BEST PRACTICE

IN PERFORMANCE RECORDING FOR SIL GENETIC EVALUATIONS

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Why Best Practice?

Achieving genetic goals requires systems and practices that maximise accuracy of genetic data. The following best practice guidelines are to help breeders extract maximum value from the genetic evaluation of data recorded.

Genetic evaluation systems based on statistical analysis of pedigree and performance records are designed to distinguish genetic effects from known non-genetic effects. These non-genetic effects include farm, season, mob, date of birth, birth rank & age of dam. Adjusting for such effects leads to more accurate estimates of “genetic merit” for individual traits (estimated breeding values or eBVs) and for profit (economic selection indexes).

Making fair comparisons between large groups of animals means balancing the additional work required to collect data for good genetic improvement with what is practical on-farm. An example is where a farmer may preferentially feed light ewes, but for genetic selection it would be ideal for all ewes to have the same feeding level, managed in as large a mob size as practical. Applying the principles of ‘best practice’ reduces bias in data collection and may detect recording errors close to the collection point (for example sex, tag duplication). Biases also occur when we confuse environmental factors with genetic effects.

Genetic progress is faster when we work with larger groups of animals . General breeding principles like this are described below, together with how to collect enough data to make effective evaluations for the different performance traits.

Best Practice Principles

1.	**Build genetic connectedness: across flocks, years, management mobs and ewe age groups**
2.	**Use accurate ID systems**
3.	**Capture accurate pedigree and birth date**
4.	**Manage sheep as larger mobs, use mob codes when groups are treated differently**
5.	**Measure all animals of the same age at the same time**
6.	**Completeness of recording: measure all key predictor traits at the appropriate times**
7.	**Minimise data recording errors**
8.	**Upload data into SIL in a timely manner**

SECTION

01

BEST PRACTICE PRINCIPLES

1. Best Practice Principles

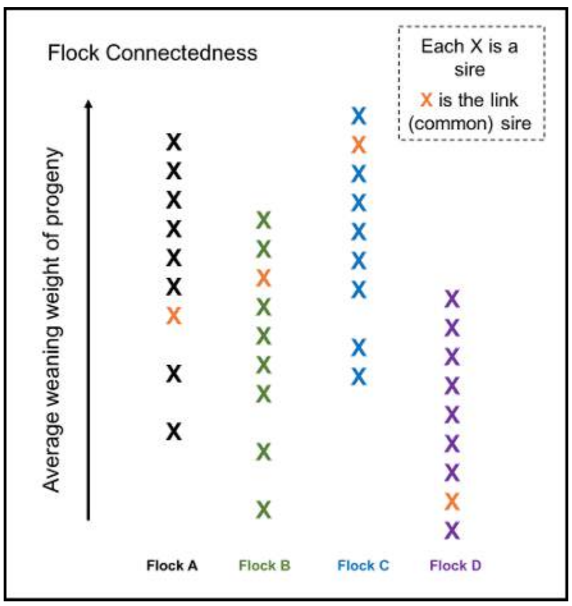
Principle 1: Build genetic connectedness

Non-genetic effects must be separated from genetic effects to allow accurate estimation of genetic merit. One way to do this is to use "link sires" to connect different groups of animals. Groups could include flock, birth year, or management mob. It is recommended that link sires have a minimum of 25 measured progeny per flock and birth year for the evaluation to make fair adjustments between groups for most traits. For low heritability traits, more progeny records would be desirable.

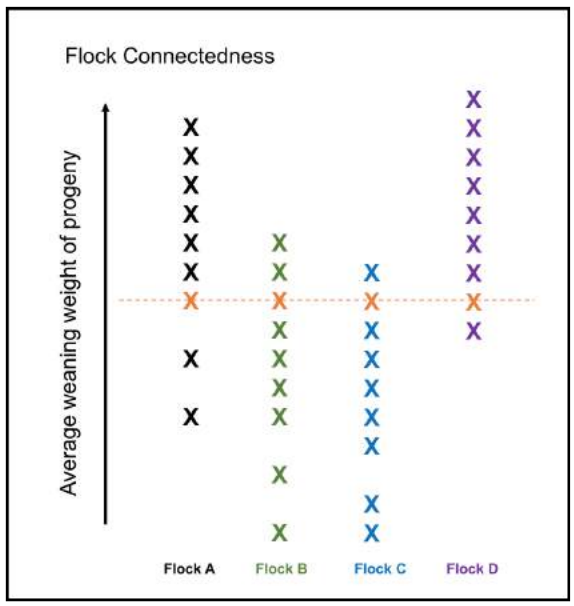
1.1 Across flocks

In its simplest form, the best way to remove non-genetic differences between flocks is to have some animals in each flock with the same sire, in the same year (a "link sire"). The link sire provides us with a benchmark to compare performance of animals and to account for non-genetic differences between flocks (location, climate, or feeding).

Example A



Example B



In the left box (Example A), four flocks each used a common link sire (orange X). Performance data is collected in each flock and all animals ranked relative to each other on merit within flock. To compare animals across flocks, we need to correct for non-genetic differences between flocks; location, climate and stocking rate etc.

The correction factors are based on the performance of the link sire's progeny in each flock - essentially providing a common base across all flocks (Example B). All animals can then be compared as if in one flock.

SIL recommends the use of at least 1 link sire in small flocks and 2 or more link sires in larger flocks each year. Progeny from these sires should be recorded for each relevant trait in all flocks to create connectedness across flocks. The link sires should have 25 or more progeny per flock measured for the traits of interest. For reproduction, retaining enough progeny to have 25 daughters with lambing records is critical.

Information on your flock connectedness, including 'traffic light' reports and 'participation and connectedness' tables can be obtained from the SIL website, or by phoning 0800 SIL HELP (0800 745 435).

These reports are generated from the New Zealand Genetic Evaluation (NZGE) which is New Zealand's largest national across flock evaluation.

Consult your SIL bureau or across flock manager for information on across flock group connectedness. Breeding groups should actively collaborate with B+LNZ Genetics or their bureau to ensure their groups maintain connectedness with the rest of industry.

1.2 Across years

To account for environmental differences between years, a link sire used across years is required to account for non-genetic effects. Without a link sire, sire teams in each year cannot be validly compared. SIL recommends the use of 2 or more link sires each year on which the relevant traits are measured in all years to connect across years. The link sires should have 25 or more progeny measured for the traits of interest. For reproduction, retaining enough progeny to have 25 lambing records from daughters is recommended.

1.3 Across management mobs

Progeny of link sires across management mobs are needed to correct for differences in feeding, animal health and management effects on measured performance. Lack of connectedness across mobs can result in under or over estimation of genetic merit for a trait if mobs have been treated differently.

Best practice for recording management groups are discussed further on page 10.

SIL recommends spreading progeny of sires across management mobs and use of large mobs where practical.

For example: avoid progeny of a sire being isolated from other progeny groups. A small group of ewes mated to an AI sire prior to the main mating and lambed separately and earlier than the main mob is not ideal. Ensuring 25 ewes (or more) are naturally mated to a sire that will also be used in the main mob and will be lambed with the AI ewes will provide connectedness between AI and main mob sires.

1.4 Across ewe age groups

There are generally three ewe age groups - hoggets, two-tooths, and mixed-age ewes. Younger ewes tend to have lower progeny birth weights, lower reproductive performance and less milking ability than older ewes. To account for this, a link sire used across ewe age groups is required to enable correction for these non-genetic effects.

Table 1: A good example of across ewe age group connectedness

Year: 2016	Progeny Counts			
	Hogget	2-tooth	Mature	Total
Ram A	49	28	60	137
Ram B	27	9	74	110
Ram C	44	90	46	180
Ram D	2	78	49	129

Although Ram B has only 9 progeny born to two-tooth dams and Ram D has only 2 progeny born to hogget dams, all four rams can be fairly compared as they share benchmarks with progeny born to similar age groups.

Table 2: A poor example of across ewe age group connectedness

Year: 2016	Progeny Counts			
	Hogget	2-tooth	Mature	Total
Ram E	137			137
Ram F		55	55	110
Ram G		120	60	180
Ram H			129	129

Ram E is the only ram used with hoggets and he is not benchmarked with any other rams. He is "isolated". Similarly, Ram H is only used with mature ewes, but other rams are also benchmarked with mature ewes, so he can be fairly compared with Ram G and Ram F but not Ram E.

SIL recommends the use of 2 or more link sires each year on which the relevant traits are measured in all years to connect across ewe age groups. The link sires should have 25 or more progeny measured for the traits of interest in 2 or more age groups.

Principle 2: Use accurate ID systems

Each animal recorded in SIL must have a unique ID (this is termed the birth ID).

The preferred and commonly used format is **flock.numerical tag/birth year (yy)**
E.g. an animal born in flock 4640 with tag number 1234 born in 2016 should be represented as **4640.1234/16**

When an animal transfers to a new flock, a new current ID may be assigned reflecting the new flock. The format is **current flock.current tag/birth year (yy).** This does not change the birth ID information.

SIL recommends rams always be identified by their birth ID to avoid misidentification.

2.1 Use of EID

As well as visual numbers on tags, animals can be uniquely identified by their EID.
There are generally two formats, depending on which brand of recording equipment is used;

- one with a space after the first three digits (987 009999543210)
- or without the space (0987009999543210)

SIL can accept either format but converts it to the 16-digit format with no spaces within SIL. Information can be printed in either format.

An EID can be added to an existing animal as a trait record. Once an EID is loaded in SIL for an animal, further data can be uploaded using the EID.

Various tagging systems can be used where the aims are long-term retention of the tag by the animal and accurate reading by an operator. Retention is addressed by double tagging systems. Accurate reading has been greatly enhanced with the advent of electronic IDs and automated reading systems.

