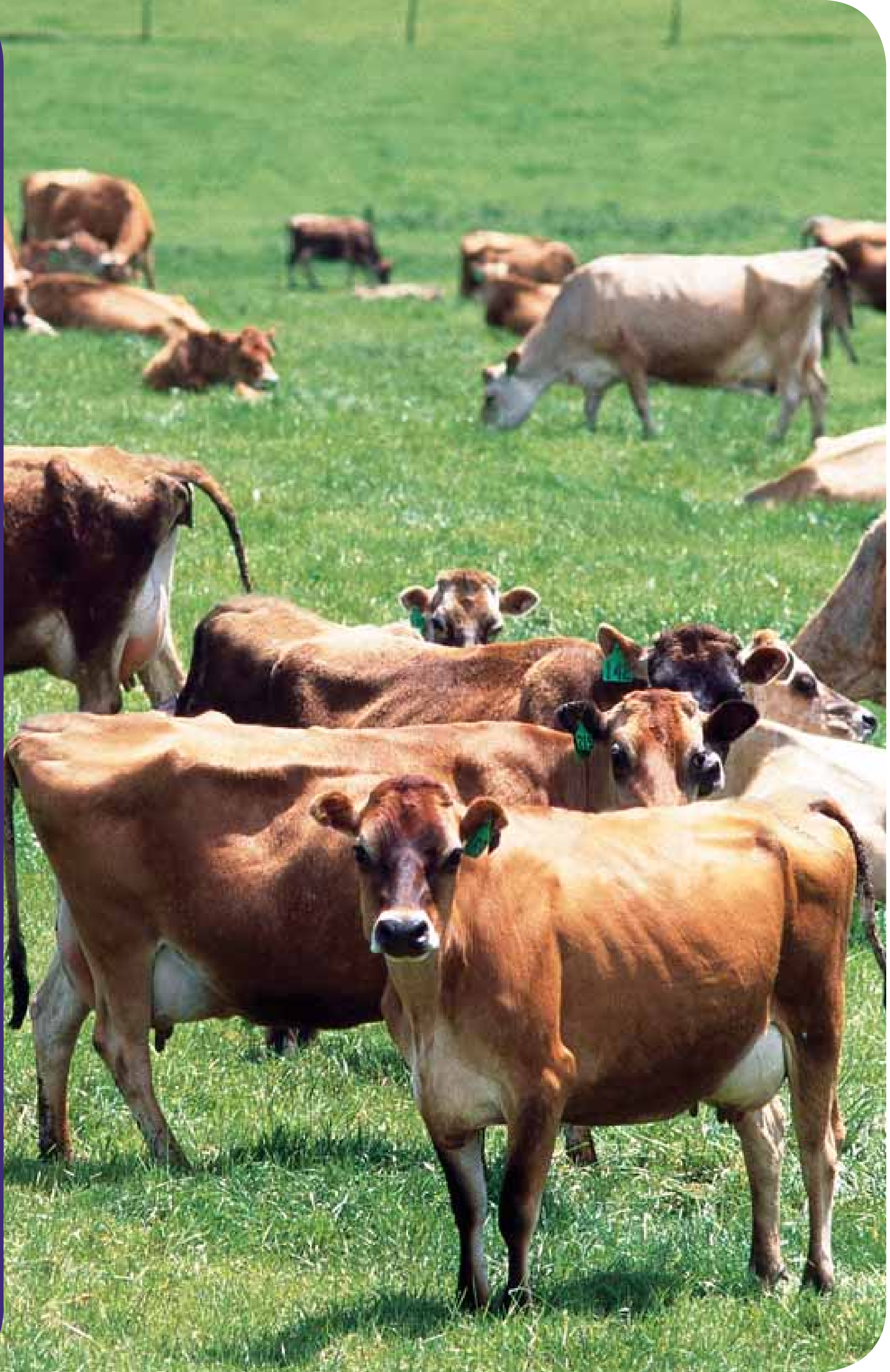
Cow indexes change for the same reasons that bull indexes do (see page 11). But you are probably not as aware of the changes in bull indexes from birth to first proof (although they are published on the AE website) as you are of the changes in the indexes of your own cows.

The indexes of your cows change before your eyes as they progress from being based 100% on ancestry at birth, to having a combination of ancestry and her own production once she is milking and being herd tested. As with a bull's indexes, the ancestry part of her index is changing by the minute as information about all her relatives enters the database.

Your cow indexes may change whenever the database is updated.

BW, PW and LW at a glance





Herd Indexes

Herd BW and PW and reliabilities

The AE system also calculates Breeding Worths and Production Worths for herds, each with their own reliability figure.

The Herd BW and Herd PW are straight averages of the BWs and PWs of the animals in the herd.

Regional and national herd averages are calculated by Animal Evaluation, and are shown on some MINDA herd reports, available on the AE website, published from time to time by the AEU, and also recorded in the annual publication, *Dairy Statistics*.

The *MINDA Herd Test Report* shows national and regional averages, along with the figures for the top 5% of herds for PW and BW.

The reliabilities attached to the Herd BW and Herd PW are also a straight average of the reliabilities of the indexes of the numbered animals in the herd.

Statistically speaking, such averaged reliabilities don’t tell you much. However, as a rough rule of thumb, and depending on the stage of season, you could expect herds being herd tested to have a BW reliability of about 45% and PW reliability of 55-60%. So those sorts of figures would tell you that the herd is herd tested regularly, while a PW reliability of 30% would tell you that the information is mostly based on ancestry rather than performance (i.e. herd testing).

Accompanying the Herd BW and Herd PW is a Recorded Ancestry figure. This records the percentage of cows in the herd that have a known sire (it excludes cows with multiple possible sires). So the Recorded Ancestry figure is an “identified paternity” measure.

The Herd BW and PW can be used to compare all herds in New Zealand, regardless of their breed make-up, so it can be used as a guide for selling and buying decisions.

How to use Animal Evaluation Indexes

The BW for breeding decisions and the PW for cow selection decisions summarise large quantities of information. Individual trait BVs and other specialised indexes provide additional, in-depth information on a large range of traits, allowing you to make the best all-round decision to suit your objectives.

However, animal indexes are just part of the total range of information that can be used to aid farm management, breeding and buying decisions. They should be used to help you with decision-making, not instead of decision-making.

1. For breeding replacements

The bull BW/Reliability is the industry standard for selecting bulls to breed the most profitable and efficient replacements. Use the individual trait BVs to help you fine-tune your selections according to your objectives.

The Reliability figure should also be considered.

The cow BW is a comprehensive guide for identifying the cows that will breed the most profitable and efficient replacements. Use it, along with your knowledge of your animals, to fulfil your breeding aims.

An animal's lactation records on their own are not sufficient for estimation of her genetic merit. Use cow indexes.

Trait evaluations can be used to focus breeding and selection decisions on individual traits of interest, eg. protein, volume, conformation and management traits. However, they should always be considered along with economic evaluations to ensure overall profitability is not compromised. It is important to remember that no single trait evaluation will be the best measure for you to base decisions on.

2. For culling poorer producers

PW and BW can be used as a guide for culling animals, based on their expected ability to be profitable and efficient lifetime producers, as well as their ability to breed profitable and efficient replacements.

Remember that both the BW and PW can be compared across age groups and breeds. So a cow with a PW of 163 is expected to be a more efficient and profitable animal than one with a PW of 136, regardless of their respective ages. In fact, she can be expected to produce $27 more profit per lactation than the lower PW cow.

The Production Worth (PW) index is the best measure of a cow's expected lifetime ability to convert feed into profit, but not all cows are at the same stage of their lifetime at the point where culling decisions are made. Farmers emphasise the PW index in their culling decisions, but also take account of health factors, suitability of the cow for their milking system, the next expected calving date of the cow, and the expected future life of the cow at the time of the decision.

Some farmers prefer to weed out poor performing young cows very intensively, while others like to give these cows a second chance. In addition, some farmers like to consider the BW of the cow in making the culling decision on the grounds that some future replacements might be retained from the cows under consideration for culling.

The Lactation Worth (LW) can be used in the case of an older cow whose current lactation performance as shown by LW indicates that she is no longer as good as she used to be. A low LW compared to PW in these cases might indicate that the cow is a suitable candidate for culling.

3. For buying and selling animals (herd, group or individuals)

Buyers and sellers take account of large quantities of information, including PW and BW, when they are agreeing prices at which to trade stock. AE indexes are an unbiased evaluation of how profitable an animal is expected to be in the national herd. They are comparable across all herds, ages and breeds in New Zealand.

PW and BW can be used as a guide for buying and selling animals, based on their expected ability to be profitable and efficient lifetime producers, as well as their ability to breed profitable replacements.

If you are selling animals, you can provide AE information to prospective buyers so they have confidence in the expected merit of the animals.

In this way, you can maximise the sale price of the better animals. If you are the buyer, you can us their AE indexes to ascertain the expected ability of the animals in question to be profitable and efficient lifetime producers, as well as their ability to breed profitable replacements. Most prospective buyers expect to see the relevant AE indexes, and ask for them.

Remember that both the BW and PW can be compared across herds. So you do not need to do complicated calculations – if you wonder whether a middle cow in a high producing herd is better than the top cow in a lower producing herd, you only need to look at their indexes – the higher BW/PW cow is the better cow, regardless of factors like their age or how well the herd is managed or fed.

