Topic 17 Precision sheep management

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Learning Objectives

On completion of this topic you should be able to:

- Describe what Precision Sheep Management (PSM) involves
- Describe the tools available for precision sheep management
- Outline how PSM can be used to improve sheep enterprise profitability and how it applies to both wool and sheep meat enterprises
- Describe how PSM can be implemented on-farm

Introduction

Precision Sheep Management (PSM) is a practical approach to managing sheep (sub) flocks to achieve increased profits. By collecting individual measurements on animals, the top and bottom performers in the flock can be identified and grouped to maximise production and minimise costs. There is a large amount of variation between animals for most traits and by collecting and using this information for selection, nutrition and disease management there can be large benefits. There are different entry levels for using precision sheep management and the identification level depends on the cost and labour availability. Many benefits from PSM can be obtained with a visual tag provided labour is available. However, using RFID tags makes data capture easier, uses less labour, greatly reduces errors in data recording, thus allowing speedy retrieval of data for differential management of sub groups. There have also been many advances in the technology using RFID tags that cannot be duplicated with visual tags. These automated systems allow information such as repeated live weights and maternal pedigree data to be captured with minimal human intervention. The benefits of adopting any of these PSM systems depend entirely on how the information will be used. Collecting the information is one step, but utilising it is the most important.

17.1 Precision Sheep Management

Precision Sheep Management involves managing (groups of) animals differentially according to their level of production or risk, rather than the more traditional approach of managing all animals within a flock equally. This will enable increased on-farm productivity through improved selection, nutrition and disease management as well as delivering targeted products to meet market specifications. Basically the goal of precision sheep management is to maximise the returns from the high value animals whilst also minimising the costs of the low value animals, resulting in a more profitable enterprise.

17.2 Opportunity - variation

The biggest resource for these improvements is the variation within each and every flock. Table 17.1 shows the average trait information of a typical flock, which is often the information that most producers will have at hand. The additional and more important information is the variation within the flock. The table shows the average of the top 25% of the animals as well as the bottom 25% for each of these traits. The difference is quite large, remembering that this is the average of the top and bottom quarters, but also there is more variation between individual animals within these quartiles. Looking at reproduction, for example, the top quarter of the flock are producing on average 1.5 lambs each year (with the best consistently rearing multiples), yet, the bottom quarter are producing on average one lamb every three years (and some animals are producing none). This variation is similar for all traits and so there are many opportunities to improve the profitability of the flock in both current generations as well as in genetic gain achieved through selection of better performers to be retained in the breeding flock. Such potential exists because most of the production traits are not only variable but highly heritable and relatively cheap to measure. Selection in any one generation will not reduce the potential to use variation in the future because variation is always regenerated in the next drop of animals

Table 17.1: Variation within a flock (Atkins, Richards and Semple 2006).

Trait	***Production level of flock:***		
	Average	***Top 25%***	***Bottom 25%***
Wool traits:			
Fleece weight (kg)	4.6	5.3	3.9
Fibre diameter (µm)	20.4	18.9	21.9
Staple strength (N/ktex)	35	42	28
Meat traits (crossbred lambs)			
Growth rate (g/day)	284	357	200
Fat depth (mm)	10.6	8.9	12.5
Reproduction			
Lambs weaned per ewe joined	0.86	1.43	0.28
Profitability traits			
Fleece value per ewe ($)	$54	$82	$37
Carcase value per ewe ($)	$33	$56	$12

17.3 Measurement options

To take advantage of this variation the performance of the animals must be measured individually. We need to know which sheep in the flock contribute to enterprise profit. Most of these traits can be precisely and cost-effectively measured as long as the animals are individually identified. There are now widely accepted and used techniques for capturing fibre diameter, fleece weight, body weight, fat scores and pregnancy scanning information on farm. Automated options are also available. Current performances can be recorded as well as lifetime records. Some examples are;

- **Lifetime fleece value** can be reliably predicted by using fibre diameter with or without fleece weight
- **Current performance and lifetime reproduction** predicted from pregnancy scanning and lamb survival
- **Body weight** captured by mustered weighing and fat scores. Multiple body weights can be used for monitoring growth rates and targeting markets by specification

17.4 Pathways to benefits

It is one thing to measure animals to collect the data, but it is another matter entirely to store the data and turn it into useful information.
There are multiple pathways to accumulate these benefits;

1. **Current generation gains.** Current generation improvements achieved by selecting higher value animals to be retained for production in the current flock (and lower value animals culled) can be quite large and the benefits can be achieved quite quickly. This has a large effect in both short and long term.