Methods for extra checking of IDs include use of pre-lists. This is where those animals considered to be in the mob are listed in pre-printed field notebooks or in electronic files and sent to electronic scale head units. Using these lists, animals that appear for assessment that are not on the list are flagged for checking and so a misread tag can be re-read or an error in that animal's status can be fixed.

Principle 3: Capture accurate pedigree and birth date

Accurate parentage is critically important to the genetic evaluation system. The analysis places a lot of emphasis on pedigree (sire, dam and other close relatives). It has been demonstrated that around 10% of animals have dam, sire or both parents incorrectly recorded when using traditional methods. 100% accurate pedigree is unlikely when it is impossible to be present at every mating and lambing. By far, most pedigree errors occur at mating rather than lambing. Mis-mothering at lambing is a factor, but rams jumping fences, gates being left open, or mistakenly including rams with ewes at mating creates most errors.

Options for recording of parentage in order of accuracy:

- **DNA Parentage**
- **Mating records and tagging at birth**
- **Mating records, pregnancy scanning and observation of mothering of lambs (up to tailing age)**

Sire-to-sire links are of utmost importance in a genetic merit evaluation system. DNA testing of new sires can be used to verify parentage. Some breeding groups have already embraced sire paternity testing with DNA technology and have made it mandatory for all new sires. This will lift the accuracy of their genetic evaluations and so accelerate genetic gain.

Sire paternity tests require a DNA sample from the young ram, the sire and ideally the dam to verify recorded pedigree. SIL recommends as best practice that flocks use DNA technology to verify sire paternity of new young sires.

3.1 Whole flock DNA parentage (e.g. Shepherd Plus)

DNA technology used for determining parentage of lambs back to sires and/or ewes is very accurate. DNA technology allows breeders “to know what they don’t know”. DNA technology will identify cases where rogue rams have been exposed to ewes or where known sires have unknowingly mated mobs of ewes.

Whole flock DNA parentage solutions rely on DNA samples being taken on all parents involved at mating. Sires samples are vitally important. Even those who are in reserve as backup rams at the start of mating that may or may not be used, should be DNA sampled. Most occurrences of pedigree error are introduced at mating, not lambing.

DNA samples should be taken on all sires on entry to mate mobs and a check that all have a DNA sample should be performed on exit of mating mobs. Ideally, only one DNA sample per animal would be needed in its lifetime. Samples should also be taken on rogue rams that are discovered in mobs of ewes whether they were with the ewes for days or only hours. All potential sires should be DNA sampled.

Ewes that have not been previously DNA sampled can be sampled at various times through the year but pregnancy scanning is an obvious opportunity. All lambs are DNA sampled usually at docking .

SIL recommends you consult your DNA parentage service provider for specific advice.

3.2 Birth date and foetal ageing

Knowing the birth date of a lamb is an important piece of information in a genetic merit evaluation system. Birth date is used to correct or adjust many weight and age-related performance traits. Lack of an approximate birth date will result in over and under estimates of merit for early and late born lambs. For flocks that closely shepherd at lambing and tag at birth, birth date is relatively easy to record. When not tagging at birth, birth date should be estimated within a 10 day period. A number of strategies can be used to refine the estimated birth date.

- **Record cycle of conception**

Use ram crayon marks and record marks or change colour weekly to identify week of conception.

- **Record foetal age**

Employ the services of a pregnancy scanner who can record foetal age (FAGE) at pregnancy scanning as well as the standard singles and multiples. foetal age can be used to predict an estimate of the days from conception and therefore a likely birth date. This is best determined between day 55 and day 90 of gestation.

- **Record lambing group**

Shed un-lambed ewes away from lambed ewes when practical (ideally every 7 to 10 days) and update foetal age accordingly.

Principle 4: Manage sheep as larger mobs and use mob codes

Comparisons of large numbers of animals under similar conditions is the best way of demonstrating the superiority of "better" animals. Separating some animals and running them in smaller mobs reduces the quality of genetic merit estimates as the animals are not being compared with the full range of variation that exists.

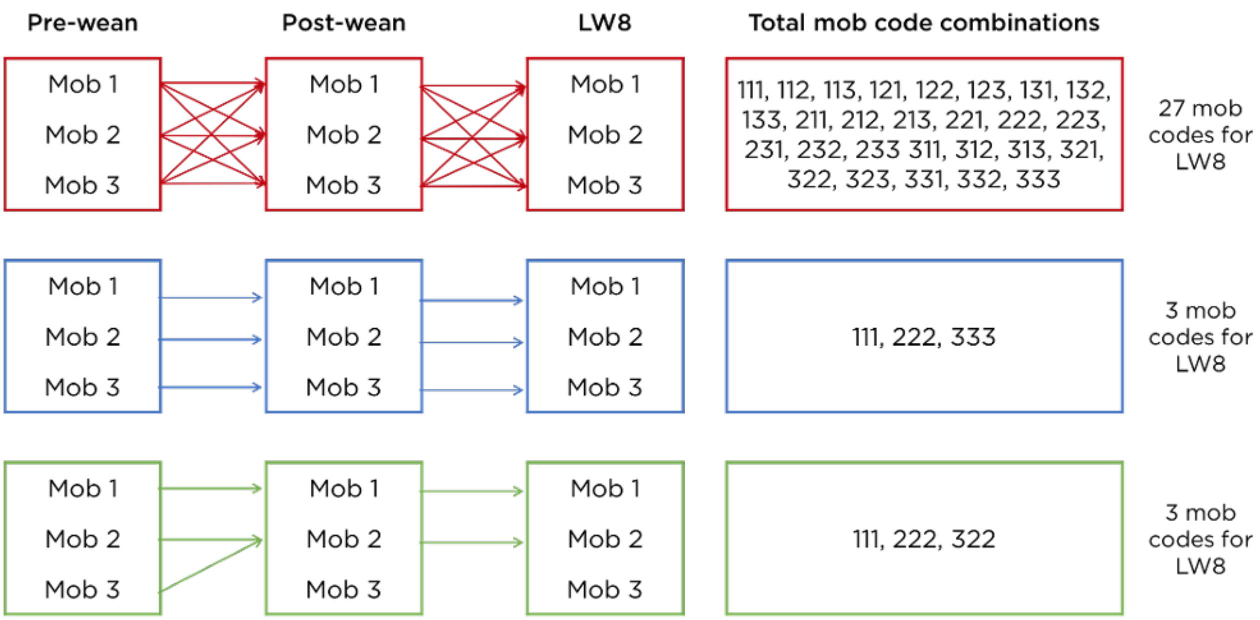
Where you need to separate mobs of animals, make sure they are coded as different mobs (e.g. mob 1 & 2 and higher) so SIL can remove the mob effect. This approach should be used when

- similar animals are run in separate mobs for a significant amount of time
- where a group of animals have been treated differently
- where a group of animals' performance are assessed by different operators.

Avoid random mixing (mobbing up) of animals. For example, if you run four mobs up to weaning and want to run just two after weaning, merge mobs 1 with 2 then 3 with 4, so that there are still 4 groups of animals that have been treated similarly. If you randomly mixed the animals before the creation of two mobs, there would be 8 (= 4 x 2) combinations of mobs reducing the size of the groups that the evaluation system makes comparisons within.

Think of this from the individual animal's perspective and imagine the animals being marked with raddle for each different management group it is placed in. The principle of the strategy for minimising the number of management groups by the time of liveweight at 8 months (LW8) is similar to thinking about minimising the amount of additional raddle marks needed to preserve the wool.

Figure 2: Example of how management mobs accumulate from weaning to liveweight8



Management mob example - using Figure 2

Lambs are run prior to weaning in three different management groups (Red, Blue, Green). After weaning, lambs were drafted into three mobs with one fed lucerne (Yellow) one fed pasture (Purple) and one fed a mixture of both (Orange). Animals were kept in these mobs till liveweight at 8 months (LW8) when they were measured by three different operators (Black, Pink, Brown).

Example (i) - animals are mixed randomly so that the possible combinations for individual animals is 3 x 3 x 3 (27 different mob codes by LW8). An individual lamb would need three raddle marks (e.g. red-yellow-black) to match all the groups that individual has been in up until LW8.

Example (ii) - animals are kept in the same mob pre-weaning up to LW8. An individual would either be Red, Blue or Green and additional raddle marks are not needed.

- Red: mob one at weaning, fed Lucerne post weaning and measured by operator one.
- Blue: mob two at weaning, fed pasture post weaning and measured by operator two.
- Green: mob three at weaning, fed a mix of Lucerne and pasture post weaning and measured by operator three.

Example (iii) - animals from the first wean mob that were fed Lucerne (Yellow) were kept in the same mob till LW8 was measured. Animals from the third wean mob (Green) were joined with the second wean mob (Blue) and fed pasture and kept in that mob till LW8. Again, there are only three possible combinations and no new raddle marks are needed.

- Red: mob one at weaning, fed Lucerne post weaning and measured by operator one.
- Blue :mob two at weaning, fed pasture post weaning and measured by operator two.
- Green: mob three at weaning, fed a mix of pasture post weaning and measured by operator two.

SIL recommends strategic merging of management mobs from weaning to LW8. Fairer comparisons of animal performance will be achieved by avoiding random assignment of animals into mobs. Consider combining all animals from one mob with another or keeping animals in the same mobs all the way through where possible.

Principle 5: Measure all animals

To get the best estimates of true genetic merit you need to compare animals against all the variation available. Recording just the better animals in a group to save time or money is not best practice. When only recording the "better" animals their superiority is not shown to best effect if they are only compared to other superior animals.

Where you do record just some animals because of cost or time, minimise bias by starting with a common earlier measurement made on all animals that is related to a later measurement. For example, all ram hoggets may be ultrasound scanned, but the best of these are sent for CT scanning. The evaluation will use the ultrasound information on all animals to adjust the eBVs that also use the CT scan data.