Pay more attention to the BW if you are wanting a cow to breed from, and to the PW if you are filling a gap and are looking for a “working cow”. Knowing their relative profitabilities then enables you to make your buying decisions taking into account the other things that are important to you, like budget, breed preferences, etc.

4. For genetic improvement in the national herd

This small section has explained how farmers can use AE indexes in their everyday dairy farming activities. How individual farmers use the BW and PW has a significant effect on their farm profitability, and their herd’s genetic progress.

Individual farmers reap massive benefits from the AE system. These benefits come about through the national herd getting better and better all the time. We call this “genetic improvement” of the national herd.

Regardless of whether you buy or breed animals on BW, the animals that you are buying in or breeding from today will, on average, be more profitable than the animals you would have bought ten – or even five – years ago. And the animals for sale in five years time will be better again.

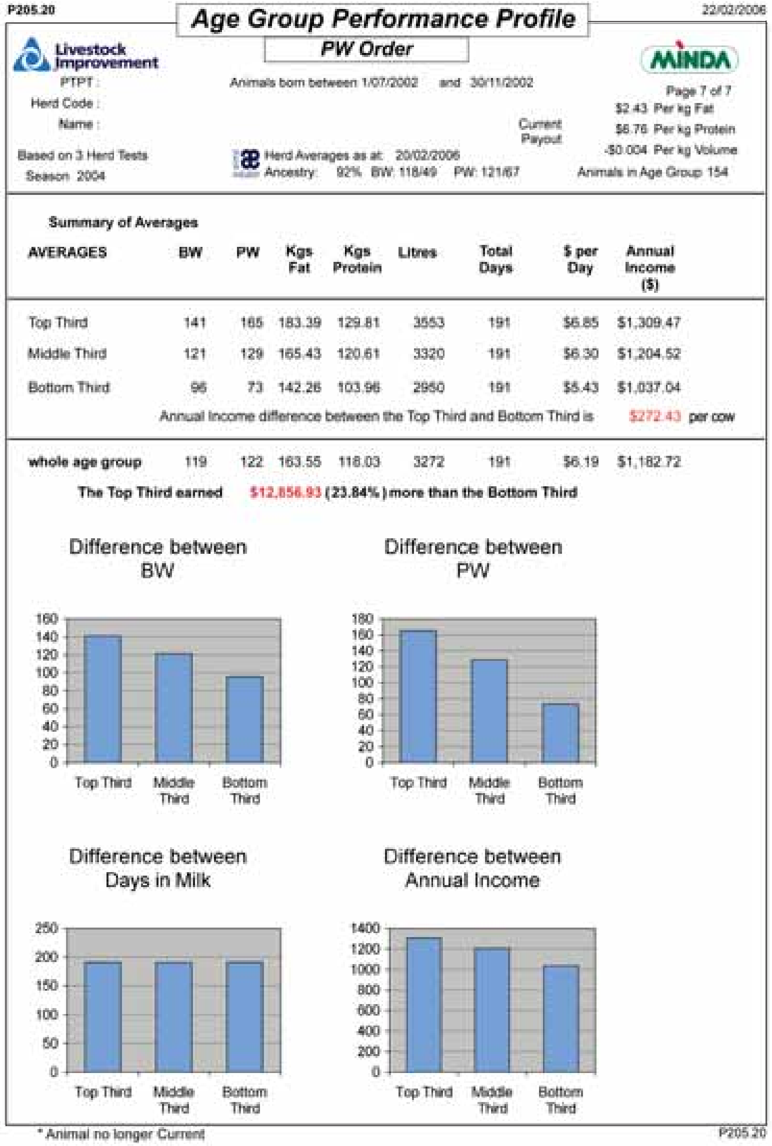
The more farmers that use AE indexes to improve their herds, the faster the genetic improvement in the national herd, and therefore in their own herds.

5. For increasing profit

The *Age Group Performance Profile Report (AGPP)* available from Livestock Improvement demonstrates how BW works in your herd. (See example on the right.)

It divides your herd into three groups by PW and then by BW: top third, middle third and bottom third. The report then shows the production of each group (kg milkfat, kg protein, litres, total days) and the income they are generating (per day and annually).

The difference between the profitabilities of the three groups will usually be very apparent. This demonstrates the usefulness of indexes in helping you to identify the most profitable cows.



P205.20

Age Group Performance Profile

PW Order

22/02/2006

Livestock Improvement

PTPT :
Herd Code :
Name :

Animals born between 1/07/2002 and 30/11/2002

MINDA

Page 7 of 7

Current Payout
$2.43 Per kg Fat
$6.76 Per kg Protein
-$0.004 Per kg Volume

Based on 3 Herd Tests
Season 2004

Herd Averages as at: 20/02/2006
Ancestry: 92% BW: 118/49 PW: 121/67

Animals in Age Group 154

Summary of Averages

AVERAGES	BW	PW	Kgs Fat	Kgs Protein	Litres	Total Days	$ per Day	Annual Income ($)
Top Third	141	165	183.39	129.81	3553	191	$6.85	$1,309.47
Middle Third	121	129	165.43	120.61	3320	191	$6.30	$1,204.52
Bottom Third	96	73	142.26	103.96	2950	191	$5.43	$1,037.04
whole age group	119	122	163.55	118.03	3272	191	$6.19	$1,182.72

Annual Income difference between the Top Third and Bottom Third is $272.43 per cow

The Top Third earned $12,856.93 (23.84%) more than the Bottom Third

* Animal no longer Current

P205.20

Genetic Improvement in the national herd

Most genetic gain in New Zealand is achieved through the use of intensively selected elite bulls.

Nearly all cows are potentially required to be parents of the next generation of replacement cows (so there is not intensive selection of cows to breed cows), but few bulls are required. Consequently intense selection of sires is possible.

The intense selection of sires begins with the breeding organisations obtaining young bulls whose genetic merit is expected to be very high on the basis of the merit of their parents. On a national basis, selection at this level is very intense – because only 500 bulls a year are retained for this purpose from the 2 million bull calves born each year. These bulls are then progeny tested in a large number of herds to identify those that have received a particularly favourable combination of parental genes.

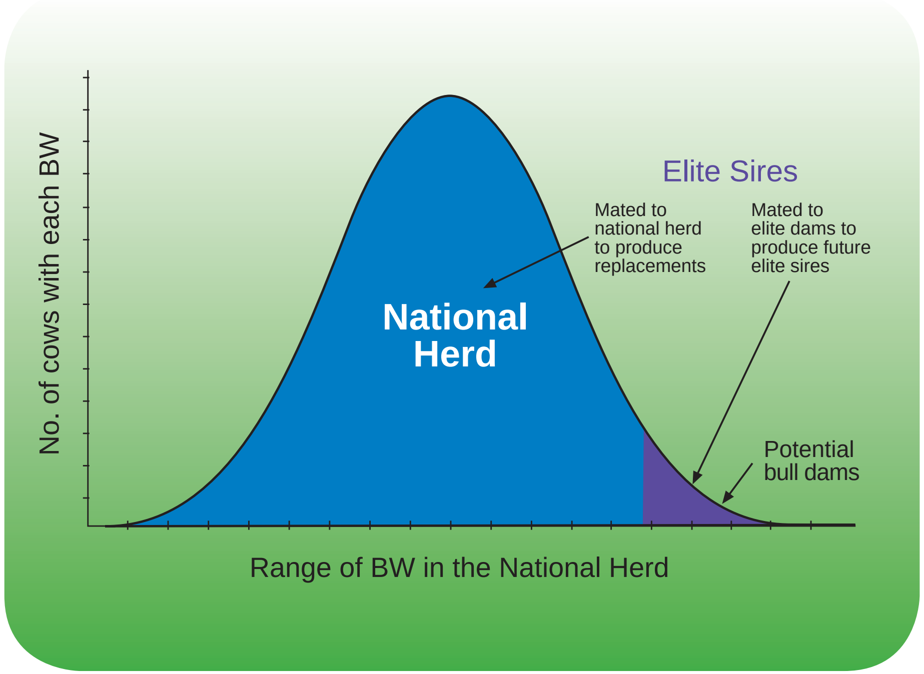
Intensity of selection amongst bulls is reinforced at the point where sires graduate from the progeny test, from which fewer than 10% of the initial progeny test entrants will proceed to be used widely in the national herd as proven sires. Progeny testing produces predictions of a bull's genetic merit, based on the performance of daughters in commercial herds under management systems which are typical for New Zealand.

Consequently, the national genetic evaluation system has important uses in the selection of sires and dams of the bulls to enter progeny testing, and in identifying the best bulls to graduate from progeny test to be used widely in the national herd as proven sires.

