Farmer decisions and aggregate supply: An explanation of the impact of major price changes†

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Abstract

Models of woolproducers' decisions provided unique insights into the impact of major price changes on supply of commodities. The slow response of many producers in some contexts may be due to their use of hierarchical decision processes rather than compensatory decision processes. Much of the response to major price changes comes from strategic decisions to change enterprises rather than marginal changes to existing enterprises. In the short term, wool producers were less responsive to price when making strategic decisions because of a perceived lack of competence in predicting long-term price trends.

1. Introduction

Each year attempts to predict the supply of agricultural commodities in Australia account for a considerable proportion of the time and effort expended by agricultural economists. Most models used to predict supply are based in some way on the twin assumptions that, when making decisions, farmers are utility maximisers and that they form and use expectations about probability distributions of uncertain variables. A major difficulty for the models is the appropriate specification for the formation and updating of these expectations. In addition, since economic theory provides minimal help in deciding which factors to include in the models and the form they should take, incorrect specification is also a major problem (Just 1992). The result depends to a large degree on guesswork by the model builder and the results of 'data mining'.

Despite these limitations the models generally give a satisfactory result when used to predict changes that might result from marginal variations in key variables. The problems arise when they are used to assess the effect of major changes in these variables. Unfortunately, this is the time when the results of an accurate prediction

would be most useful. A good illustration of this occurred with the season 1992-93 sheep and shorn wool forecasts by the Australian Bureau of Agricultural and Resource Economics. The 1992 projections for sheep numbers were nearly 5 per cent less than the revised forecasts for 1993, while projections for shorn wool production were nearly 11 per cent less than the 1993 figures (Australian Bureau of Agricultural and Resource Economics 1992, 1993). Such a discrepancy could have been an important factor in the significantly overoptimistic wool price forecasts for the 1992-93 season.

2. Research objectives and hypotheses

A general aim of this research was to attempt to advance some explanations for the differences in forecasting performance between situations of major and minor changes in key variables. A further aim was to suggest directions for future research that might lead to solutions to the problem of forecasting when large changes occur in key variables. These aims are consistent with the call by Just (1992, p. 33) for 'a new generation of models . . . at the micro level to support aggregate model specification and related forecasting, market and policy analysis.'

In this context the study explored the framework in which Australian wool producers made major production and marketing decisions (e.g., whether to change from prime lamb production to merino ewe breeding, whether to mate some merino ewes to prime-lamb rams, and when to sell their wool). The objective was to identify and evaluate, at the farm level, major stimuli determining the production and marketing decisions of wool producers, including price, and seasonal conditions.

Given the aims of the study were essentially exploratory and descriptive - specific, testable hypotheses were not advanced. Instead, development of the theoretical model and the associated empirical techniques was guided by the following beliefs:

(1) To develop an understanding of the reasons for the choices made by wool producers, information would need to be collected on specific decisions they had made;

(2) as far as possible the approach used to collect the information should avoid introducing theoretical bias (e.g., by collecting probability distributions where apparently they were not used in the decisions).

It was also felt that often wool producers would be insensitive to minor variations in price and seasonal conditions. Their sensitivity to these changes was expected to vary with the type of decision being made.

3. Analytical approach

Wool producers make a range of decisions, from the mundane organisation of the equipment and resources for daily jobs, to decisions that will ultimately decide the prospects for survival of the farm as a business. These decisions are taken in a complex and turbulent environment, where prices for their output (e.g., wool) and some of their inputs (e.g., money), involve major ambiguities that are compounded by the ever-present uncertainties of the weather. Therefore, any attempt to describe and predict their decisions has to incorporate these factors.

An equally important factor is that the information-processing capacities of the wool producers are limited (as are those of the rest of humanity). Given the ambiguities of their decision environment and their processing capacities, wool producers in this study would have been unlikely to have a clear idea of the alternatives they faced, or of the outcomes for those of which they were aware. This implied the wool producers would be using simplifying rules and models based on their experience to cope with this environment. Support for this view comes from a range of sources (e.g., Simon 1955; Payne 1976; Janis and Mann 1977; Schoemaker 1982; Larichev, Moshkovich and Rebrik 1988; Heath and Tversky 1990; Grether 1992).

If the results of this study were to make a meaningful contribution to understanding wool producers' decisions, then the analytical approach chosen needed to be able to incorporate the main features of these rules. This was so, even if a consequence was behaviour that would not be considered 'economically rational'; otherwise, the underlying reasons for the behaviour would be masked by the assumptions of the model.

After an examination of the literature, the hierarchical decision model (Gladwin 1977) was chosen. It assumes decisions are decomposed so that the various alternatives are compared sequentially using several characteristics or aspects. The two-stage decision process hypothesised for the model allows for informal or unconscious processing, as well as a formal or conscious processing stage. The stages of this process can be elicited and formulated as a series of questions or criteria which form a decision tree.

An advantage of this approach is that the models can be tested directly using the decisions trees and individual decisions. Theoretical bias is reduced because no assumptions are made about which factors should be included in the models. As well, the criteria are elicited from decision makers and therefore do not assume capacities they do not possess.