To get good estimates of merit on sires requires 20-25 measured progeny. If you are not measuring all animals, then SIL advises using a representative percentage of each sire (>15%).

Weaning weight is one of the most important measurements. The presence of a wean weight is used to inform the number of animals present at weaning and account for culling and selection on later recorded traits, including survival. A weight on all live lambs at weaning is essential.

Principle 6: Completeness of recording

The sub-indexes that make up the NZMW and NZTW can be considered individually. Each sub index has its own specific key traits that should be measured (e.g. wool should measure fleece weight at 12 months (FW12), meat yield requires an autumn ultrasound measurement of eye muscle width, eye muscle depth, fat depth (EMW, EMD, FD) and an associated liveweight (LW6/8/10).

Table 3: Sub indexes included in NZMW and NZTW indexes

New Zealand Maternal Worth	
Reproduction	DPR
Survival	DPS
Lamb Growth	DPG
Adult Size	DPA
Wool	DPW

New Zealand Terminal Worth	
Survival	TSS
Lamb Growth	TSG
Meat Yield	TSM

SIL recommends all breeders record the key traits in the New Zealand Maternal Worth (NZMW) or New Zealand Terminal Worth (NZTW) indexes as a minimum.

Historically, where some key traits are not recorded, the evaluation can still produce estimates of merit for a trait but with lower accuracy and with poorer discrimination from other traits. Refer to Appendix 9.1 for a detailed summary of traits that inform each sub index.

For example, NZMW includes lamb growth and adult size. If no adult liveweights are recorded, they will be predicted from early liveweights with less accuracy than if an actual measurement was recorded.

In 2017, SIL will be reviewing whether these estimated values with low accuracy should be printed or included in overall indexes. Watch SIL communications for more details in the coming months.

Table 4: Key eBVs that make up the production sub index groups

	Reproduction	Survival	Growth	Adult Size	Meat Yield	Wool
Required	NLB	SUR	WWT	EWT	HQLY	LFW[2]
		SURM	WWTM		LNLY	FW12
			CWT		SHLY	EFW[2]
			EWT		FATY[1]	
					FD	

[1] FATY considered as part of Meat Yield sub index for Terminal Sire only
[2] FW12 measures inform LFW and EFW

Table 5: Key eBVs that make up the health sub index groups

	Facial Eczema	WormFEC	Dag	STAY
Required	GGT21	FEC1/FEC2	DAG3	EXITFATE (c/k/u)
			DAG8	

Some health traits have prescribed protocols that need to be followed (e.g. Facial Eczema and WormFEC™) and breeders need to be registered with SIL for these traits to be evaluated. Refer to the SIL website for further instructions - www.sil.co.nz.

Principle 7: Minimise data recording errors

The aim should be to employ systems that facilitate error checking and allow for correction where these are detected, preferably close to the time and location the error is made. Electronic data capture will help minimise errors because it eliminates manual recording of animal ID and performance. However, a full electronic system itself does not eliminate all sources of error. Animals can do things that introduce errors, such as two animals with feet on the weigh scale platform.

Non-electronic systems can pick up a lot of errors, but require the people employing them to be very vigilant and aware of possible errors or issues that need to be addressed.

Where practical, checks should be put in place for the following;

(a) Duplicate tags. Use of pre-lists or ID files in electronic systems help eliminate these at the time of recording.

(b) Calibration of measuring equipment. Scales can be checked prior to weighing using a known weight.

(c) Data outside reasonable limits. Checks need to be in place for the limits expected for a mob or for performance relative to a previous performance record.

(d) Mismatch of performance with visual assessment. Small sheep are seldom heavy - and vice versa. Animals with wide eye muscles usually have deep eye muscles.

(e) Expected animals not present. Fates and statuses should be updated regularly.

(f) Unexpected animals present. Was tag misread or has that animal been mistakenly fated as “not present”. Dead animals can be “resurrected”.

(g) Wrong sex. Often animal tag position indicates sex, but errors can occur at tagging. Where an animal has the wrong sex, this needs to be updated and, if necessary, the animal needs to be moved to the correct management group.

(h) Minimise or eliminate the number of times data is handled by a human. This includes data collection, transcription to sheets for data entry by another party and data entry onto the computer.

It is worth noting that data entry is a skilled job which involves carrying out checks as part of the process. SIL helps this by providing tools to flag errors and to summarise data. These summaries can be used to detect some types of data error. The sooner a data error is detected, the easier it is to correct. In some cases, it may not be possible to identify the source of the error and so setting data to “missing” rather than supplying an unreliable data point may be the best option.

Principle 8: Upload data into SIL in a timely manner

Genetic evaluations cannot benefit from data that is not available. With the large across flock national evaluation, the NZGE, now including all flocks, data should be entered onto SIL in a timely manner so regular evaluations always have access to the latest data. Modern data capture systems make this a lot easier to achieve than previously. Best practice will see data added to SIL within 10 working days of the data being completed.

8.1 Main data types and their characteristics

(a) ID, Parentage and pedigree – Parentage is the building block for pedigree. SIL constructs pedigree from ID information on the parentage of individuals. It also constructs some derived traits like litter size from parentage data.

(b) Fates and statuses – These are used to record what happened to an animal at some stage of its life. It may impact on its current status (present or absent) or tell us how it was different to others e.g. progeny of AI sire, reared by a foster ewe or that it was an ET ewe. Constant vigilance with fates and statuses is needed and they can be readily updated. Update fates and statuses after not seeing animals you expected to see, or seeing animals you did not expect to see. Mating is a good time to update live animal status for mating pre-lists.

(c) Measurements – These are measures of performance, usually on a continuous scale. They are usually weights, linear or area dimensions, and most often collected by a "machine" e.g. weigh scales, ultrasound or CT scanner. Test the scale weigh accuracy with known weight before starting (e.g. water filled drenched containers, tractor weights)

(d) Scores – These are assessed by a trained operator and relate to a defined scale that is pictured or described in simple terms. Examples are body condition score (BCS) or dag score. Typically, this information is manually recorded or manually entered onto a data capture device. Scores usually exhibit some degree of operator bias. For this reason, when more than one operator is employed to collect such data, operators should be identified by different "mob codes".

(e) Counts –This may be for low number ranges like number of lambs or higher numbers like faecal egg counts.

(f) Derived traits – These are traits derived from other performance and pedigree data in the SIL database. For example, survival is derived from the number of lambs born per ewe and the presence/absence of a weaning weight for those lambs. Sometimes data errors in component traits are only detected when these traits are derived.

A key part of performance assessment is linking ID with recorded performance. High quality data involves using routine checks for data consistency. Simple checks like maximum/ minimums, averages and the standard deviation (a measure of average variability) can pick up many errors.

SECTION 02

REPRODUCTION - ADULT

2. Reproduction - adult

2.1 Natural mating

Why

Mating is a key event. Although mating data is not directly used for genetic evaluation, it can be useful to troubleshoot for errors in assigning parentage for lambs by:

- recording the ID of rams mated with a single sire (MRAM) or sire group (MATEGP)
- recording the mating period including ram introduction (MDATE) and removal (MGPEXIT).

When

Rams are typically introduced to ewes for 2.5 cycles (= 45 days) in the autumn. SIL allows for ram introduction at any time of year and for any length of time, therefore specifying the mating dates and mating regime (single sire, or a group of sires) is needed.

How

When the ram(s) are introduced to the ewes, record MATEGP and MDATE for all ewes and rams. For assisting pedigree assignment, it is recommended to record the date of ram removal (MGPEXIT) at the end of mating.

Record

- **MRAM - when single sire mating. The ID of the sire is used to identify a group of sires and ewes.**
- **MATEGP – when multi-sire mating, as in the case for whole flock DNA parentage. A group name is used to identify a group of sires and ewes.**
- **MDATE – date the sires were introduced to the ewes.**
- **MGPEXIT – recorded on ewes and rams on the date they are removed.**

2.2 Pregnancy scanning and foetal aging

Why

Determining the number of foetuses the ewe carries is a recommended management tool for providing appropriate feed for ewes carrying single, twin and triplet (or more) lambs. It also provides a measure of number of lambs born and lamb survival for flocks that are not tagging lambs at birth (e.g. un-shepherded at lambing, or tagging lambs up to tailing age) or flocks which employ DNA technology for generating parentage. Pregnancy scanning information can also be used when lambing information is missing (e.g. abortion).

When

Skilled operators can detect pregnancy as early as day 30 of gestation but identifying the number of foetuses, particularly twins versus triplets, is optimal between days 70 and 90 of gestation. Consult with your operator for specific advice on timing for best accuracy.

How

For un-shepherded or DNA parentage flocks that employ pregnancy scanning, foetal age (FAGE) should also be determined at pregnancy scanning. FAGE is the estimated number of days since conception at the time of pregnancy scanning. Be aware that pregnancy scanning operators that measure FAGE effectively will need extra time. Where practical, extra aids for determining the 10 day window of birth date is such as ram crayon changes at mating and shedding out during lambing can be used to improve the accuracy of date of birth estimation.

Record

- **PREGSC per ewe as dry (0), single (1), twin (2), or triplet (3)**
- **Include date of measurement**
- **If more than one scanner, use a different mob code for each scanner.**
- **FAGE as the estimated number of days from conception at the time of pregnancy scan.**

It is essential to enter records for dry (non-pregnant) ewes (PREGSC = 0) on SIL. By not recording the dry ewes the average is over estimated. In the example below, consider 15 ewes mated, with 5 becoming dry, 5 pregnant with singles and 5 pregnant with twins. Not recording dry ewes results in an overestimate of the average (150% instead of 100%). Without recording drys, ewes with singles appear below average, while dry ewes are treated as average.

Table 6: An example of good and poor practice for recording pregnancy scanning.