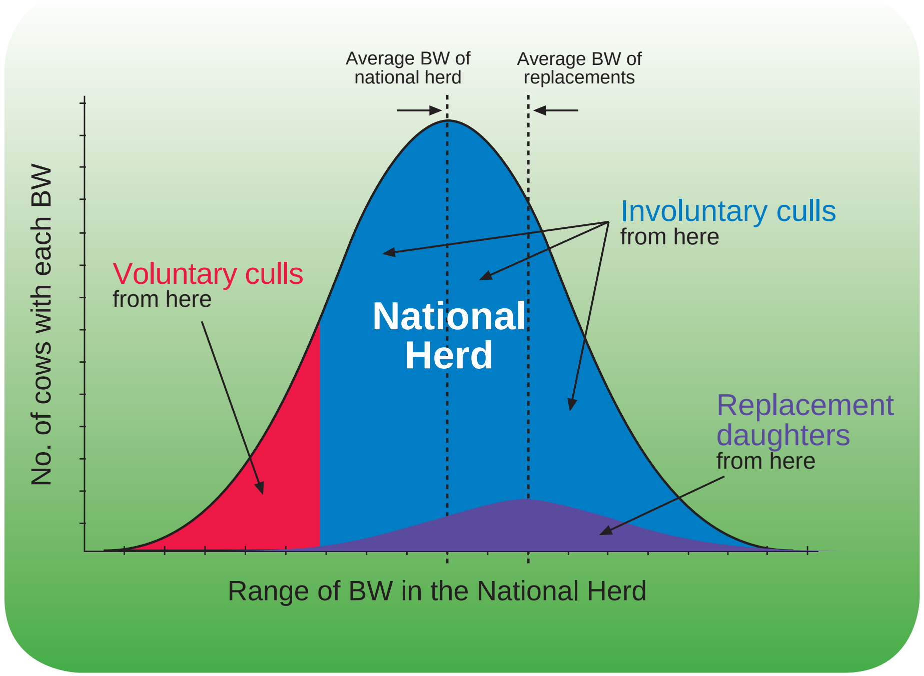
The following graphs illustrate how genetic improvement comes about.

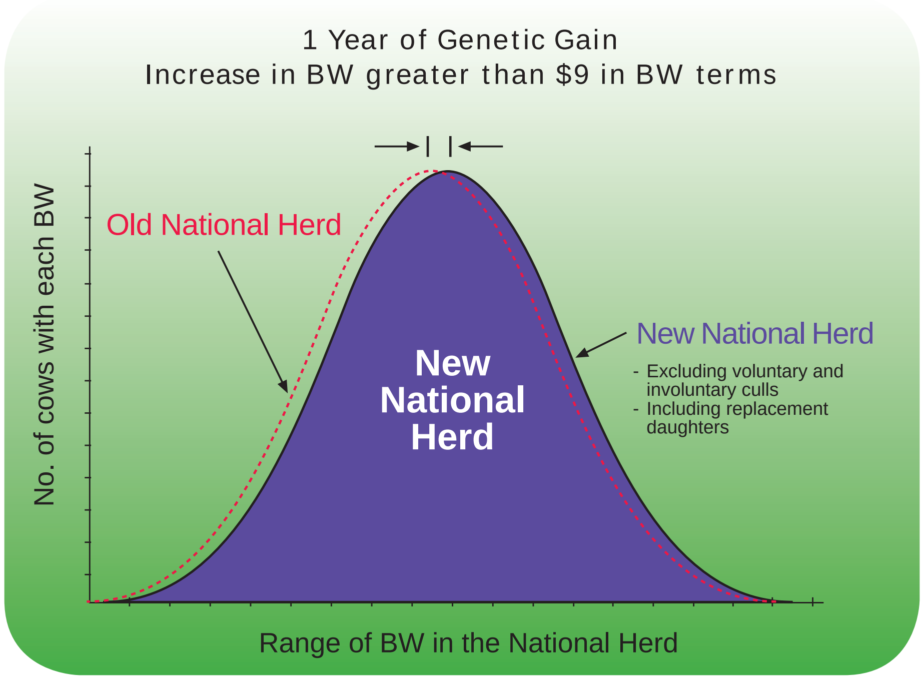
How genetic improvement comes about

- Using AE indexes, particularly the BW, AB companies identify bulls to be used as sires of sons. These elite sires are mated to elite dams in the national herd. These elite dams are also identified using AE indexes.



- Bull calves from the matings are progeny tested.
- Four years later, thanks to the AE system, these bulls become proven bulls.
- The best of these bulls (identified through their AE indexes) are marketed and mated over the national herd.
- Meanwhile, back on the farm, farmers have been continuing to mate their cows to elite bulls.
- They now have replacement daughters.
- These daughters took the place of both voluntary culls (identified through AE indexes) and involuntary culls.





- And so a new national herd with an improved BW is created.
- This improvement is the visible result of having indexes that measure the profitability of our dairy animals.
- *It has been estimated that, using the breeding systems and technology in New Zealand up to the present time, the theoretical achievable gain per year is $9.94 in BW terms. In fact, the actual genetic gain per year for the decade to 2004 was $9.23.*

DJ Garrick and RG Snell, 2005

- As a result of the Dexcel Holstein-Friesian Strain Trial, where, as part of the trial, New Zealand genetics of the 1970s were compared with New Zealand genetics of the 1990s, Dexcel researchers concluded:-

The last 25 years of dairy cow breeding has increased potential EFS (Economic Farm Surplus) by $600/ha ... Aim for high $BW cows, but make sure that the type of high $BW cow you breed suits your farm.

Proceedings of the 3rd Dairy^3 Conference (2005) - Macdonald, Thorrold and Pryce

Of course, herd improvement is not achieved without the support and work of the entire dairy industry – the AB companies who prove the bulls, the farmers who offer their herds for progeny testing, the research funded and/or carried out by Dairy InSight, Dexcel, Fonterra, Livestock Improvement and other industry organisations, and – most of all – by the farmers who trust the BW and other indexes, use elite bulls, provide vital animal information through herd testing and other recording activities, and employ excellent management and herd improvement techniques.

That's why the BW is the industry index.

Frequently Asked Questions (FAQ)

1. What is the ***RAS List***?

The *RAS List* is the common name for the *Ranking of Active Sires*, a listing produced by the Animal Evaluation Unit after each Animal Evaluation run. The *RAS List* is actually several lists: the top 50 Holstein-Friesian, the top 30 Jersey, the top 10 Other (breeds), the top 25 Crossbred, and the top 30 for all Breeds.

The latest *RAS List* is always available on the Animal Evaluation website (www.aeu.org.nz). Or you can order from Animal Evaluation, Private Bag 3016, Hamilton, phone 07 856 0917, if you do not have access to the internet. It is also published once a year in the *Dairy Exporter* (usually the October issue), but the information on this *RAS List* is only current for a few weeks (until the next Animal Evaluation run). AB company representatives usually have current *RAS List* information.

To be eligible for inclusion on a *RAS List*, a bull must have commercial quantities of semen available (likely to have 500 doses of semen available in the following mating season), to be nominated (enrolled for a fee) by their marketer, and have a Breeding Worth Reliability of 75% or more. He must also be eligible for the Interbull International Genetic Evaluation Service. One of the Interbull criteria is that a bull must have daughters in at least 10 herds.

2. What's the difference between the Animal Model and the Economic Model?

The Animal Model is the name of the statistical method used to estimate an animal's BV for any particular trait.

The Economic Model is the name of the system used to assign an economic value to any particular trait, ie. to establish how much each unit of the BV contributes to the animal's overall profitability indexes for breeding or production as measured by the BW, PW and LW.

3. Who decides which traits are included in the BW?

Basically, the dairy industry! The world-wide customers for our dairy products, the national market place and the economic environment together dictate which traits are (or become) economically important.

However, in the practical sense, the NZAEL Board of Directors make the decision to include a particular trait, and their decision depends on research (how the trait can be measured, its economic importance), and the availability of technology (to perform the calculations to include the trait in the BW).

4. Who decides the directors of NZAEL?

Dairy InSight, on behalf of the industry, has appointed eight NZAEL Directors from different sectors of the dairy industry: farming, extension, research and milk processing. As at March 2006, they are Lawrence Satherley (Chair), Ted Coats, Mark Leslie, Hugh Blair, John Lynskey, Philip Luscombe, Steve Ireland and Bruce Thorrold.

5. What information is collected about animals for use in the AE system?

The following records are collected for the evaluation of New Zealand dairy animals:

- herd identification
- traits other than production
- test day milkfat yield
- birth date
- test day protein yield
- test day milk yield
- breed
- liveweight
- calving date
- fate codes
- drying-off date
- mating details

The main sources of animal information are herd test records, TOP records, liveweight records and animal details recorded on the database.

6. Why was "1985-born cows" chosen as the base cow?

As the question indicates, a genetic base is chosen arbitrarily. The 1985-born cows were the first generation of cows for which we had records of all the traits that were going to be included in the Breeding Worth.

The choice of which base group to use affects the size and the sign (+ve or -ve) of the evaluation, not the ranking of animals. Animals that have higher genetic potential than the base have a positive evaluation figure, and animals that have lower genetic potential than the base have a negative evaluation figure.

The Animal Evaluation system can function with any genetic base of the industry's choosing. At some stage the industry could decide that the 1985 base is "too historical" and change to a more recent base. For example, it could choose the 1995-born cows, or the 2000-born cows.

7. What is the BW of the base cow?

Zero.

The BW is simply the trait breeding values multiplied by their respective economic values, and summed. Since each of the seven trait breeding values for the genetic base cows averages zero by definition, and since an economic value multiplied by zero results in zero dollars, the BW is the sum of seven lots of zero, ie. 0.

8. Is the genetic base the same for all trait evaluations?

The 1985-born cow is used as the base for all trait evaluations except Calving Difficulty. Calving Difficulty measures the effect a bull has on the birth of its own offspring, not the difficulty with which his daughters give birth. So Calving Difficulty is measured relative to a sire base.