2. **Genetic gains – future generations.** In addition to current generation gains (and independent of the sire purchasing policy) is the genetic gain that can be made in future generations, through the progeny of these selected breeding ewes. Selectively retaining higher value ewes will increase genetic merit of their progeny but the effect per year is relatively small initially and takes time for the benefits to accumulate. This is an additive benefit to ram selection, rather than relying on genetic change coming just from the ram source

3. **Optimise flock structure – age group, sexes.** If data has already been collected for current and future generation gains, this same information (with no further investment) can also be used for optimising flock structures. Rather than selecting animals after first shearing (for example) and keeping all of these animals until they reach a given age, variable age culling allows animals to remain in the flock related to their contribution to overall flock productivity. The optimum culling age is a compromise between the reduction in value of wool due to increasing fibre diameter with age and the opportunity for more intense selection among young animals when fewer replacements are required.

The proportion of ewes to wethers also has an impact and individual measurements are useful management tools to determine the trade-off between the potential value of the wether kept for wool production versus its cash value as a meat animal. The scale of per animal benefit from selection in wethers can be considerably higher than in ewes because the intensity of selection in wethers is greater. Without selection though, the value of wether flocks is less economically attractive.

4. Targeted management. Management inputs are often not cost-effective if applied to the whole flock. PSM enables management to match key inputs such as nutrition and parasite control to the needs and potential of each animal. For example, feed costs can be reduced by only feeding animals that require supplementation according to the animal condition and history, rather than feeding the whole flock.

5. Targeting markets. Targeting markets is another opportunity where animals can be chosen for high value markets and costs can be reduced for the low value markets, depending on factors such as different growth rates and target weights for various meat markets. Precision Sheep Management can be applied to selected sub-flocks to exploit this variation in value within flocks.

17.5 Identification options

There are various levels of identification at which producers can enter precision sheep management, depending on costs and labour availability. RFID tags are not a necessity to gain benefits from this variation. They are, however, a means of reducing the errors and labour component attached to using visual tags.

1. No permanent identification. Selection decisions can be made according to measurement taken at the time and keeping the sub flocks separated thereafter, for example pregnancy scanning groups.

- Low cost
- Instant decision
- One-use information.

2. Group IDs might be used to identify like groups, which can then be separated into those specific groups throughout their lifetime, for example micron bands.

- Low cost
- Re-use group information
- Current decision to split is final.

3. Individual identification is needed to combine information on various traits that are measured at different times or from different sites. Individual IDs also enable decisions to be made in the future about information collected previously, for example, the information would be available for regrouping if the breeding objective changed or the proportion of animals within the subgroups needed to be adjusted. Previous information can also be used for determining feed requirements leading into joining.

- Optimum flexibility, reuse data in different years and at different operations
- Higher cost, higher labour, less visible, more reading errors

4. Radio frequency identification (RFID) is really an extension of the individual identification. RFID tags enable flocks to be run together at different times of the year and can be easily drafted according to different criteria for certain events throughout the year. Historic data can be incorporated and used more efficiently. This type of management can be achieved with just visual tags, but the labour component is much higher when drafting according to manual draft lists relying on previous information.

- Auto capture, auto draft, less labour, less error, record and retrieve multiple parameters
- Higher cost initially, but saving later.