	15 ewes	difference from average	15 ewes	difference of average
dry	5	-1	-	0
single	5	0	10	-0.5
twin	5	+1	5	+0.5
average	100% lambing		150% lambing	

SECTION 03

REPRODUCTION - HOGGET

3. Reproduction - hogget

3.1 Hogget Fertility

Why

Producing lambs in the first year of life is a predictor of fertility as an adult ewe. However, pregnancy and rearing lambs is a significant challenge to the young ewe while she is still growing. Hogget lambing can have an impact on a number of traits including adult size so it needs to be recorded in a way that the appropriate adjustments in SIL can be applied.

When

Although individual farm practices may vary, a typical period for mating hoggets is 1.5 cycles starting 4 weeks after the mature ewes. Pregnancy scanning (between day 35 and 90 of gestation) should be carried out to determine pregnancy status for hogget fertility (HFER) and number of foetuses present for hogget fecundity (HNLB). In flocks where close shepherding at lambing is possible, the number of lambs born could also be recorded.

How

Introduce mature rams to ewe hoggets 1:70 (1 ram to 70 ewe hoggets). Use of ram hoggets with ewe hoggets is not recommended as they can be less successful at mating.

It is recommended that all mated ewe hoggets are pregnancy scanned. Experience shows that some 'unmarked ewes' can be pregnant and the consequences of pregnancy for a hogget are considerable. SIL evaluations that include HNLB also need to know the litter size a ewe hogget is carrying. It is essential to record pregnancy scanning results for all mated hoggets, including those that are not pregnant (PREGSC = 0).

Record

- **Record all hoggets put to the ram.**
- **Autumn liveweight (LW8/LW10) which is equivalent to LWMATE in adult ewes.**
- **PREGSC, include records for all mated and scanned hoggets including dry hoggets (PREGSC= 0). SIL will automatically generate a missing value for PREGSC of all unmated hoggets.**
- **HNLB, if recorded in addition to PREGSCAN**
- **Record EXITFATE if dry hoggets are culled**

SIL states it is essential to record pregnancy scanning results for all mated hoggets, including those that are not pregnant (PREGSC = 0).

Additional records

Additional records could include the following, but are not currently part of hogget fertility or later reproduction evaluations:

- Birth weight (BW) and wean weight (WWT) of lamb progeny.
- Weight of hoggets at lambing (LW12) and weaning (LWWEAN). For these weight measurements, hoggets that were "not mated" or "mated but not pregnant" and "mated and pregnant" need to be recorded as separate management groups.

Best practice for hogget lambing: see *'Hogget performance: Unlocking the potential'* available as a pdf at www.beeflambnz.com.

Example

When recording hogget lambing there are three common scenarios;

(a) All lambs recorded alive and dead (i.e. conventional tagging at birth)
(b) Only some of the lambs are tagged at birth and subsequently recorded
(c) No lambs tagged at birth or subsequently recorded.

For scenario a) - follow standard recording practices.

For scenario b)

I. if retained for stud, DFATE remains as 0 and BFATE is recorded as appropriate (see table 7, pg 25).
II. If retained for multiplier, DFATE is X on the hogget and BFATE is recorded as X for the lamb. These codes indicate incomplete recording for reproduction and survival, which flags to SIL that this information should not be used for survival analysis.
III. In both cases, if lambs are not tagged at birth, DFATE of U should be used.

For scenario c) - a DFATE of U (lambed unrecorded progeny) should be used.

SECTION 04

SURVIVAL

4. Survival

Why

Currently, simple survival data (present at birth and alive/dead by weaning) is used in the SIL genetic evaluation. No other variables are currently used to predict lamb survival BVs.

When

Lamb ID should have been matched with dam ID at lambing or by DNA parentage through tagging and collecting a tissue sample at docking.

For flocks that shepherd at lambing and supply the number of lambs born (SNLB), dead lambs must be recorded to get an accurate measure of lamb losses around this time.

For DNA parentage flocks the number of lambs the ewe carries (effectively NLB) is informed by the litter size at PREGSC with lambs missing at docking assumed to have died since lambing. The accuracy of Shepherd PLUS means that it is very unlikely a ewe will be assigned more lambs from those at weaning than she was scanned with. It is more likely that such disparities are due to errors in counting the number of foetuses at scanning.

How

For flocks that shepherd at lambing;

Lambs tagged at birth with visual tags and/or EID tags. Dead lambs should be assigned a unique ID, although an actual tag can be assigned, it is not specifically required. Record dam fate (DFATE) and lamb birth fate (BFATE) codes – refer table 7 (pg 25). The data evaluation requires a unique ID even for dead lambs.

For flocks that use DNA parentage

DNA samples should be taken from all lambs, usually at tailing. Tissue sampling units (TSU) and Tissue sampling pliers, or TSUs already paired with RFID tags can be purchased from your tag supplier (e.g. Allflex) or DNA service provider (e.g. Zoetis).

It is recommended to TSU sample all possible sires at mating and previously un-sampled dams at pregnancy scanning to ensure all potential parents of progeny have a DNA profile for accurate parentage assignment.

Your DNA service provider will be able to give you instructions on how to link tissue sample ID with animal ID as part of their service.

Note; where dead lambs are not TSU sampled for DNA parentage, only maternal survival is assessed as sire parentage of dead lambs cannot be generated.

Record

Shepherded at lambing flocks

- Lamb ID (Birth flock.Birth tag/Birth year and/or EID tag) matched to Dam ID. Date of birth (DOB), number of lambs born (NLB)
- Lamb fate codes (BFATE) and for ewes, dam fate codes (DFATE) and EXITFATES for ewes/lambs leaving the flock due to reasons such as culling or death.
- Relevant comments (REMARK)   Birth weight (BWT) can be recorded, but currently this is not included in SIL evaluations.
- Lambing group

For DNA flocks;

- Pregnancy scan with Foetal Age
- Lamb ID (Birth flock.Birth tag/Birth year and/or EID tag) matched to TSU sample
- Lambing group
- Note a dead lamb record will be assigned against the ewe where there is a difference between pregnancy scan and live lambs assigned.

Pregnancy scan data is used to derive litter size (NLB) for the lambing of a ewe and consequently birth rank of her lambs. However, you can record an actual litter size as well and request your bureau to enter this as “SNLB” (Supplied NLB) which will override the derived NLB value.

Essential extra information for Lamb Survival is birth fate (BFATE) codes. These are used to determine if a lamb died before or survived to weaning. Some BFATE codes are used to credit the right dam for a lamb’s survival (e.g. a fostered lamb fate code).

Due to compatibility with historical recording systems, there are a number of different codes that code a lamb as died. SIL groups these such that the survival calculations are simply based on whether a known lamb is dead or alive at weaning.

The fate of the dam, for ewes that are to be culled or that foster a lamb, should be recorded under DFATE. If the ewe exits the flock at or around lambing, an EXITFATE should be recorded. Note that the EXITFATE is not the same thing as a DFATE. Your bureau can provide advice on how to efficiently record the two variables.

Full sets of lamb fate codes (BFATE), dam fate codes (DFATE) and ewe exit codes (EXITFATE) are available from your SIL service provider. Common examples are provided in table 7 (pg 25), and section 8.5 (pg 44). Ewes can be given more than one DFATE i.e. AI and aborted = AT, and lambs more than one BFATE i.e. AI and born dead = LJ

Table 7: List of Lamb Fate Codes (BFATE) and Ewe Fate Codes (DFATE)

Lamb Fate Codes = BFATE	
Fate code description	
E	ET progeny
F	Fostered
H	Hand-reared
J	Born dead
J3	Died within 3 days of birth (autopsy)
K	Died between birth and rearing
L	AI progeny
M	Died misadventure
P	Born dead - Premature (autopsy)
R	Born dead - Rotten (autopsy)
X	Multiplier lamb
1	Died between rearing and weaning
4	Culled at birth (alive but not tagged)

Ewe Fate Codes = DFATE	
Fate code description	
A	AI dam
B	Barren
C	Foster mother
D	ET donor
G	Assisted
N	Not mated
O	Natural Mating
P	Pen mated
R	ET recipient
S	Screened in ewe
T	Aborted
U	Lambed, unrecorded progeny
X	Multiplier ewe
Y	Multiple ram joining group

SECTION 05

GROWTH

5. Growth

5.1 Lamb weaning weight (WWT)

Why

Liveweight of the lamb at weaning is the measure of growth due to a lamb's own potential, its mother's potential and other effects. We use this data to estimate lamb (direct) and ewe (maternal) genetic effects (WWT and WWTM eBV). Weaning weight is a predictor for a number of other traits and to account for selective culling for later recorded traits. It is essential ***all*** lambs are recorded at weaning. WWT is also used to inform Survival, see previous section)

When

Weaning is typically at 10-12 weeks of age but it is common to wean earlier or later than this, particularly when grass growth demands this for good pasture management. Animals need to be treated in a way that is consistent within mob. Avoid measuring some lambs for weaning weight directly off pasture and others several hours later, when part of the same management group.

Birth date (actual or estimated from FAGE at scanning) is used to adjust weaning weight. All animals within a management mob must be measured on the same day. For animals assessed on different days, there may be effects that occur between the two time points that advantage one group relative to another, and simply adjusting for birth date will not take this effect out.

How

Weigh all lambs, being consistent with time they are off pasture.

Record

- **Date**
- **WWT for lambs**
- **Management groups if managed differently in the preceding period.**

Example of correct management group use

Mob recording is VERY important. If groups have been managed separately so that there may be a feed/management difference between mobs, they should be recorded as separate mobs. See principle 4, page 10.

Mob codes

Weaning sets the initial mob code for an individual in an analysis – after that, mobs are cumulative. Whenever practical, when combining mobs after weaning try to combine whole mobs. see figure 2 page 10.