9. Why was "4500kg DM" chosen as the base unit of feed?

Like the base cow, the base unit of feed is a purely arbitrary figure, but it's necessary for making valid comparisons in the Animal Evaluation system.

If you want to measure the fuel consumption of your car, it doesn't matter whether you look at how many kilometres to the litre it does, or how many kilometres to the 10 litres it does. As long as you always use the same measure, you will get the same efficiency ranking for fuel consumption. In BW, you get the same efficiency ranking whether you use dollars per tonne of feed or dollars per 4.5 tonnes of feed.

The 4.5 tonnes figure was chosen because it was an approximation to the average amount of feed consumed by a cow at the time.

10. Why are relatives so important in the evaluation of an animal?

For a bull with a large number of daughters, information on daughter performance compared to herdmates is the most powerful source for estimating the bull's genetic merit – provided that the genetic evaluation system has appropriately accounted for the genetic merit of the dams of the bull's daughters, and that the bull's daughters have not been given special treatment to enhance their performance.

For a cow, it's important to take account of the performance of her close relatives compared to their herdmates, because these cows have genes in common with her.

11. Can unidentified animals or animals without records be evaluated?

Yes. The evaluations of unrecorded animals include an 'average' parent or genetic group solution which is substituted for the missing parent information. Genetic group solutions are based on the estimated ancestry of all unrecorded animals of the same birth year, breed and country of origin.

12. How does the Animal Evaluation system cater for the fact that not all farmers have the same objectives?

The Animal Evaluation system identifies bulls which have high merit for profit – which is a common objective for farmers – while collecting data on other traits that farmers can use to meet their other objectives.

High BW bulls have a wide range of size, breed, fertility and other traits to suit all farmer preferences.

The system currently provides genetic information on 26 different traits: milkfat, protein, milk, somatic cell score, liveweight, total longevity, residual survival, cow fertility, calving difficulty, body condition score, adaptability to milking, shed temperament, milking speed, overall opinion, stature, body capacity, rump angle, rump width, legs, udder support, fore udder, rear udder, front teats, rear teats, udder overall and dairy conformation overall.

Farmers may need to supplement this information with other information to suit their objectives.

13. Will we lose the progress we've already made if we select animals for multiple traits, instead of sticking to selecting animals for yield?

Bill Montgomerie, Animal Evaluation Manager, says: "No. We have been very successful at selecting for yield over the last 50 years. We try to maintain that excellent rate of progress while getting better at addressing other important traits – those traits that are generally referred to as functional traits, like fertility, resistance to mastitis, longevity, etc."

14. What factors are taken into account in the Fertility BV?

Excluding management factors, the key factors for successful reproductive performance in seasonal dairying are:

1. The ability of the cow to resume cycling soon after calving, and to be mated early in the herd's mating period.
2. The cow's ability to conceive, sustain a pregnancy and calve early in the herd's subsequent calving period.

Both these aspects are evaluated in the cow Fertility BV.

15. Why does longevity (as in the Residual Survival BV) have a positive economic value?

It costs to breed and rear replacements for cows in a herd – particularly, to feed a young animal before it comes in to full production.

If cows survive for a longer time in the herd, then a proportion of farm feed that would have been used to rear replacements is available for the milking herd. The economic value for longevity is therefore positive.

Longevity is also associated with a number of characteristics linked to the cow's suitability for the farming system. For example, suitability of the cow's temperament in the farm dairy, speed of milking, readiness to conceive and bear a calf, maintenance of good health and ability to walk to and from grazing are all factors that are desirable to farmers and therefore make it less likely that the cow will be culled. Consequently, genetic evaluation of longevity is an important aspect of the AE system.

16. What's the difference between Residual Survival and Total Longevity?

Total Longevity reports expected differences in herd life – the number of days from entering a milking herd for the first time to finally leaving a milking herd.

Production, liveweight, somatic cells in milk, and fertility all affect Total Longevity. For example, higher producers generally stay longer in herds than lower producers; higher SCC cows don't last as long as lower SCC cows on average; and less fertile cows don't last as long as more fertile cows.

To avoid double counting in the BW index, we have to construct "Residual Survival". "Residual" means what's left over, so the Residual Survival BV is simply a measure of herd life after the effects of the other traits in BW have been filtered out of the reckoning.

In general we do not expect farmers to use Residual Survival as a secondary selection criterion. It is simply a device to avoid double counting in BW. Farmers who want a secondary selection criterion for herd life should use Total Longevity – and that's why it is shown on the *RAS List.*

Total Longevity BV indicates the genetic merit of an animal for days of herd life. A Total Longevity BV of 84 for a bull indicates his daughters are expected to last 42 more days in the herd than daughters of a bull with a BV of 0.

17. Why is Total Longevity included on the ***RAS List***, when it's not included in the BW?

It is shown on the *RAS List* because it's a simple-to-understand-and-interpret measure of an animal's longevity.

18. How often do the Economic Values change?

Economic Values are updated every February. This is why you should be very careful that you are always looking at current BW figures, and why you cannot compare a BW for an animal this year with its BW of last year.

If you are reading this book after February 2007, the latest EVs are readily available on www.aeu.co.nz.

19. Generally, why do Milk, Liveweight and Somatic Cell have negative EVs?

Because, ***all other things being equal***, the higher volume cow, or the heavier cow, or the high SCC cow, is less profitable.

20. Why does Milk have a negative EV?

Most of New Zealand's milk production is exported in solid form as butter, cheese, milk powder and other manufactured dairy products. For these products, the liquid must be removed, and this has a cost – the more liquid that has to be removed, the higher the cost. Other costs relating to milk volume are involved in refrigerating and transporting liquid milk from the farm for processing. New Zealand farmers are therefore levied a charge on the supply of milk to cover the costs incurred by the milk processor in manufacturing exportable product from the milk supplied.

Milk volume and the associated lactose also require significant feed intake to produce.

The economic model therefore produces a negative economic value for milk volume, because of the processor's levy and the feed required to produce volume and lactose.

21. Why does Liveweight have a negative EV?

Liveweight has a bearing on profitability because feed for maintenance increases with liveweight. Although both large and small cows can be highly efficient feed converters, a higher yielding cow is not always converting feed more efficiently than a lower yielding herdmate.

Body size is important in New Zealand, where it's not uncommon for mixed herds to have some cows heavier than 600 kilograms, and some cows lighter than 400 kilograms.

In these circumstances, the relative efficiency of a farmer's cows cannot be assessed by considering only their yields.

Additional body size without additional milksolids is costly. If two herdmates have identical milk production, but one is heavier than the other (say, by 100 kilograms), then the heavier cow effectively wastes feed by converting more feed for liveweight maintenance, which is not a saleable output.

The Animal Model of the AE assesses the feed requirements for body maintenance and growth, while the negative EV for liveweight ensures that the BW considers how well larger cows are "earning their keep".

22. Surely there are some good things about a higher liveweight!

Yes, heavier animals have a higher salvage value, and are expected to breed bigger, more valuable bobby calves. Also, because you need fewer large animals than smaller animals on the same area of land, you can save on operating costs.

However, after offsetting these liveweight related income streams against the costs, the Economic Model derives a negative economic weight for liveweight.

23. Does the Animal Evaluation system favour lighter cows, or cows of any particular breed?

No. Bill Montgomerie of the Animal Evaluation Unit says that breeders of large, or conversely smaller, cattle have no reason to fear for the future of their particular style of cows, providing they breed for efficient converters of feedstuffs to milksolids.

Likewise, breeders of Jersey or Holstein-Friesian, crossbreeds or any other breed can rest assured that their breed is fairly represented.

Two examples: In the Animal Model, the slower maturing characteristics of Holstein-Friesian cows, compared with smaller Jersey cows, are adequately accounted for. The Economic Model includes a recognition that the per-kilogram prices for bobby-calves and cull cows increase in steps as the weight of the animal increases.

24. Won't a negative value for some traits (liveweight and milk volume) mean than we will breed smaller and smaller cows, and cows with lower and lower milk volume?

Bill Montgomerie of the AEU says that negative economic values do not lead to either lower volume cows or to smaller cows. "Both volume and liveweight are positively genetically correlated with milkfat and protein yield. Therefore, both liveweight and volume tend to increase with genetic improvement of cattle (as they have continued to do since the introduction of the AE system in 1996). Negative economic values merely restrain the rate of increase in these traits, avoiding economically wasteful genetic change occurring as an unintentional consequence of the genetic improvement programme."

25. How can the AE system take liveweight into consideration when not all cows are weighed?

Liveweight recording has been practised for over fifteen years for inspector-scored liveweights for two-year-old heifers, and for over ten years for scale-recorded weights for mixed age cows.

You might be surprised at how many actual weights are recorded: for each of the last six years over 50,000 scale weights have been recorded for mixed age cows.

Bulls that are progeny tested have a high proportion of their daughters with liveweight records. For example, 74% of the production-recorded daughters of the progeny test bulls born in 1997 and reported in the *2002 New Zealand Dairy Sire Summary* had at least one liveweight record. On average, these bulls had 83 production-recorded daughters and 61 liveweight-recorded daughters. This level of recording enables the genetic merit for liveweight for these bulls to be evaluated with a high degree of precision.