17.6 Tools for enhancing PSM – Software

These tools are available to help make better informed decisions. Obviously the tools are not going to make all of the hard decisions for the producer, but the more informed people are about the impact of their decisions the better their decisions are likely to be. All of these tools are available free of charge and can be downloaded from the Sheep CRC website www.sheepcrc.org.au

1. **Decision Support Tools (Strategic)** Helps set objectives and visualise the progress that can be made
   - Where can I be in ten years?
   - Customised to an individual situation

Selection Assist
- Breeding direction (can compare alternative objectives and select objective by choosing desired outcome)
- Compare selection/flock outcomes (can estimate increase or decrease in each trait in 5-10yrs and what impact this will have on other traits)
- Importance of sources of genetic gain - Ram only, Ewe only or a combination of both

Wether Calculator
- Optimal wether proportion (economic basis – must still consider non-economic factors, such as importance of wethers for worm and pasture management strategies)
- Selection options (compare selection options - often, no selection results in no economic incentive to have wethers in flock)
- Impact of wool/meat market

OFFM Calculator
- Additional profit from measuring FD (or can clip preparation cover testing costs and results be available for other purposes?)
- Clip preparation / selection & breeding (benefits from OFFM can come from a number of sources, how much from each one?)
- Impact of price changes

Merino vs Terminal Sire Flock Structure Model
- Maximum number of ewes to terminal sires whilst still producing enough progeny for the breeding flock to be self sustaining.
- Determine how many short the self replacing flock will be if mate more than break-even to terminal sire
- Identify alternatives to enable more ewes to be mated to terminal sire (eg looking at increasing no lambings, reproduction rate, etc.)

Smart Merino
- Integration of Decision Support Software (The decision support tools listed above rely on the same base flock information to be entered in each tool. Each tool also answers a particular question in a simple process, but it can be hard to predict the effect of changing a number of aspects within the flock and know what the overall outcome is. Smart Merino integrates all of the decision support tools that have been developed and allows the user to look at a number of management decisions and then view the overall impact that the combined decisions will have on the flock.

2. **Operational Software** Relies on the input of individual data and informs management decisions
   - How do I get there? (Implement decisions from decision support tools)
   - Generate selection and action lists

Simultaneous Assortment
- Allocation of meat and wool animals to production and/or mating groups. Traditionally a lot of producers selected their wool producers and used the excess for meat production if they were running a dual meat and wool enterprise. Alternatively some just used the oldest animals for meat joinings and the younger age groups for joining for wool production. This results in a selected group and a (in this case) meat

group that has no benefit for meat production. This tool is designed to simultaneously select animals for both better meat and better wool production/mating groups. This results in 80% of the maximum selection advantage that could have been achieved in single trait selection but there are now 2 potentially valuable groups of animals instead of a single selected groups and the alternative.

Lamb Growth Predictor

- Calculate individual growth rates (this growth can be used for predicting future weights or adjusted to reflect expected conditions)
- Future weight predictions
  - Predict weight on certain date
  - Predict number of animals over target weight on certain date
  - Predict date animals will reach certain weight
  - Predict date a percentage of flock will be over target weight
- It is also useful for selecting animals for certain markets – the faster growers vs the slower growers.

17.7 Tools for enhancing PSM – Hardware

1. RFID tags

As mentioned previously, RFID tags are not essential to practice Precision Sheep management, but they enable more efficient ways of collecting and managing on-farm data (with lower labour requirements), resulting in higher accuracy of data capture and easier retrieval of historical information. The tags are fully retrievable and reusable, so the upfront cost can be spread over a number of generations. The cost of tags has reduced dramatically over the past 15 years and they have always been quite reliable. These tags also provide scope for developing animal activated data capture. Some tags currently available are shown in Table 17.2.

2. Readers

- Portable

Stick readers are used to scan the RFID tags of individual sheep. The information is usually sent via Bluetooth to a data logger. There is some storage facility within some stick readers, but this is limited. This information can then be used to add information into the database on the animal scanned, or can be used to retrieve information in the data logger from a previous activity.

- Panel (fixed)

Panel readers are used when scanning many animals moving in single file. Panel readers are usually attached to a race, or on a weigh scale or in an autodrafter. The information is then sent to a data logger and used in the same way as the portable stick reader.