SIL selection objectives

Selection for fast growing lambs favours genetics that produce large ewes as adults. This has implications for flock feed requirements as larger ewes generally eat more. SIL selection objectives for maternal sheep are designed to favour animals that produce large fast-growing offspring for a given size of ewe. For more information on recording EWT – see section 5.3.

5.2 Autumn liveweight (LW6, LW8, or LW10)

Why

Liveweight (LW) measured in autumn is the key measure of post-weaning lamb growth and will be used to inform carcass weight (CW) eBV. This liveweight measure is usually associated with ultrasound eye muscle scanning.

When

The SIL Lamb Growth evaluation analysis uses just one liveweight measurement, either at 6 months (LW6), 8 months (LW8) or 10 months (LW10) depending on which occasion had more animals measured in a mob. It is best practice to record autumn LW in both males and females.

How

Weigh all animals. All animals within a management mob should be measured on the same day.

Record

- **Date and liveweight for LW6, LW8 or LW10. Management groups (mob code) if managed differently in the preceding period.**
- **EXITFATES for any animals culled**

REMEMBER: If you measure autumn liveweight multiple times, the genetic evaluation will use the measurement with the greater number of animals measured.

5.3 Ewe adult size and body condition score

Why

Measuring liveweight and body condition score (BCS) will help determine the ewe's maintenance feed costs and genetic potential to hold condition.

When

For management purposes it can be valuable to measure BCS, and adjust feed accordingly, at multiple times of the year (Premating, Mating, Pregnancy Scan, Lambing, and Weaning). For genetic evaluation purposes we need at least **one record** of ewe BCS **per annum** with a **liveweight recorded** at the same time.

Best practice is to measure LW and BCS of ewes at mating (LWMATE/BCSMATE). More precise estimates of merit come from measuring these traits in all ewes, every year at this time. The ideal time to record these measurements is close to the beginning of mating but it is acceptable to measure them up to 3 weeks either side of ram introduction.

Optional; BCS and ewe liveweight measured multiple times in the year (mating, pregnancy scanning, and weaning) may be used in future evaluation research to determine whether ewes that fluctuate in BCS and/or LW are more productive or last longer than ewes that maintain BCS and/or LW, and what genetic advantage there is to such patterns of change.

How

Weigh all animals.

Assess BCS in the range 1 to 5 at the same time as liveweight. It is common to use increments of 0.5 when a ewe is not quite good enough for one category, but better than the one below. There is no need to break it down any more than this.

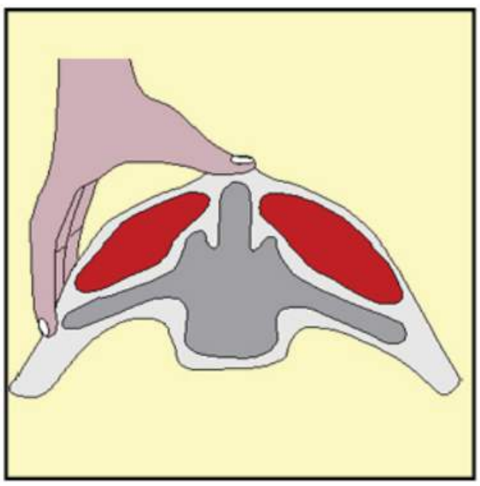
Note: BCS data without an associated LW is not used to predict the BCS BV. You must have both collected at the same time.

Where possible use one BCS assessor per farm. Record each assessor as a separate mob code when multiple BCS assessors are used.

Guidelines on how to assess BCS can be found on the B+LNZ website (beeflambnz.com). Type “body condition score” into the search box and filter by documents.

A simple summary is provided below;

- BCS 1 - no fat and no muscle, animal emaciated and consider euthanasia
- BCS 2 - animal skinny but some fat and muscle detected
- BCS 3 - animal prime with good amount of fat and muscle detected
- BCS 4 - animal overweight with considerable fat and muscle detected
- BCS 5 - animal obese, difficult to feel bones



SECTION 06

MEAT YIELD

6. Meat Yield

6.1 Live animal measurements – Ultrasound (EMA) and CT scanning (CTSCAN)

Why

Production of meat is a major source of income from sheep farming. There are several scanning technologies that can currently be used to predict meat weight and yield in live animals and have the data used in SIL genetic evaluations, namely ultrasound and computed tomography (CT) scanning. Ultrasound scanning is relatively inexpensive on a per animal basis and can be done on farm, but is only moderately accurate at predicting the weight of meat and fat in the carcass. CT scanning is very accurate, but is expensive to measure and animals must travel to special facilities to be evaluated. Both can be used in breeding programmes to improve meat yield. Best practice guide for both processes are given below to outline how genetic progress can be maximised while minimising investment in scanning.

When

The aim is to evaluate animals at a time and liveweight similar to normal slaughter age and weight. The best time to ultrasound and CT scan is at or around the same time as autumn liveweight is measured. Later measurements (e.g. the following spring) will increase the differences between animals, but there is no guarantee that the animals have not changed ranking through the winter.

How

Ultrasound scanning provides moderate accuracy of prediction for individual animals, so breeding value accuracy is greatly improved by scanning many animals. Ultimately breeders will decide how much investment they are willing to make into ultrasound scanning, so the following principles apply to maximize the return on that investment.

- Best practice is to measure at least 25 progeny per sire. In flocks where progeny numbers per sire are small, this can be achieved by scanning both ewe and ram lamb progeny.
- Ensure a fair representation of each sire's progeny is scanned.
- Up to an additional 30% genetic progress can be made by ultrasound scanning ewe lambs. If ewe lambs are scanned, then there should be similar representation across sire lines, and selection for scanning should be on the basis of performance (based on breeding values).

With CT scanning, meat yield is measured very accurately, but at a high cost. Best practice for cost effective use of CT scanning involves the practice of two-stage selection. This is where animals are screened using ultrasound scanning to find the top ranked animals, and then only CT scanning the top group to give the best ranking of these elite rams.

The proportion of rams to CT scan again depends on the investment a breeder is willing to make. Best practice is to scan between 5 and 10% of ram lambs each year. There is little additional economic benefit in CT scanning more than 15% of ram lambs, and very little benefit from scanning less than 5% of ram lambs. Whatever percentage scanned, breeders should try and balance numbers from each sire line.

Record

Ultrasound Eye Muscle

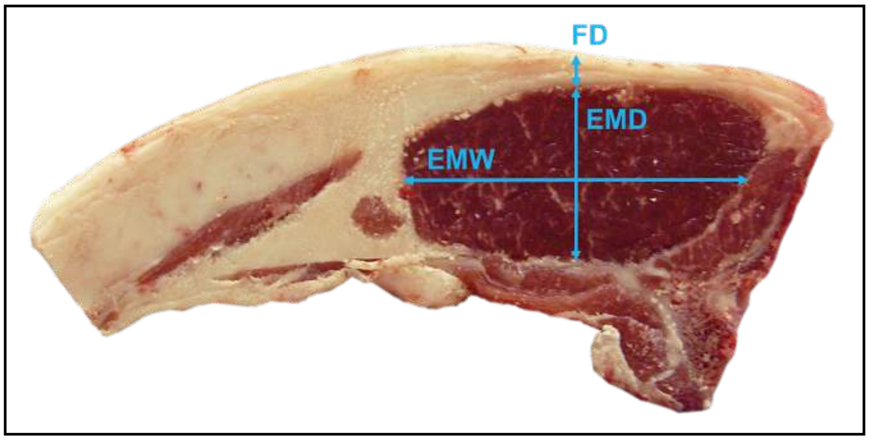
- **EMD - Eye muscle diameter (cm)**
- **EMW - Eye muscle width (cm)**
- **FD - Fat depth (mm) directly over the point where EMD is measured**

There are some differences between scanner operators in the ultrasound scanning site. Consistency of measurement site within a flock is more important than where the actual measurement site is located, i.e. it is best not to change the measurement site once it is established in a flock. If more than one scanner operator is used, a separate management code should be recorded.

CT Scan

- **HQLY - Hind Quarter Lean Yield**
- **SHLY - Shoulder Lean Yield**
- **LNLY - Loin Lean Yield**
- **FATY - Fat Yield**
- **LEANY - Lean Yield**

Cross-section view of the loin as is scanned by ultrasound:



6.2 Measurements post slaughter - Carcass weight (CW) and VIAscan

Why

Actual carcass weight and meat yield measurements at slaughter are the most accurate information on dollar value of progeny produced and is directly relevant to payments commercial breeders will receive. However, best practice would require measurement of an unbiased sample, as is achieved by killing all progeny (or all male progeny) in progeny test situations. CW and VIAScan information on cull animals can still be of value if these principles are followed.

How

In 2016, the only slaughter measurements that have been calibrated for inclusion in meat yield evaluation are VIAScan measurements from Alliance. Research in developing calibration of additional meat processor measurements of meat yield (calibrating to CTSCAN measurements) is currently underway and expected to be available by 2018.

Ideally, to assess meat yield merit of sires, the majority (>80%) of progeny should be measured (killed) on one day. Carcass weight and meat yield in young animals is particularly sensitive to differences in age, nutrition, gender and general management prior to slaughter and so attention to recording accurate management groups is vital.

When

Assessing genetic merit is best served when animals are most variable. Carcass weight and meat yield is also best assessed when progeny have had time to express their own merit separate to the maternal environment. For these reasons, carcass weight and meat yield measurements are recommended to be taken around 4 to 6 weeks post weaning.

Record

- **Carcass weight (hot or cold) CW**
- **VIAscan measurements**
    - **VSCWT** **VIAscan Carcass Weight**
    - **VSLEG** **VIAscan Leg Yield**
    - **VSLOIN** **VIAscan Loin Yield**
    - **VSSHLD** **VIAscan Shoulder Yield**
    - **VSMOB** **VIAscan Mob**

SECTION
07

WOOL

7. Wool

7.1 Wool - Fleece weight and fibre diameter

Why

Wool is an important income stream for maternal sheep. In fine and medium wool sheep breeds, fibre diameter and fleece weight determine value.