The graduates of these progeny test programmes become the sires of the great majority of the cows in the national herd. Consequently, a very high proportion of New Zealand cows have a large number of sisters with recorded liveweight, and nearly all New Zealand cows have a large number of close relatives with liveweight records upon which their genetic evaluation is based.

It is a fact, though, that the PWs for your herd will be more accurate if actual liveweight information is available. Liveweight information will be more easily collected with the advent of walkover weighing and farmers who use them will benefit from more accurate PWs.

26. What factors are taken into account in the Longevity BV?

In order to make use of as much information as possible, AE uses records from cows that are still alive, as well as records from cows whose herd life has finished.

For a cow that has completed her herd life, the record is the number of days from her first calving to her final herd test.

For a cow that is still alive, her expected herd life is calculated, taking into account her:

- currently attained age
- production (higher yielding cows have lower risk of being culled than lower producing herdmates)
- 4 TOPs that relate to acceptability as a herd member (eg. behaviour at milking time)
- 12 TOP traits that relate to the physical conformation of the cow
- percentage of overseas genes
- calving date (late calvers have a higher risk of being culled than early calvers).

27. Why does Somatic Cell have a negative EV?

A higher SC score is undesirable, just as high somatic cell counts in a milking cow are.

28. Why is protein valued so highly?

Per kilogram, protein is the most valuable of the milk components for which you receive payment.

The increased feed energy needed to support the production of an additional kilogram of milk protein as a consequence of genetic change is much less than the increased feed energy needed to support an additional kilogram of milkfat. Consequently, the economic value given to a kilogram of milk protein exceeds the economic value accorded to a kilogram of milkfat. This is partly due to the higher farm-gate price for protein and partly due to the lower feed energy input required to produce it.

The Animal Evaluation system therefore favours animals which are well suited to producing high yields of milk protein per unit of feed, where the feed is characterised by high proportions of forage rather than concentrate.

29. Can you have a negative BV or BW?

Yes. Some cows have a negative BV for some production traits.

A negative BW for a cow does not mean that a cow is expected to earn negative net income – it simply means that the cow is expected to earn so many dollars less than the base cow would earn.

30. How much does environment affect milk production?

On average, 30% of the differences in milk production between animals of the same age, breed, season of calving and herd is due to differences in genetic merit and 70% is due to differences in environmental effects. The effect of the environment is even greater when comparing the production records of animals across ages, season of calving and herds.

Animal evaluations help remove the guesswork from farmer decisions by providing a means of comparing animals of different herd, age, breed, and season of calving on an equal basis.

31. Does the BW reliability figure apply to all production traits?

No. Reliabilities are calculated for all BVs produced by the Animal Evaluation system, including TOP BVs, but generally, it's the reliability of the BW that people are most interested in, so that's what's shown on the *RAS List*. Other reliabilities are available on the AEU website, www.aeu.org.nz.

32. Why does an animal's initial BW (ie. its ancestry BW) have such a low reliability, even though its sire and dam figures might have high reliabilities?

At conception, an animal gets a unique set of genes from each of its parents. This exact combination of genes will never be replicated in another animal from the same two parents (apart from identical twins).

Although we might have accurate assessments of the merit of an animal's parents, we cannot know the likely merit of the unique combination of genes it has inherited from those parents until such time as evidence (in the form of the animal's own performance or the performance of its progeny) starts coming in.

33. Can you give an example of what is meant by using indexes together with other knowledge?

If Sire A and Sire B have BW/Reliability estimates of +$230/85 and +$220/95 respectively, this indicates that Sire A is expected to generate greater economic returns than Sire B through breeding replacements which are more efficient converters of feed into profit.

However Sire B's higher reliability means that his evaluation is less likely to change with further information.

Either sire could possess other qualities which swing the breeding decision in his favour. For example, daughter conformation or semen price. All these factors can be considered in light of your personal objectives and preferences.

Use your knowledge of your animals. For example, let's say you have two cows, and one has a $60 PW advantage over the other. But if she is needing a CIDR device every year, if she kicks you, or if she is prone to lameness, that $60 advantage could well be used up by those traits! You will weigh these traits up to decide which is the more profitable cow.

34. Why should a cow's indexes be used for breeding decisions, rather than her actual production records?

The actual level of production of a cow is more strongly determined by farm environment and management than it is by genetic merit. An animal will perform better under favourable environmental and management conditions than under unfavourable conditions. Unfortunately, the animal is not able to pass on the favourable environmental conditions it has experienced in its life!

This is why you should use indexes to guide your decisions, rather than the animal's actual production records.

35. How does a bull qualify to be in the ***New Zealand Dairy Sire Summary***?

To be in the *Sire Summary*, a bull must be enrolled for Animal Evaluation, have a Breeding Worth Reliability of 75% or higher, and have at least one two-year-old daughter herd tested in the last five years (ie. be a recently used sire).

36. Why was the AE system developed to provide across-breed comparisons, rather than within-breed comparisons?

Because across-breed comparisons were needed, and because it could be done!

At the time, crossbreeding was becoming increasingly popular. From 1991 to 2001 the percentage of replacements that were crossbreds rose from 21.6% to 35%. Crossbred cows were the highest producers of milksolids on average through these years.

Farmers with mixed breed herds and/or crossbred cows in their herd needed to be able to make comparisons between cows. In these circumstances it was an important priority for the Animal Evaluation system to have the capability to rank cows of all breeds and crosses.

37. How does the Animal Evaluation system in NZ compare to evaluation systems overseas?

Most major dairying countries have a national genetic evaluation system to estimate breeding values for animals' traits associated with milk production.

They use standard statistical techniques recognised by Interbull, and taught at post graduate level at universities with major agricultural science facilities.

All Interbull member countries estimate breeding values for milk yield, milkfat yield and milk protein yield. In addition, each produces breeding values for other traits considered important in that country. For example, most estimate breeding values for cow longevity and stature.

Most national systems combine information from the estimated trait breeding values into a total index formulated in accordance with a breeding objective, using traits relevant to the objective, and have a means of assigning relative importance to each of those traits.

In New Zealand the breeding goal adopted for the national genetic evaluation system is to "identify animals whose progeny will be the most efficient converters of feed into farmer profit."

We are different from most countries participating in international genetic evaluations for dairy cattle via Interbull for the following reasons:

- We have a very low input system. Feed required for body maintenance comprises a higher proportion of total farm feed. Consequently New Zealand farmers readily perceive that supplying feed for body maintenance is an important factor in their operations.
- We have more breeds of cattle. Generally high input systems overseas are stocked with cows of a single breed, so there's not much variation in body size of the cows. This means that body size is not an important economic factor in breeding objectives.
- Our milk price is low by international standards, and our grain prices are high. (This is the reason that New Zealand dairy farmers typically adopt relatively low input systems.)
- Our systems are based on seasonal calving.

So, in calculating economic weights for important profit related traits of cows in New Zealand, it is natural to analyse net income relative to intake, and to find the impacts on net income brought about by genetic change in the traits included in the breeding objective. Genetic change in these traits has impacts on net income per cow, on feed intake per cow, and on net income per unit of feed.

38. Why is it that LIC (Livestock Improvement) provides the cow indexes?

A little bit of history is probably required here.

Cow and bull indexes were originally begun by the forerunners of LIC when it had the Herd Improvement Plan as its guiding principle, and when it was part of the New Zealand Dairy Board (NZDB). These successive organisations set up the database, collected data, performed the research and development, and eventually developed, with dairy industry support, the first indexes of an animal evaluation system.

When LIC became a farmer-owned co-op in 2002, LIC voluntarily passed the responsibility for the bull BW to Dairy InSight. And so the indexes for bulls are dairy industry indexes, available to all in the dairy industry.

At the same time, it was agreed that information about cows would continue to be provided by commercial dairy service providers, and not by Dairy InSight.

Any service provider can provide cow indexes, but the cow BW, PW and LW are indexes provided by LIC at its own cost. This is why LIC charges other companies or individuals for cow information if they are not using the MINDA service. BWs, PWs and LWs are available through Livestock Improvement's MINDA service.

However, if you're not using the MINDA service you can still obtain the cow indexes. If your herd test or herd records provider wishes to supply the cow BW, PW and LW indexes to you, they can obtain them from LIC for a fee.

39. Who pays for Animal Evaluation?

Of the cost of running the Animal Evaluation system, approximately 10% is paid directly by AB companies (including LIC) for evaluations of their bulls; approximately 36% is funded by Dairy InSight, and the remaining 54% is paid by LIC's MINDA service for the operation of the cow indexes.

This is why LIC charges other companies or individuals for cow information if they are not using the MINDA service.

40. How do we know that cow BWs and PWs are a good representation of what is actually happening in a herd?

You can use the information available about the cows in your own herd. Selecting a few isolated cows will never prove anything, so you need to consider your whole herd. Divide your herd into three groups by their PW, and then by their BW: top third, middle third and bottom third. Then examine the production from those groups of cows (as a group), and the income they are generating.

The difference between the profitabilities of the three groups will usually be very apparent. This demonstrates the usefulness of the indexes in helping you to identify the most profitable cows.

If you are a MINDA user, your LIC representative can arrange for you to receive a report on your herd called *Age Group Performance Profile*, which does this analysis for you. It lists the three group averages for BW, PW, kg milkfat, kg protein, total days, dollars per day and annual income. A sample of this report is shown on page 21.