Portable and stick readers have become quite reliable and robust. The cost of these readers has increased a little, given increases in costs of production. However, there is far greater range of readers available now all with many more scanning and on-board data capture opions than there used to be.

Some of the readers currently available are detailed in Table 17.2.

Table 17.2: Some RFID tags and readers currently available

Allflex RS340 Stick Reader	
Allflex RFID Tag	
Allflex RFID Tag	
TruTest XRS Reader	
TruTest Panel	
Shearwell SDL 400	
Shearwell RFID Tag	
Leader Stick Reader	
Leader RFID Tag	

3. Printers and scanners

Portable stick readers are often used with printers (Figure 17.1) in scenarios where the animals' ID is required after the animal has been scanned. Eg during shearing the animal can get its ID scanned and a printer can print out the barcode of that ID. When the fleece from that animal is weighed (and the sheep has gone), this printed ID can be taken with the fleece and scanned in to automatically match the ID with the weight of the fleece. Other information such as which bin line it was allocated to can also be added in at this time.

Figure 17.1: PSM printers and scanners.

4. Autodrafters

Autodrafters (Figure 17.2) collect information on the animal (such as RFID and/or weight) and open gates automatically into different pens according to a set criteria eg drafting list set by the user, or weight ranges. The animals enter through the first gate which is usually closed by the user (via a remote control) or triggered to close via weight on the platform. The tag of the animal is read by a panel reader on the side of the crate (if it is set up for RFID) and sent to the data logger. If scales are under the crate this is also sent to the data logger and matched with the ID of the animal. The data logger then tells the drafter which gate to open according to a draft list. This could be set according to a current real-time weight, or a previous drafting list set up in data logger for that particular animal.

Figure 17.2: Prattley auto drafter.

17.8 Tools for enhancing PSM – Remote/Automated technology

Walk Over Weighing and Pedigree MatchMaker were developed through the Cooperative Research Centre for Sheep Industry Innovation (Sheep CRC) as alternative ways of collecting information with low labour and low cost.

1. Walk Over Weighing (WOW)

Walk-Over-Weighing was developed to enable the collection of regular body weights without the need to muster the animals or bring them to yards. WOW incorporates a set of trap yards and a race so the sheep's weight can be recorded as part of its natural movement to feed or water. The animal ID is

recorded when the animal walks over a weigh platform into a yard containing an attractant (such as feed or water). A weight corresponding to an ID is recorded by a data logger. These weights over a period of time can be used to calculate the average weight of the animal during that period and multiple weights can be used to calculate growth rates. Growth rates can be used to predict whether each animal will reach a target weight and in what time frame (see Lamb Growth Predictor notes). It is also useful to monitor the condition of the animals because the system can pick up relatively small changes in weight well before a visible change in condition score is evident. This can be used to make feed adjustments or manage parasites before having a large effect on the performance of the animals. The actual and predicted growth rates can also be used to target the product to the correct market and close monitoring and prediction assist the meeting of market specifications. This automated data capture reduces stress on animals (with no handling necessary) and does not take labour away from other farm activities.

It is well suited to pastoral settings where labour is scarce and the animal stress and cost of mustering sheep are important factors. It can also be used in feedlot or rotational grazing systems where regular monitoring of a sheep's weight is needed for tactical management decisions.

Setup

Figure 17.3 shows a typical setup for WOW:

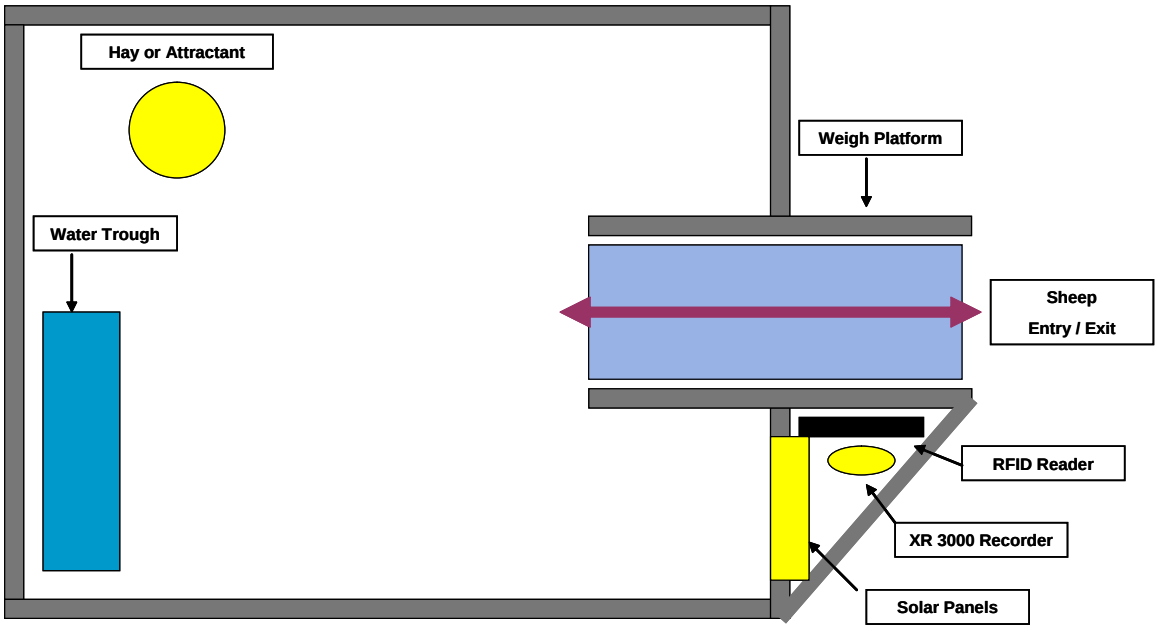

Figure 17.3: A typical WOW setup (SJ Semple)

Training Sheep

It is important (and necessary) to train the animals to use the system. Training is reasonably simple, but without it, reasonable weights are not captured. To train the sheep;

- Construct fenced enclosure with entry point into water source
- Place race in entry point for the sheep to investigate, leave twice the race width for animals to walk through
- As animals start using the entry point, narrow the gap until entry is only via the race
- Ensure that animals have an unobstructed view through the system
- Never force animals through the system, they can become frightened and refuse to use it
- If animals are reluctant to enter, incentives such as supplementary feeds may be used to entice them through the system.
- Turn on electronic components once the animals are comfortable using the race

Skipping this step will result in inaccurate weights as animals move too quickly over the platform to get an accurate weight. The data collected from this system needs to be analysed by a software tool such as WeighMatrix. This removes the inaccurate data (such as those where two animals were on the scale at the same time) and provides an estimated weight of each animal for that period of time. Multiple weight estimates can be used to make predictions on future growth of the animals and can be used to predict slaughter dates, nutrition and parasite intervention required.

2. Pedigree MatchMaker (PMM)

Determining pedigree in sheep flocks is an expensive and time consuming process. It is often achieved through tagging and recording during lambing or occasionally DNA matching at a later date. The result is that there is a relatively low proportion of animals in Merino breeding flocks that have full pedigrees. A PMM set up is shown in Figure 17.4.

Pedigree MatchMaker was developed as an alternative approach to collecting pedigree. Pedigree MatchMaker is a low cost, low labour alternative. This system relies on ewes and lambs having RFID tags and uses a similar setup to the WOW system, but without the weigh scales under the platform. The (time) order of the tags are recorded as the animals walk past the reader on the way in to the fenced off attractant. After providing a list of ewe tags and lamb tags, the collected information can then be used to match lambs to their dams according to the level of association between all of the ewes and lambs. Trials have shown the maternal association has similar accuracy to that of the manual mothering up process provided the data is collected for at least 4-6 weeks. This electronic process is much less labour intensive and lower cost.

PMM could be most useful in situations where full pedigrees are currently not possible rather than as a replacement method for mothering up or DNA fingerprinting. PMM is designed to calculate a pedigree to a reasonably high level of accuracy through a fairly inexpensive and low labour input methodology.