When

Hogget fleece weight is a more reliable predictor of genetic merit for wool production than lamb fleece weight and is preferred for best practice. Hogget fleece weight is typically measured when the animal is at 12 months of age (FW12).

How

Wool value index is estimated from hogget fleece weight (FW12). If FW12 is not measured, it can be predicted from lamb fleece weight at 6 months (FW6) if available. Wool fibre diameter (FDIA) and clean fleece weight (CFW12) are also included in the evaluation if available.

FDIA is measured by taking small samples from the side or fleece of a sheep and is measured with a portable instrument such as an OFDA2000 (Optical Fibre Diameter Analyser); or a mobile instrument system called a Fleecescan.

Record

- FW12 Fleece Weight at 12 months
- Management groups if managed differently in the preceding period

<u>Optional</u>

- LFW Lamb Fleece Weight
- EFW Adult Ewe Fleece Weight
- FDIA Fibre Diameter

As long as all animals are treated the same, it does not matter whether animals are shorn as lambs or not, or are lambed as hoggets etc. prior to the measurement. If animals have been treated differently prior to recording fleece weight, a management group should be recorded.

SECTION 08

HEALTH TRAITS

8. Health Traits

Health traits are considered restricted traits that you will need to register with SIL and follow the prescribed protocols. Details about how to register can be found on the SIL website. Lists of SIL flocks registered for Health traits can be found on the SIL website. Presented here is an overview of the measurements involved for each trait.

8.1 WormFEC^{TM} - recording for parasite resistance

Why

Recording for resistance (WormFEC) requires faecal sampling and egg counting

Resistant animals mount an immune response to reduce or eliminate the population of worms in their gut and decrease the reproductive ability of any worms that remain. Measuring how resistant they are to allowing the eggs to develop is a trait of high value to the industry, to reduce the reliance on anthelmintics for supporting lamb growth.

When

The FEC test is carried out in late summer or autumn in lambs. The test is best measured when the majority of animals are expected to experience a worm challenge. The worm burden typically allowed to develop over 5-8 weeks after drenching. For female lambs, consider the amount of time available for lambs to recover in time for hogget mating if this is to occur.

How

First you need to organise a challenge with an approved operator to count the faecal samples. These approved operators will also provide advice and associated services. Currently, the only approved operator is Techion Group.

The challenge starts after anthelmintic treatment. General technical advice including which drenches are appropriate to use for your situation, can be obtained from Techion Group (www.techiongroup.co.nz).

Allow levels to get up to 800 eggs per count (or more) which usually takes 6 weeks. Test the mob weekly

Mob faecal sampling - Collect fresh faecal samples expected to be from 30 different individual animals (~1 teaspoon per animal) which can be collected from mobs in the yards or cornering mobs in the field.

Individual stool sampling - Collect fresh stool directly from animal in the yards (approx 1 dessert spoon per animal)

Base Challenge - Collect mob faecal sample at a time when a worm challenge is expected and should be more than 500 eggs per gram (epg). If not, delay the effectiveness test until the natural challenge is greater. Drench all animals.

Effectiveness of drench – sample 8-10 days after drenching and epg should be zero. If not, consult with your vet to investigate whether you have drench resistance and another drench family is required.

Challenge test - Sample the mob weekly and allow the average worm burden to build up to at least **800 epc** (eggs per count) which can be expected to take around 6 weeks to occur. Sample eight female lambs per sire individually (or all animals if preferred) recording EID to each sample (barcoding of samples is advisable) and send sample to testing laboratory (eg Techion). Drench animals as normal after test.

Record

Test animals only once, but there are two options based on the timing of the test.

- **FEC1 – faecal egg count prior to March – preferred time.**
- **FEC2 – faecal egg count after March**
- **Management groups if managed differently in the preceding period.**

SIL recommends testing between 20 (minimum) and 30 (ideal) progeny per sire line to give an accurate representation of the breeding value of each sire.

8.2 Facial eczema (FE) – RamGuard

Reminder: Facial Eczema is considered a restricted trait that you will need to register with SIL and follow the prescribed protocols.

Why

Facial Eczema, (FE) is a disease that mainly affects ruminants such as cattle, sheep, deer, and goats. It is caused by the fungus *Pithomyces chartarum* which requires warm humid weather with night time temperatures of over 13°C (55°F) for several days, and dead matter at the bottom of the sward for rapid growth. The spores of the fungus release the mycotoxin Sporidesmin which affects the animal's gastrointestinal tract causing a blockage in the bile ducts that leads to liver damage. Elevated levels of GGT in the blood are indicative of liver damage and these will elevate before clinical signs of the disease are evident.

Protection from the toxin can be provided by zinc treatment (drench or capsule), spraying fungicides, growing crops or legumes and herbs. Genetic selection for tolerant animals is by far the most effective solution for the industry.

For up to date information on Facial Eczema see *"Facing up to facial eczema"* available as a pdf at www.beeflambnz.com.

FEGold is a brand promoted by breeders recording for FE tolerance see www.fegold.co.nz for more information.

When

The best time to test (dose) animals in FE prone areas is in the spring when the animals will not be receiving a natural FE challenge. This also represents the time when the most important animal traits have already been recorded and the top animals (rams) for testing can be selected on indexes. The other option is to test animals after weaning and before autumn when the animals are yet to receive a natural challenge. The toxin dose is given as mg/kg liveweight therefore testing smaller animals is more cost effective.

How

Five lambs of the same sex per sire, including link sires, should be selected. The dose for the lambs will be predetermined by the FE testing status of the lamb's birth flock and the sire's flock FE status and previous results. Selected lambs are dosed by a veterinarian on the farm with blood collected for a base GGT enzyme level plus a second blood collected 21 days later that will measure GGT21 levels. Elevated GGT is indicative of liver damage and in this case is used to measure the response to the Sporidesmin dose.

Record

- **GGT:** GGT levels in the blood at dose treatment as a base level
- **DOSE:** the amount of sporodesmin given in the challenge (mg/kg of liveweight)**.**
- **GGT21:** GGT levels in the blood 21 days after dose treatment

RamGuard™

RamGuard™ is the name of the service for sheep and cattle breeders to select for Facial Eczema (FE) tolerance in animals. Results and data from RamGuard™ testing is used to assign a Status rating to both Flocks and Individual rams.

Flock Status rating includes factors such as:

- the dose rate they test at
- the number of years the flock has been testing
- the degree to which the sheep tested each year react

Individual Status rating includes factors such as:

- the dose rate individuals were dosed at, or
- the dose rate an individual's progeny were dosed at

Note:

- Flock Status Rating is related to, but not the same as Individual Status ratings.
- RamGuard™ scientists determine the dose rates that flocks use each year and produce status ratings for Flocks and Individuals.
- The dose rate a flock is tested at is not used in the SIL genetic evaluation of Facial Eczema tolerance.
- GGT21 breeding values may be similar for sheep tested at different dose rates.
- Using the flock status rating along with the estimates of genetic merit for individual animals (GGT21BV or DPX index) provides the means to rate animals for FE tolerance.
- When animals have similar values for GGT21BV or DPX, those from a flock with a higher status rating are likely to be more tolerant to FE.

More information on Flock and Individual Status can be found on the SIL website

Natural Challenge

Seek advice from RamGuard experts before considering recording GGT21 in response to a natural challenge.

8.3 Dag Score

Why

Removal of dags is a costly and bothersome exercise for farms. Identifying animals with a tendency to produce less dags is highly valued. Note: dagginess may be due to sensitivity to feed changes, consistency of faecal matter and is not directly related to parasite resistance or resilience. The economic weighting reflects the savings made with reduced dagging and crutching.

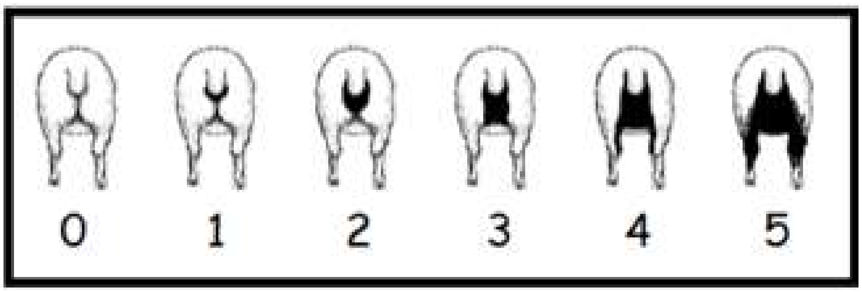
When

Record Dag Score on two occasions;

DAG3 occurs after weaning (Dec-Feb). DAG8 occurs at the autumn liveweight (Mar-May) with LW8 preferred. ADAG may also be measured in adult ewes

How

Dagscore is measured on a 6 point scale (0 to 6), see diagram below



There is no need to avoid drenching in order to seriously challenge sheep to scour. In order to get the best discrimination for genetic merit for Dag Score, we should aim to get about 50% of sheep with a Dag Score greater than zero. The first opportunity is at weaning (DAG3) when typically lambs have NOT been crutched or drenched prior to being measured. The next opportunity is at autumn liveweight (DAG8) where it has typically been some time since animals have been drenched or dagged. You can crutch and drench sheep after scoring them.

Record

- **Date, Operator (if more than one)**
- **DAG3 - Dag Score at 3 months (weaning)**
- **DAG8 - Dag Score at 8 months (hogget)**
- **ADAG – as adult at weaning or mating**
- **Management Groups if managed differently in the preceding period**

Common examples of management groups for this trait are whether some, but not all, lambs were crutched or drenched during the period when dags developed. If uncertain please speak to your SIL bureau.