41. Is the NZAEL using internationally accepted methods of animal evaluation?

Internationally, the best available practice uses the statistical method known as the Animal Model, in which information from all recorded relatives is incorporated in the evaluation of every animal.

By 2000, the Animal Model had been implemented by thirty-five of the thirty-six Interbull participants responding to their survey. New Zealand implemented the Animal Model in 1996, as part of the development of Animal Evaluation. (See next question.)

The international industry is now moving to the concept of a test day model, which accounts for each cow's lactation curve having a different shape – thus accounting for differences in persistency and maturity. Research has confirmed that genetic evaluations based on test day information account for environmental effects better.

The New Zealand Test Day Model, currently being developed, will further improve the accuracy of BVs and the AE system in general.

42. What sort of quality control is NZAEL subjected to, to ensure our Animal Evaluation system is up to international standards?

The New Zealand Animal Evaluation Limited (NZAEL) currently manages the national breeding objective on behalf of Dairy InSight. Dairy InSight is an incorporated society that co-ordinates and funds dairy industry activities that are financially beneficial to New Zealand dairy farmers.

NZAEL reviews the national breeding objective annually, and recommends the statement of goal, the list of traits to be evaluated and the assignment of relative importance to each of the traits. The review includes a report to Dairy InSight on the input data used for the Economic Model; and on compliance with the established procedures.

NZAEL also monitors breeding value estimation carried out as part of the national genetic evaluation system, to ensure that it meets the standards required by Interbull for participants in international genetic evaluations.

Interbull conducts validation checks before incorporating data from a new national genetic evaluation – New Zealand's data has been accepted at every Interbull international evaluation since being included in 1996.

Other audits are commissioned from time to time as required, including scientific peer review by national and international experts. Additions and modifications (eg. Calving Difficulty BV, Cow Fertility BV, and re-definition of the Longevity BV) are usually submitted for peer review.

43. How well is the Animal Evaluation system working?

Animals born in the eight years from 1997 to 2004 are the result of matings conducted while the AE system has been in place.

The main income factor for dairy farmers and for the AE system is milksolids yield (combined milkfat and protein):

Annual genetic trend for increase in milksolids yield

Animals born in	1985 - 1996	+ 2.57 kg per year
Animals born in	1997 - 2004	+ 3.55 kg per year

An important cost factor for dairy farmers and for the AE system is milk volume:

Annual genetic trend for increase in milk volume yield

Animals born in	1985 - 1996	+ 36.0 litres per year
Animals born in	1997 - 2004	+ 37.5 litres per year

Another important net cost factor for dairy farmers and for the AE system is liveweight:

Annual genetic trend for increase in liveweight

Animals born in	1985 - 1996	+ 1.5 kg per year
Animals born in	1997 - 2004	+ 0.8 kg per year

Fact Files

Breed averages for bulls

Holstein-Friesian

Production traits

Trait	Average	Highest	Lowest
BW	68.3	249.3	-185.7
Milkfat BV	26.3	66.6	-16.5
Protein BV	32.9	70.7	-12.5
Milk Volume BV	1092	2045	-217
Liveweight BV	82.3	139.1	11.2
Fertility BV	-5.5	11.2	-25.3
Somatic Cell BV	0.26	1.96	-0.78
Residual Survival BV	-10	568	-612
Total Longevity BV	25	731	-827
Calving Difficulty BV	6.4	26.3	-6.2

Traits other than production

Trait	Average	Highest	Lowest
Adaptability to milking	0.13	1.27	-1.32
Shed temperament	0.13	1.36	-1.35
Milking speed	-0.01	1.54	-1.82
Overall opinion	0.23	1.29	-0.83
Stature	1.47	2.80	-0.22
Capacity	0.17	1.42	-0.90
Rump angle	-0.03	0.88	-0.91
Rump width	0.53	1.49	-0.47
Legs	-0.03	0.35	-0.42
Udder support	0.33	1.72	-1.27
Front udder	0.18	1.37	-1.30
Rear udder	0.29	1.65	-1.24
Front teat placement	0.12	0.95	-1.06
Rear teat placement	0.41	1.80	-1.00
Udder overall	0.34	1.82	-1.42
Dairy conformation	0.37	1.32	-0.64

Based on 2692 recently used Holstein-Friesian AB sires as at 20 February, 2006.

Jersey

Production traits

Trait	Average	Highest	Lowest
BW	101.5	331.9	-149.1
Milkfat BV	13.5	64.7	-45.2
Protein BV	5.9	41.0	-33.2
Milk Volume BV	-102	885	-12.38
Liveweight BV	-43.8	5.3	-91.2
Fertility BV	0.8	12.2	-13.9
Somatic Cell BV	.28	1.71	-0.74
Residual Survival BV	56	575	-625
Total Longevity BV	133	692	-887
Calving Difficulty BV	-5.6	-0.1	-12.6

Traits other than production

Trait	Average	Highest	Lowest
Adaptability to milking	0.10	1.38	-0.96
Shed temperament	0.13	1.45	-0.94
Milking speed	0.12	1.22	-1.55
Overall opinion	0.13	0.92	-0.68
Stature	-0.75	0.32	-1.74
Capacity	-0.03	0.96	-1.16
Rump angle	-0.06	0.78	-1.00
Rump width	-0.27	0.53	-1.15
Legs	0.06	0.32	-0.17
Udder support	-0.05	1.25	-1.22
Front udder	0.13	1.26	-0.95
Rear udder	0.12	1.35	-1.28
Front teat placement	0.06	1.06	-0.77
Rear teat placement	-0.07	0.97	-0.93
Udder overall	0.09	1.47	-1.18
Dairy conformation	0.02	0.95	-1.13

Based on 1366 recently used Jersey AB sires as at 20 February, 2006.

Breed averages for bulls

Ayrshire

Production traits

Trait	Average	Highest	Lowest
BW	41.5	196.2	-135.2
Milkfat BV	8.0	44.0	-30.8
Protein BV	15.4	41.1	-19.7
Milk Volume BV	503	1314	-615
Liveweight BV	21.6	97.5	-44.0
Fertility BV	-8.4	11.0	-28.9
Somatic Cell BV	-0.01	1.74	-0.95
Residual Survival BV	127	679	-382
Total Longevity BV	-1	581	-723
Calving Difficulty BV	-2.4	11.1	-10.2

Traits other than production

Trait	Average	Maximum	Minimum
Adaptability to milking	0.09	1.06	-1.10
Shed temperament	0.10	1.21	-1.04
Milking speed	0.00	0.98	-1.03
Overall opinion	0.15	0.95	-0.59
Stature	0.09	1.74	-1.30
Capacity	0.24	1.09	-0.86
Rump angle	0.32	0.98	-0.23
Rump width	-0.06	0.71	-0.75
Legs	0.00	0.20	-0.26
Udder support	0.13	1.03	-0.64
Front udder	0.16	0.84	-0.62
Rear udder	0.00	0.73	-0.94
Front teat placement	0.13	0.78	-0.70
Rear teat placement	0.21	1.50	-0.83
Udder overall	0.15	0.95	-0.65
Dairy conformation	0.17	0.91	-0.44

Based on 514 recently used Ayrshire AB sires as at 20 February, 2006.

Crossbred

Production traits

Trait	Average	Highest	Lowest
BW	144.0	269.9	-18.9
Milkfat BV	30.6	56.7	-2.8
Protein BV	24.8	44.9	2.1
Milk Volume BV	504	1243	-185
Liveweight BV	15.1	76.1	-48.6
Fertility BV	0.8	8.9	-13.2
Somatic Cell BV	0.26	1.11	-0.84
Residual Survival BV	112	390	-364
Total Longevity BV	289	577	-252
Calving Difficulty BV	-1.4	4.3	-6.1

Traits other than production

Trait	Average	Highest	Lowest
Adaptability to milking	0.16	0.71	-0.77
Shed temperament	0.17	0.77	-0.57
Milking speed	0.14	0.74	-0.50
Overall opinion	0.27	0.85	-0.42
Stature	0.15	1.36	-1.10
Capacity	0.21	1.10	-0.42
Rump angle	-0.01	0.64	-0.60
Rump width	0.05	0.87	-1.02
Legs	0.05	0.28	-0.19
Udder support	-0.03	1.04	-1.17
Front udder	-0.01	0.88	-0.01
Rear udder	0.01	1.01	-1.10
Front teat placement	-0.03	0.84	-0.75
Rear teat placement	0.06	1.37	-1.07
Udder overall	0.01	0.91	-1.05
Dairy conformation	0.18	0.86	-0.61

Based on 174 recently used Crossbred AB sires as at 20 February, 2006.

Cow averages and rankings

The following table shows where cows rank in relation to all cows in the country (herds with at least 80 current cows), as at 20 February 2006.