Advantages of the method:

- High accuracy with low labour input
- Modest cost – tags can be re-used and/or they become the permanent identification of the animals for their lifetime
- Simple algorithm for matching (Using PedigreeMatrix software)
- Simultaneously generates a lamb survival record for ewes that can be used for selection on reproduction rate
- Improve accuracy of EBVs
- Female pedigree leads to a 19-21% improvement in selection accuracy
- Improving the accuracy of breeding values will speed up genetic improvement and productivity; leading to an increase in economic gains
- More precise comparison across years
- More precise comparison between animals over time
- Across – flock evaluation
- Great aid in comparing BVs of adult ewes against potential replacement hogget ewes
- Provides genetic links between flocks to allow for across-flock evaluation.

Figure 17.4: Pedigree Matchmaker setup

Recommendations for optimal accuracy:

- Train animals for system

It is very important to train the animals to use the system, preferably training the ewes prior to lambing. This involves a similar process to that described for the walk-over-weighing earlier. It needs to be a gradual process. (See WOW training sheep section above).

- Record RFID tags for 4-6 weeks (90-96% accuracy)

The accuracy of records depends on the quality of data collected. By recording the tags for 4-6 weeks there should be enough data to achieve 90-96% accuracy. By recording for less time than this the accuracy is reduced. DO NOT JUST STOP RECORDING WHEN YOU THINK THERE ARE LOTS OF RECORDS. The accuracy that we are referring to here is based on a comparison to the manual mothering up process.

- Record before or after marking (allows flexible management)

Whether the association between the ewes and their lambs are recorded before or after marking did not make any difference to the accuracy of the results. This means there is a bit of flexibility available in the system so that if there are other events happening on the farm, the timing can be adjusted to suit. Also, it enables multiple flocks to be recorded if there are more flocks, by recording one group prior to marking and another following marking. It also means for those that timing isn't an issue, the tags can be inserted at lamb marking and no extra handling is needed and recording can start after that.

17.9 Implications and conclusions

With the availability of on-farm measurement and identification systems there are many opportunities within precision sheep management to manage selected groups of animals in a precise way. The biggest thing to note though is that there is no one big money maker – the benefits are incremental. There are also no set guidelines for adoption. There are many places where we can make better use of existing technologies and information to achieve higher profits. There are also opportunities for the development of new technologies to improve productivity and profit. The most important benefits will be the ability to better handle risk. Some examples of risk minimisation include:

- **Which animals to cull?** Culling less productive individuals (instead of an age group) to reduce stock numbers, which will have less impact on the overall productivity of the flock. A flexible culling policy becomes particularly effective under situations leading into or recovering from drought or other disasters.
- **Which animals need treatment?** Only treating the ones at risk or requiring treatment instead of all animals
- **Which animals will benefit from more resources?** Additional resources can be provided to those that will maximise marginal returns

- **When is the optimal time for intervention?** Optimising the time for intervention, selection or sale of less productive animals

Precision Sheep Management provides an opportunity. It is ready and can easily be implemented in all flocks at various levels of adoption. There just needs to be a change in the way people think; Don't look out and see a flock of sheep, look out and see a paddock full of individuals with lots of opportunities.

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Richards, J. S., S. J. Semple, et al. (2010). "Practical application of precision sheep managment." Proceedings of the 25th Annnual Conference of the Grasslands Society of NSW Inc.pp. 53-60.

Readings

There are no readings provided for this topic however the list of references provides sources that may be of interest. There are also many brochures available to read (and webinars to watch) containing information for Precision Sheep Management and associated tools on the Sheep CRC website (www.sheepcrc.org.au):

http://www.sheepcrc.org.au/information/publications/publications-precision-sheep-management.php

http://www.sheepcrc.org.au/resources/precision-sheep-management-training-webinars.php?rt=1314763516

http://www.sheepcrc.org.au/management/measuring-recording-and-decision-making.php

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Revision Questions

1. Describe two PSM tools and how they can be used to improve sheep enterprise profitability.

2. What is PSM and why is it important?

3. Describe the sort of data that can be collected with PSM tools and how it can be utilised to improve enterprise efficiency and profitability.

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