8.4 Bare Belly and Bare Breech

Why

A desire to select animals that are bare around the points and belly is valuable to reduce crutching costs and reduce tendency to produce dags.

When

Bareness of wool from the breech can be measured relatively easily around the time of weaning. It could also be assessed when either DAG3 or DAG8 is being measured whereas assessing belly bareness may fit best with crutching lambs over the board or shearing of ewes at FW12. Repeat measurements are not required.

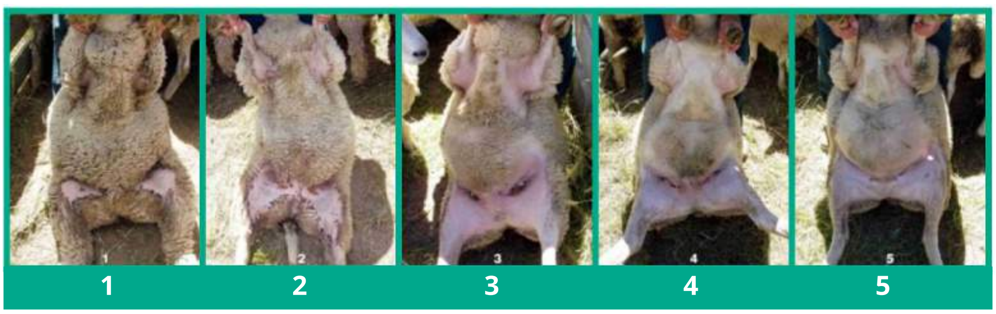
How

The date and score (1-5) for each individual animal should be recorded under the appropriate trait names (below) relative to age of measurement. Again, noting management groups such as mob, operator and whether some animals have been crutched within the previous 6 weeks should be noted.

Record

- **Belly Bareness**
  - **BBELLY** **as a lamb = preferred record**
  - **BBELLY18** **at 18 months**
  - **BBELLYMA** **at mixed age**

Belly Bareness Score



- **Breech Bareness**
  - **BBREECH** **as a lamb = preferred record**
  - **BBREECH18** **at 18 months**
  - **BBREECHMA** **at mixed age**

Breech Bareness Score

8.5 Stayability (STAY)

Why

The ability of the ewe to remain productive in her flock for longer than others is a desirable economic trait. The index reflects the cost of replacements when sheep exit the flock earlier than others.

When

Record EXITFATE as and when a ewe leaves the flock. Peak periods for culling are post weaning and post pregnancy scanning of dry ewes. Exit fates can be recorded for all age classes of stock. The eBV relates to the ewe stayability in the flock.

How

Currently this breeding value is predicted from the presence or absence of ewes in the stud flock at each age given she was present as a two tooth. In future, it is intended to distinguish between ewes that exit for commercial reasons and sound ewes that are removed from the stud flock for knowledge reasons usually only available to stud breeders (such as rearing poor growing lambs based on individual weaning weights).

Ewes will exit the flock for reasons including those that are un-avoidable (e.g. she died or went missing), standard commercial culling reasons (e.g. she was dry, had mastitis, lameness or faults) and culled as part of stud practice such as culling on breeding values or index values, or transfer for use in a commercial flock.

As a minimum the date the ewe exited and the category (commercial, knowledge or unknown) should be recorded. It is optional to record the detailed reason for exit (refer table). The exact reason why she exited the flock is 'nice to have' information that may be used in further research development of this trait, but is not currently required for this research eBV.

Record

EXITFATE codes.

At minimum, record as

- **C Commercial reason that would be obvious without performance records**
- **K Knowledge reason reliant on performance records (EBVs, Indexes etc.)**
- **U Unknown, use sparingly**

As a guide to defining C, K or U codes, more detailed codes are listed below. These may also be recorded, and will provide extra data which may enhance this trait given more R&D.

Commercial categories		**Knowledge Categories**	
Died		**Culled**	
D1	unknown time, not lambing	L1	lambs born dead
D2	at lambing	L2	poor mother at lambing
D3	pregnancy related	L3	number of lambs/lambing
D4	other known disease	L4	lamb losses
M1	misadventure	L5	litter size recent
Culled		L6	total lamb wean weight
M2	misadventure	X1	lambs born with fault
P1	failed to get pregnant	X2	wool problem
P2	mated late	X3	faults seen in relatives
P3	wet dry	X4	breed type fault
P4	bearing prolapse	G1	animals own eBVs / indexes
P5	assisted birth	G2	relatives eBVs / indexes
H1	poor condition	G3	animals own gene test result
H2	excess condition	S1	age
H3	non-fatal disease	S2	when flock size reduced
H4	teeth or mouth breakdown	S3	sold to other stud
H5	feet or leg breakdown	S4	sold for commercial use
H6	eye problem		
H7	udder problem		
H8	testicle problem		
H9	other reason		
A1	one of a few ewes aborting		
A2	one of many ewes aborting		

SECTION
09

APPENDICES

9.1 Chronological order for recording traits for each sub index

		Maternal Worth	Maternal Worth	Maternal Worth / Terminal Worth	Maternal Worth / Terminal Worth	Terminal Worth	Maternal Worth	Maternal Worth	Health Sub Indexes			
Age	**Month**	**Reproduction**	**Survival Maternal**	**Survival Direct**	**Growth**	**Meat Yield**	**Wool**	**Hogget Fertility**	**Dag**	**WormFEC**	**Facial Eczema**	**Stayability**
Lamb	Spring											
	Summer	*WWT	*WWT	*WWT	WWT	WWT	WWT	WWT	DAG3	WWT		
Hogget	Autumn	LW6/8/10			LW6/8/10	LW6/8/10 EMD, EMW, FD *CTSCAN *VIASCAN	LW6/8/10	LW6/8/10	DAG8	FEC1/FEC2	LW6/8/10 GGT21	
	Winter							PREGSC				
	Spring						*FW6 FW12	*NLB				
	Summer							*WWT				
Two tooth	Autumn	LWMATE BCSMATE			LWMATE BCSMATE				ADAG			EXITFATE
	Winter	PREGSC (FAGE)	*PREGSC									EXITFATE
	Spring	NLB	NLB									EXITFATE
	Summer	WWT of lambs	WWT of lambs									EXITFATE
Mixed Age (repeat)	Autumn	LWMATE BCSMATE			LWMATE BCSMATE				ADAG			EXITFATE
	Winter	PREGSC (FAGE)	*PREGSC									EXITFATE
	Spring	NLB	NLB									EXITFATE
	Summer	WWT of lambs	WWT of lambs									EXITFATE

*WWT - presence of a wean weight is used to inform the number of animals present at weaning and account for culling and selection on later recorded traits

*PREGSC in grey - is optional and will be used to infer NLB if NLB is not supplied

*CTSCAN and *VIASCAN in grey is optional for Meat Yield

*FW6 in grey - is optional and will be used to predict FW12 if FW12 is not measured

*NLB and *WWT in hogget fertility is optional.

9.2 Summary of Indexes

Sub-index average, top and bottom values for April 2016 run GE 33500

	TSS	TSG	TSM	DPR	DPS	DPG	DPA	DPW	DPM	DPF	DPX	DPD
average	**+29**	**+642**	**+313**	**+272**	**+174**	**+1261**	**-506**	**+130**	**+94**	**+48**	**+566**	**+13**
top	+154	+1062	+642	+795	+546	+2100	+256	+334	+456	+533	+1145	+85
bottom	-96	-223	-16	-251	-198	+422	-1268	-74	-268	-437	-566	-59

Summary of SIL Indexes and weighting of the components they summarise

SIL Indexes	Equations
Terminal Worth	***TSG + TSM + TSS***
Maternal Worth	***DPR + DPS + DPG + DPA + DPW***
TS Growth	(* TSG) ₵ = 68 x WWTeBV + 195 x CWeBV
TS Meat	(* TSM) ₵ = 407 x LNLYeBV - 200 x FATYeBV + 271 x HQLYeBV + 136 x SHLYeBV
TS Survival	(* TSS) ₵ = 4567 x SUReBV
DP Reproduction	(* DPR) ₵ = 2231 x NLBeBV
DP Survival	(* DPS) ₵ = 9246 x SUReBV + 8378 x SURMeBV
DP Growth + Adult size	(* DPG+A) ₵ = 136 x WWTeBV + 121 x WWTMeBV + 374 x CWeBV - 119 x EWTeBV
DP Meat	(* DPM) ₵ = 752 x LNLYeBV + 501 x HQLYeBV + 251 x SHLYeBV
DP Wool	(* DPW) ₵ = 113 x FW12eBV + 261 x LFWeBV + 327 x EFWeBV
DP Health Facial Eczema	(* DPX) ₵ = -1433 x GGT21eBV
DP Health WormFEC	(* DPF) ₵ = -4.14 x FEC1eBV - 4.14 x FEC2eBV - 3.12 x AFECeBV
DP Health Dag	(* DPD) ₵ = -48 x LDAGeBV - 51 x ADAGeBV
DP Hogget Lambing	(* DPH) ₵ = 1037 x HFEReBV + 502 x HNLBeBV

9.3 Glossary: general terms, breeding values, indexes

General Terms	Description
Accuracy or reliability	A scale of relative accuracy for BVs and indexes. As more information is used in the prediction of the animals BV and Index, accuracy of the prediction increases. Traits or characteristics which are more heritable and more related to other predictor traits have higher accuracy.
Across flock analysis	A SIL evaluation that uses data from more than one flock. Use of 'link sires' (see definition) is needed to get 'genetic connectedness'. Connectedness is required to make comparisons of genetic merit between animals in different flocks.
Breeding Value	A measure of genetic merit for a particular trait (whether directly measurable or not), estimated from performance, pedigree and/or from DNA tests.
DNA Parentage	Flocks recording this are using DNA to assign both sire and dam of all lambs. This gives the most accurate (100%) pedigree compared to traditional methods (85-95%) so estimates of genetic merit are more accurate.
Dual Purpose Breed (DP)	Ewe breeds selected for lamb production and ewe maternal performance.
Genetic Connectedness	This is a measure of how well linked two flocks are genetically. Strong links are built by two flocks using the same sire in the same year. The progeny of such 'link sires' are used to benchmark genetic merit. Such connectedness is needed to validly compare the BVs or indexes for animals in different flocks.
Genetic Trends Graphs	SIL produced Genetic Trend Graphs show the genetic progress a flock is making. Accurate graphs require a flock to be using link sires between years i.e. the same sire is used in consecutive years to allow non-genetic effects to be removed and show how average genetic merit for a trait or index has changed.