	Median	Top 5%	Top 10%	Top 25%	Bottom 25%	Bottom 10%	Bottom 5%
Cow BW	104	> 162	> 150	> 129	< 77	< 50	< 32
Cow PW	106	> 196	> 176	> 142	< 67	< 29	< 5

> Greater than Less than <

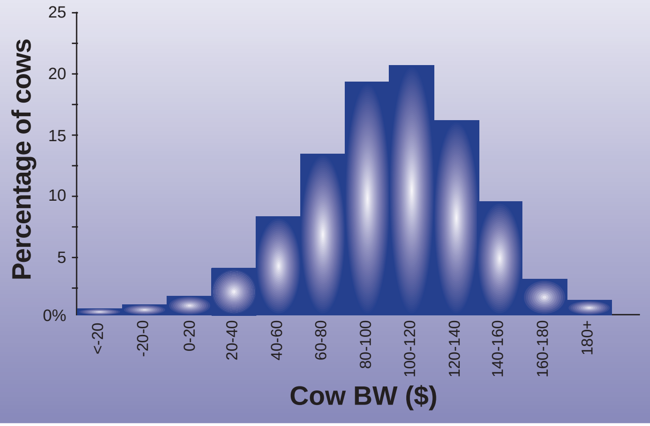
Herd averages and rankings

The following table shows where herds rank in relation to all herds (herds with at least 80 current cows), as at 20 February 2006.

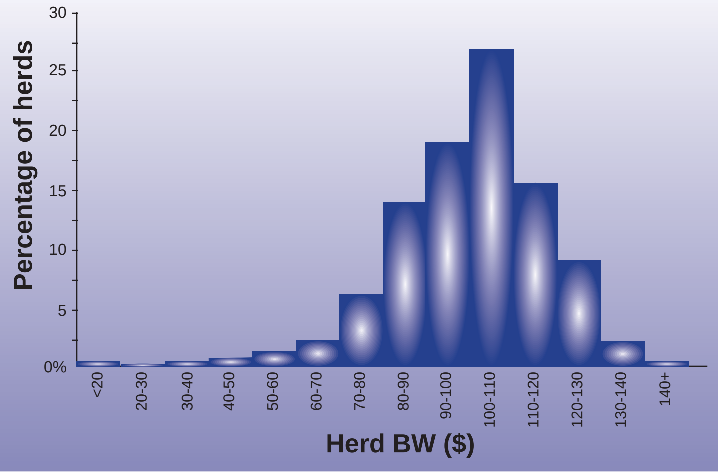
	Median	Top 5%	Top 10%	Top 25%	Bottom 25%	Bottom 10%	Bottom 5%
Herd BW	103	>129	>123	>113	<91	<79	<68
Herd PW	105	>134	>127	>117	<92	<79	<70

> Greater than Less than <

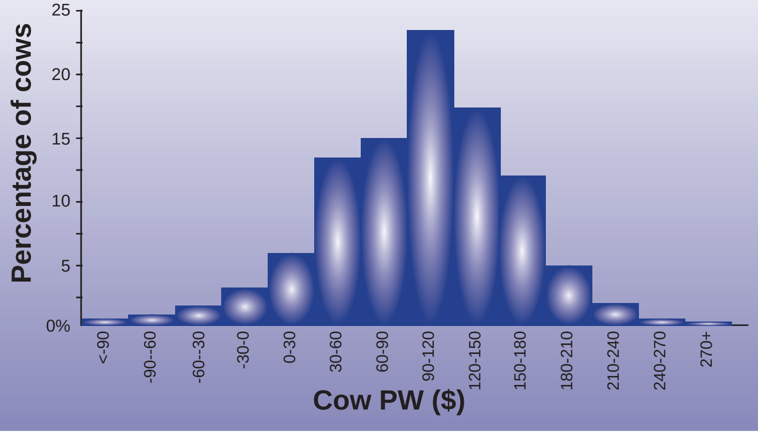
Distribution of cow Breeding Worth for New Zealand cows



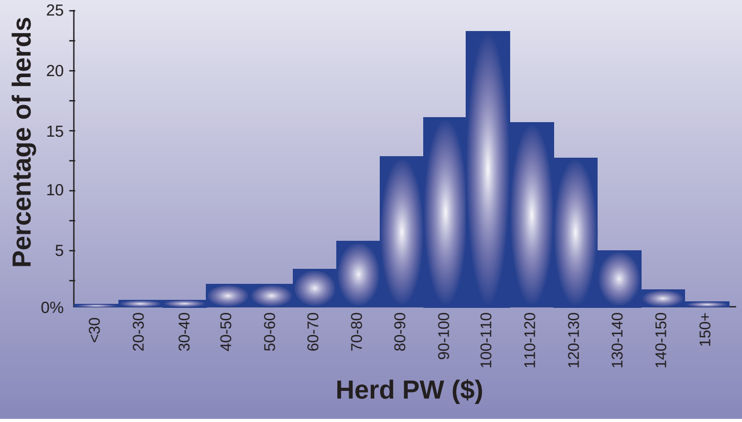
Distribution of herd Breeding Worth for New Zealand herds



Distribution of cow Production Worth for New Zealand cows



Distribution of herd Production Worth for New Zealand herds



Breed averages for cows

The average evaluations (includes all cows in herds, signed up for herd testing in the current season), as at February, 2006.

Index	All Cows	Holstein-Friesian	Jersey	Ayrshire	Crossbred
BW	103	95	117	64	111
PW	105	93	113	66	123
LW	121	107	130	76	140

Breed averages for heifers

Average BW and PW figures of the 2005 born heifers:

2005 Born	All Breeds	Holstein-Friesian	Jersey	Ayrshire	Crossbred
BW	146	138	160	96	153
PW	141	129	148	89	156

Average BW and PW figures of the 2004 born heifers:

2004 Born	All Breeds	Holstein-Friesian	Jersey	Ayrshire	Crossbred
BW	135	127	153	87	143
PW	132	120	141	81	148

Average BW and PW figures of the 2003 born:

2003 Born	All Breeds	Holstein-Friesian	Jersey	Ayrshire	Crossbred
BW	121	116	132	78	127
PW	119	110	123	73	133

Average BW and PW figures of the 2002 born:

2002 Born	All Breeds	Holstein-Friesian	Jersey	Ayrshire	Crossbred
BW	108	101	122	69	116
PW	108	97	115	65	124

- In New Zealand, the AE system currently provides estimated breeding values for 26 traits

They are:

milkfat
protein
milk
somatic cell score
liveweight
total longevity
residual survival
cow fertility
calving difficulty
body condition score
adaptability to milking
shed temperament
milking speed
dairy conformation overall
overall opinion
stature
body capacity
rump angle
rump width
legs
udder support
front udder
rear udder
front teats
rear teats
udder overall

- The 1 to 9 scale is used for evaluating TOP traits in a bull's daughters, where 1 and 9 represent biological extremes.

Assessments are carried out in progeny test herds as a matter of course, but a significant amount of information also comes in from other herds, particularly from pedigree herds. All two-year-olds in the herd are inspected to avoid bias and to allow valid comparisons. Traits are scored across breeds.

Adaptability to milking – describes how soon the heifer settled into the milking routine after calving. (The extremes are: 1 slowly, 9 quickly).

Shed temperament – temperament in the farm dairy while being handled (1 nervous, 9 placid).

Milking speed – milking speed (1 slow, 9 fast).

Overall opinion – farmer's overall acceptance of the heifer as a herd member (1 undesirable, 9 desirable).

Stature – height at the shoulders in centimetres in 5 centimetre bands (1 less than 105 cm, 9 taller than 140cm).

Capacity – depth and width of chest and body in relation to the physical size of the heifer (1 frail, 9 capacious).

Rump angle – angle of a line between the centre of the hips and the top of the pins (1 high, 9 low).

Rump width – width of pins, hips and thurls relative to the size of the heifer (1 narrow, 9 wide).

Legs – straightness or curvature of the back legs while the heifer is walking (1 straight, 9 very curved).

Udder support – strength of the suspensory ligament, and the udder depth relative to the hocks (1 weak, 9 strong).

Front udder – attachment of the front udder to the body wall (1 loose, 9 strong).

Rear udder – height and width of the rear udder attachment (1 low, 9 high).

Front teats – placement of the front teats relative to the centre of the quarters (1 wide, 9 close).

Rear teats – placement of the rear teats relative to the centre of the quarters (1 wide, 9 close).

Udder overall – all udder traits (1 undesirable, 9 desirable).

Dairy conformation – all dairy conformation traits, excluding udder traits (1 undesirable, 9 desirable).

• The BW currently includes seven traits, but this hasn't always been the case

Originally (from 1996) the BW included just 5 traits: Milkfat, Protein, Milk, Liveweight and Survival.

In 2000, Survival was changed from a percentage measurement, to a more meaningful measurement of days, and was given a name change, Longevity. The 5 traits in the BW were now: Milkfat, Protein, Milk, Liveweight and Longevity.

In 2003 Fertility was included in the BW. And because Fertility was now included in the BW, the fertility component had to be removed from the Longevity BV, and so came another name change – Residual Survival for the BW component. The BW now included 6 traits: Milkfat, Protein, Milk, Liveweight, Residual Survival and Fertility. The user-friendly Longevity BV was now named Total Longevity.

Likewise, when the Somatic Cell score was included in the BW in May 2005, the somatic cell component of the Residual Survival had to be removed. As at 1 January 2005, the BW includes 7 traits: Milkfat, Protein, Milk, Liveweight, Residual Survival, Fertility and Somatic Cell.

• Conformation traits in the BW

Conformation characteristics can affect farmer satisfaction in two ways:

- they can be associated with the ability of cows to survive in the herd
- they can be associated with the pleasure that farmers gain while working with the cows.