General Terms	Description
Goal Trait Group	Breeding objectives are a combination of broad trait categories termed Goal Trait Groups. One or more breeding values contribute to a Goal Trait Group which has a corresponding sub-index. Combinations of relevant sub-indexes comprise summary indexes of merit (see Index section).
Index	Net value of genetic merit across a range of traits that relate to the breeding objective. Higher values are better for all SIL indexes. SIL DP indexes have units of cents per ewe lambing, while SIL TS indexes have units of cents per lamb born. Indexes can be separated into sub-indexes for general goal traits (see Goal Trait Group definition).
Link sires	Link sires have progeny in more than one flock in the genetic evaluation. This provides the essential benchmarking needed to allow us to compare genetic merit of animals from different flocks and from different years within flocks. Between year comparisons are used to produce Genetic Trend Graphs.
Maternal breed (DP)	Ewe breeds selected for lamb production and ewe maternal performance. (See Dual Purpose breed.)
Outside sires	Sires from outside the flock(s) in the evaluation. Outside sires will have estimates of genetic merit (BVs and indexes) close to zero until progeny in the evaluated flock(s) have performance data.
Terminal (Sire) breed (TS)	Sheep breeds selected for meat production including direct survival and growth.
Within flock analysis	The analysis or evaluation uses all the information from one flock. For sires from other flocks (outside sires), estimates of genetic merit (BVs and indexes) will be close to zero until their progeny in this flock have performance data.

Breeding Values		Description
Adult body weight	EWT	Liveweight of adult ewe
Adult dag score	ADAG	Adult dag score
Adult ewe fleece weight	EFW	Weight of ewe fleece
Adult faecal egg count	AFEC	Faecal egg count for adult ewes
Belly bareness score	BBELLY	Belly bareness score at weaning
Body Condition Score	BCS	Body Condition Score 1-5
Breech bareness score	BBREECH	Breech bareness score at weaning
Carcass weight	CW	Post-weaning growth rate, expressed in terms of carcass return
Eye muscle area	EMAc	Eye muscle area in 18kg carcass
Faecal egg count prior March	FEC1	Faecal egg count in lambs, late summer
Faecal egg count from March	FEC2	Faecal egg count in lamb, autumn
Fat yield of carcass	FATY	Fatness - above or below average for 18kg carcass
Fleece weight as a lamb	LFW	Weight of lamb fleece
Fleece weight at 12 months	FW12	Weight of hogget fleece
GGT at day 21 after dose	GGT21	Lamb GGT values 21 days after facial eczema challenge
Hind quarter lean yield	HQLY	Hind quarter lean yield in 18kg
Hogget fertility	HFER	Ability of hogget to get pregnant
Hogget number of lambs born	HNLB	Ability of hogget to have more lambs
Lamb dag score	LDAG	Lamb dag score in summer or autumn

Breeding Values		Description
Lamb survival, direct	SUR	Lamb vigour birth through to weaning
Lamb survival, maternal	SURM	Ewe mothering ability
Lean Yield	LEANY	Average lean yield across carcass region in 18kg carcass
Liveweight at 12 months	LW12	Liveweight of hogget (12months)
Liveweight at 8 months	LW8	Autumn liveweight - post weaning growth
Loin lean yield	LNLY	Loin quarter lean yield in 18kg carcass
Number of lambs born	NLB	Litter size in adult ewes (2-tooth &
Resilience, age at first drench	DRAGE	Lamb age at first drench under worm challenge for resilience
Resilience, liveweight gain	RGAIN	Lamb liveweight gain under worm challenge for resilience
Saliva carbohydrate larval antigens	CARLA	Antigens in saliva indicate an immune response to a worm challenge. Animals with high levels of antibodies are better at preventing worms establishing in the gut and so considered more parasite resistant.
Shoulder lean yield	SHLY	Shoulder quarter lean yield in 18kg carcass
Stayability	STAY	Ewes ability to remain productive longer
Tail bare skin length	TSKIN	Length of bare skin area on the underside of the tail
Tail length score	TLENSC	Tail length score at tailing/docking
Twinning rate	TWIN	More twin and fewer single or triplet lambs at given lambing percentage
Weaning (body) weight	WWT	Pre-weaning growth rate
Weaning weight maternal	WWTM	Ewe milking ability contributing to lamb weaning weight

Indexes		Description
DP Adult Size	DPA	A function of the adult ewe liveweight BV (EWT)
DP Bareness	DPB	The genetic propensity to have clear points (no wool) around the belly and breech (rear end). Based on BBELLY & BBREECH BVs.
DP Dag Score	DPD	Propensity to carry dags – based on LDAG (lamb) & ADAG (adult) BVs.
DP Facial Eczema Tolerance	DPX	A rating of an animal's ability to tolerate an FE challenge, based on the RamGuard system. The level of challenge can differ between farm so this index is most accurate for comparisons within farm and birth year. Based on GGT21 BV.
DP Hogget lambing	DPH	A function of ewe lamb fertility (holding to the ram) and litter size as a 1-year old dam. Based on 2 BVs - HNLB, HFER
DP Internal Parasite Resilience	DPZ	An animal's tolerance and ability to perform under a parasite challenge. Based on 2 BVs for rate of liveweight gain (RGAIN) and age when drenching is required (DRAGE). This differs to resistant animals that actively fight a parasite challenge resulting in a lower faecal egg count.
DP Internal Parasite Resistance	DPF	Predicted from faecal egg counts (FEC) using the WormFEC system. Based on 3 BVs - FEC 1 & FEC 2 for lambs & AFEC for ewes.
DP Lamb Growth	DPG	A function of 3 BVs – pre-weaning growth and ewe milking ability (WWT & WWTm), and carcass weight (CW)
DP Lamb Growth + Adult Size	DPG+A	A function of 4 BVs in DPG and DPA
DP Lamb Survival	DPS	A function of 2 BVs – lamb vigour (SUR) & ewe mothering ability (SURM)

Indexes		Description
DP Meat (Yield)	DPM	A function of carcass lean yields in 3 carcass regions – shoulder, loin and hindquarter (BVs SQLY, LQLY, & HQLY). Yields are deviation for kg of tissue at a standard carcass weight (18kg). Fat yield (FATY) is not addressed in this index but there is a degree of relationship between fat yield and lean yields (high FATY tends to be associated with low lean yield).
DP Reproduction	DPR	The economic value of more lambs per litter, per year, for 2-tooth and older ewes. Based on NLB BV.
DP Stayability	DPL	Ewe longevity based on how many years they are able to stay productive in the flock. STAY is the BV that informs this index and is currently being field tested by industry.
DP Twinning	DPT	The tendency to produce more litters of 2 and fewer of 1 or 3. Based on TWIN BV.
DP Wool production	DPW	A function of fleece weight BVs (LFW, FW12, EFW).
New Zealand Maternal Worth	NZMW	An industry standard index for dual purpose sheep based on Reproduction, Lamb Survival, Lamb Growth + Adult Size, and Wool production.

Indexes		Description
New Zealand Terminal Worth	NZTW	An industry standard index for terminal sire sheep based on Lamb Survival, Lamb Growth and carcass Meat Yield.
TS (Lamb) Growth	TSG	A function of 3 BVs – pre-weaning growth (WWT), post-weaning growth (CW) and ewe milking ability (WWTm)
TS Meat (Yield)	TSM	A function of carcass lean yields in three carcass regions – shoulder, loin and hind quarter (BVs SQLY, LQLY, HQLY). Yields are deviation for kg of tissue at a standard carcass weight (18kg). Fat yield (FATY) is not addressed in this index but there is a degree of relationship between fat yield and lean yields (high FATY tends to be associated with low lean yield). Eye Muscle Area calculated (EMAc) BV from width and depth of eye muscle as scanned by ultrasound is included.
TS (Lamb) Survival	TSS	A function of SUR (lamb vigour) BV.
TS Dag Score	TSD	Propensity to carry dags – based on LDAG (lamb) & ADAG (Adult) BVs.
TS Internal Parasite Resistance	TSF	Predicted from faecal egg counts (FEC) using the WormFEC system. Based on 3 BVs - FEC 1 & FEC 2 for lambs & AFEC for ewes.

9.4 How on-farm measurements relate to the sub indexes

Recorded on farm	**The sub indexes (goal trait groups) these on-farm measurements go into**
Weaning weight	Growth, Meat, Survival, Parasite Resistance,
Lamb fate code	Survival
Autumn liveweight	Growth, Meat, Wool, Reproduction, Parasite Resistance
Hogget liveweight	Growth, Wool, Parasite Resistance
2-tooth liveweight	Growth
Meat scanning	Meat
Wool measurements	Wool, Parasite Resistance
Pregnancy scanning	Reproduction, (Survival)*
Hogget lambing	Growth, Reproduction
WormFEC™	Parasite Resistance
Dag score	Dag Score
FE (RamGuard)	Facial Eczema

* Pregnancy scanning results only used when bureau flags them to be used after breeder instruction

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