The second of these factors is not taken into account in BW, although in some market niches it may affect the prices at which cattle are traded.

The first factor is taken into account in BW via the estimation of breeding values for longevity. Because longevity has quantifiable effects for profitability, its inclusion in a comprehensive index like BW is standard practice for national genetic evaluation systems.

In New Zealand, conformation traits have measurable (but minor) effects on longevity. For example, cows with high scores for udder conformation are less likely to be culled for udder break-down than cows with low scores for udder conformation.

• Heritability of traits

The heritability figure indicates how much of the merit exhibited by an animal for a trait can be attributed to its genes. As with almost everything else with genetics, this figure is an estimation, based on current scientific knowledge. For example, a heritability figure of 25% for milk volume indicates that, pooled across the whole population, 25% of the total variation in yields between cows of the same breed/age/calving dates within a herd and year is due to genetic effects.

These heritability estimates are the ones currently (as at February 2006) being used by the Animal Evaluation system. Note that these are the estimates of the heritability of the traits ***as they are defined in the AE system***, ie. they are not a constant, but are themselves subject to re-estimation as a new data source is incorporated, or the methods used to calculate the relevant BVs change. Heritability is a measure of the degree (0 – 100%) to which offspring resemble their parents for a specific trait.

Trait	Heritability
Milkfat	28%
Protein	31%
Milk	35%
Liveweight	30%
Fertility	2.5%
Somatic Cells	15%
Residual Survival	7.2%
Adaptability to milking	13%
Shed temperament	14%
Milking speed	21%
Overall opinion	13%
Stature	40%
Capacity	24%
Rump angle	24%
Rump width	23%
Legs	7%
Udder support	23%
Front udder	21%
Rear udder	24%
Front teat placement	28%
Rear teat placement	28%
Udder overall	25%
Dairy conformation	22%
Calving difficulty	4.3%
Total longevity	7.2%

Note that low heritability does not necessarily imply that genetic selection cannot improve a trait. Lower heritability traits such as fertility can respond to genetic selection because there is significant genetic variation associated with the trait.

• The difference between heritability and repeatability

Heritability refers to the proportion of an animal's yield and liveweight differences which are due to differences in ***genetic merit*** ie. available to be passed on to progeny.

Repeatability refers to the proportion of an animal's yield and liveweight differences which are repeated from year to year. This is a result of the ***genetic merit of an animal plus any permanent factors*** (eg. rearing environment) which will affect its lifetime performance.

• Animals with no records

Animal evaluations are based on the genetic links provided through ancestry information. For animals with no records of their own, such as young stock, ancestry records are the source of information used to establish their expected ranking relative to others. For animals where only partial or no ancestry records exist, other methods are required to produce their evaluations.

An 'unrecorded' animal is defined as having part or all of its ancestry records missing. Animals which fall into this category include those with unrecorded sire and/or dam identification codes.

An animal can have 'unrecorded' ancestry and still have records on its own performance. The performance of unrecorded animals relative to their recorded contemporaries is used to estimate the genetic merit of the group of 'average' sires and the group of 'average' dams which would have been required to breed these types of animals.

A Genetic Group solution represents the 'average' sire or dam for all unrecorded animals of the same birth year, breed and country of origin.

Where an animal's ancestry records are incomplete, the appropriate genetic group solution is substituted for the missing parent information.

Genetic group solutions are used in the following situations :

1. For animals with missing ancestry and no records of their own, evaluations are based on genetic group solutions. The reliability of this type of evaluation is always zero.

2. For animals with missing ancestry, but records of their own, evaluations are a combination of any known parent information, genetic group solutions for missing parents and their individual performance relative to contemporaries. The more records on the animal itself, the less effect the genetic group solution will have on its evaluation. The reliability of this type of evaluation is generally lower than that of fully recorded animals.
3. For animals with an uncertain AB sire (eg. either one of two AB sires could be the sire), evaluations are a combination of known dam information, their individual performance relative to contemporaries and a genetic group solution representing the 'average' of all these sires, (not the average sire of all unrecorded animals of the same age, breed and country of origin). In this way, the system distinguishes between animals with true missing ancestry and those with an uncertain AB sire.

• Animal Model

The Animal Model is the name given to the statistical method by which information from all recorded relatives is incorporated in the evaluation of every animal.

Strictly speaking, the Animal Model is made up of a number of animal trait evaluation models. For example, the animal model used for evaluating the protein trait is a different animal model from that used for evaluating the conformation traits.

The Animal Model is used to calculate the BVs for all traits except calving difficulty. (The Sire Model is used for calving difficulty.) It establishes how much of an animal's measured performance is due to herd-year-age effects, how much can be passed on to offspring (genetic), how much will be repeated at the next record (genetic + permanent) and how much is due to temporary effects.

The Animal Model was implemented by New Zealand in 1996 as part of the development of Animal Evaluation.

• Economic Model

(You might sometimes see the Economic Model referred to as the Breeding Objectives Model, or as the Farm Model. They are different names for the same thing.)

The Economic Model is used to establish the value of genetic changes in the traits included in the BW. This is not the same as noting, for example, that a kilogram of milkfat has a particular value in payout. When you get a genetic change in the herd's milkfat producing ability, you also get a change in the herd's feed requirements. The Economic Model calculates the value of improved milkfat yield per unit of feed. In this way, it does not get the benefits of extra yield confused with the benefits of extra feed supply.

As prices and costs change, and farm operations change, the economic values are affected.

The descriptions, definitions and the assumptions used in the Economic Model are available on request. Since it consists of over 40 equations, most of them mathematically and scientifically complicated, and since it has to account for different values of income received at different times (genetic effects occur in the future), the Economic Model is extremely complex.

These are some of the things the Model takes into account:

- It uses farm production data to derive production performance of age groups.
- It derives liveweights for different times of the animal's life given mature liveweight.
- It accounts for survival rates.
- It accounts for feed demands for energy to support the dairy cow's requirements, and to support growing heifer replacements.
- It accounts for net farm income across a 20 year time horizon.

To derive the economic value of a trait from the Economic Model, all factors in the model are held constant apart from the trait under consideration, which is increased by one unit (a kg for protein, a day for Residual Survival, etc.) to mimic genetic change. The economic value of the trait is the difference between the net farm revenue in the base situation, and the net farm revenue after the genetic change.

In order to incorporate the most up-to-date information possible, the Animal Evaluation Unit collects data from a number of sources in accordance with the recommendations of an expert group convened to advise on procedures for annual updating of economic values. The benefits of genetic improvement occur in the future, so expected future prices for milk components are obtained each year from the dairy industry.

Information sources

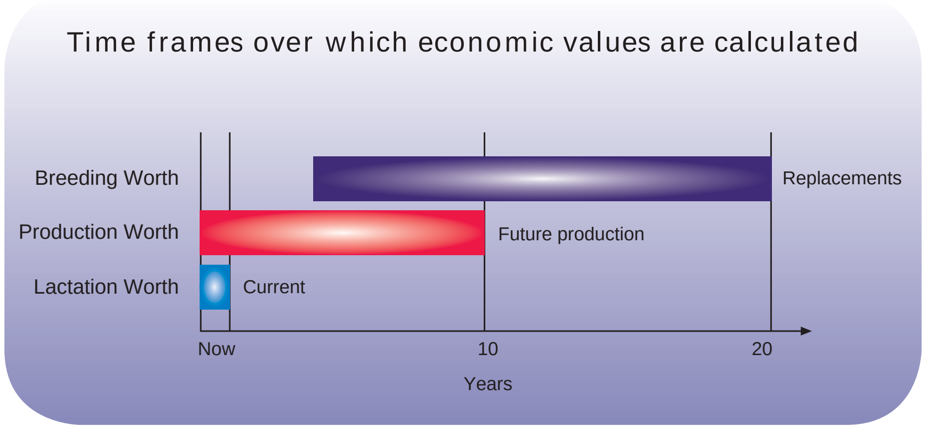
Economic Values are calculated based on prices, costs, and herd performance for an average dairy farm.

Milkfat and protein prices	NZ dairy company payouts
Volume charges	NZ dairy company payouts
Cull cow prices	NZ Meat & Wool New Zealand
Bobby calf prices	Meat Companies
Farm costs	Dexcel, Statistics NZ, veterinary practices, *Dairy Statistics*
Interest rates	NZ Institute of Economic Research

Economic values used in indexes

Lactation Worth measures an animal's ability to convert feed into profit in the current season only. Breeding and Production Worth measure an animal's ability to convert feed into profit through breeding or production, over a number of seasons.

The diagram below demonstrates the different time-frames over which economic values are calculated for each type of evaluation.



Time frames over which economic values are calculated

The diagram below shows the different economic values used in the calculation of the various indexes of the Animal Evaluation system. Remember the BW is a long-term value (over 20 years), the PW a middle-term value (over 10 years), and the LW a short-term value (over the current season).

$ per unit BV, PV and LV

	BW	PW	LW
	$*	$*	$*
Protein	6.328	5.709	6.505
Milkfat	1.251	1.266	1.512
Milk volume	-0.070	-0.067	-0.077
Liveweight	-0.987	-0.901	-1.032
Fertility	1.638		
Somatic Cell	-21.744		
Residual Survival	0.033		

*Note: Each economic value is expressed in terms of today's dollar.

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