A major weakness of the model was that it did not incorporate an adequate theoretical explanation of the underlying motivation for behaviour and for the selection of the aspects included in the decision trees. This was overcome by construing hierarchical decision models as simplified representations of people's decisions within the framework of personal construct psychology (Kelly 1955). This approach is outlined in Murray-Prior (1994). In simple terms it involves assuming people behave as 'scientists' whose motivation and behaviour are directed by their expectations of the future and the interactions of their behaviour with the future. The combination of personal construct psychology and the hierarchical decision model provides a theory and empirical model of behaviour that explains the motivation and reasons for behaviour, allows for and explains learning, and can describe and predict individual decisions.

4. Research design

Using this approach, a series of models was developed of production and marketing decisions for merino wool production in the New England Tableland. The models were developed from personal interviews with a sample of graziers from the Armidale Rural Lands Protection Board. Two groups were selected from the sample frame. The first group was used to develop and test interview techniques and formats, develop initial models, refine the models and to undertake limited testing of the models. Models that

had been developed with the initial group were tested with the second or 'test' group. Adaptations of the repertory grid, laddering and pyramiding techniques (Dunnett 1988), which are derived from personal construct theory, were employed in the interviews to help find the criteria graziers used to make their decisions.

The sampling unit was defined as the management team of a grazing unit who had country that could be used to run a commercial sheep operation. A property also had to have at least one person who spent most of their time working on the property. From a list of 910 farmers in the district who had more than 500 sheep, 75 were selected randomly for each group. From the initial group, 45 were interviewed, two of them as part of the pilot for the second series of interviews. Forty-nine were interviewed from those selected for the 'test' group. The remainder were not interviewed because they were considered part-time operators, they refused, or a suitable time could not be arranged.

Interviews were conducted for the initial group from July 1991 to January 1992 and for the 'test' series from May to July 1992. A list of the decisions for which models were developed is given in Table 1. The models marked with a * were only at a preliminary stage of development after the initial series of interviews. An attempt was also made to develop models which could predict changes in livestock numbers. It was not successful because the factors involved in decisions to increase or decrease stock numbers proved to be too situation-specific and the models too complex and difficult to generalise. Therefore, only the most important factors influencing a change in livestock numbers were elicited.

Most of the models achieved success rates of 80 per cent or better for individual decisions (Table A1). In this respect their success was similar to the rates reported by Gladwin (1975, 1976) and Zabawa (1984).

Table 1

List of production and marketing decisions modelled

Begin merino breeding
*Stop merino breeding
Change micron of merino breeding flock
Keep young seconds to reduce micron of wool clip
Run own wethers after merino breeding begun
Begin to keep own wethers past 4T
*Stop running own wethers
Mate ewes from merino breeding flock to prime lamb rams to sell 1x lambs
*Raise own 1x ewes by mating ewes from merino-breeding flock
*Buy merino ewes and breed 1x ewes
*Mate bought merinos to produce 1x lambs
Begin to buy merino woolcutters
Micron type of woolcutters to buy
Buy another micron type of woolcutter
Stop buying a micron type of woolcutter
Delay sale of wool
Whether to sell main lines by auction or private sale

5. Results

Two conceptually different types of decisions, which have been categorised as major strategic decisions and major annual decisions, were modelled in the study. They were treated as separate decisions because they tended to involve different sets of factors. Only the major strategic decisions are discussed here. Decisions to change livestock numbers, however, are discussed in combination with the major strategic decisions, because in a sense they are part of the same story.

Farmers make many types of decisions, some of which are made only rarely, and some of which occur regularly. While almost all the decisions modelled in this study can be

considered as major decisions, or big decisions in Malcolm's (1992) terminology, they were all decisions made within the context of maintaining farm viability. Some decisions occurred regularly, consequently, the aspects used in these decisions were 'tried and tested' because there had been many opportunities for producers to experiment. These were classified as major annual decisions and included decisions about the sale time of wool and whether to sell by private sale or by auction.

Conversely, most decisions about changes in the enterprise mix occurred infrequently, and then often in different contexts from previous decisions of the same type. In this situation producers would have had less opportunity to try out different approaches, therefore it was considered many aspects involved in the decisions would have been decided as each decision arose. Such decisions are called major strategic decisions.

Not all decisions fell neatly into these categories. For example, a decision to mate cfa or cull merino ewes to prime lamb rams to produce 1x lambs reflected a decision to make a major change in emphasis on some properties, but was a minor speculative decision on other properties where it was made regularly.

Change because of a major strategic decision often had a major impact on the management of the property and was generally expensive to undertake, both in direct and opportunity cost terms. Many had the potential to have a disastrous impact on the financial viability of the property if a poor decision was made and circumstances turned against the producer. In addition, the long lead times involved with some changes complicated the decisions because they increased uncertainty about prices.

An example of a major strategic decision, the decision to change the micron of the merino breeding flock, is given in Figure 1a and Figure 1b. It contains a couple of sub-decisions and all of the types of factors contained in other decisions of this type. The factors involved in the major strategic decisions can be considered under five main headings: the trigger aspects which initially initiated a decision to change; price changes and relative profitability of the possible enterprises; strategi· orientations (e.g., not to chase the market, or to buy in sheep); physical context (e.g., land, labour, management skill, other enterprises, seasonal); and risk (sometimes allowed for in strategy and

Figure 1a

Change micron of merino breeding flock

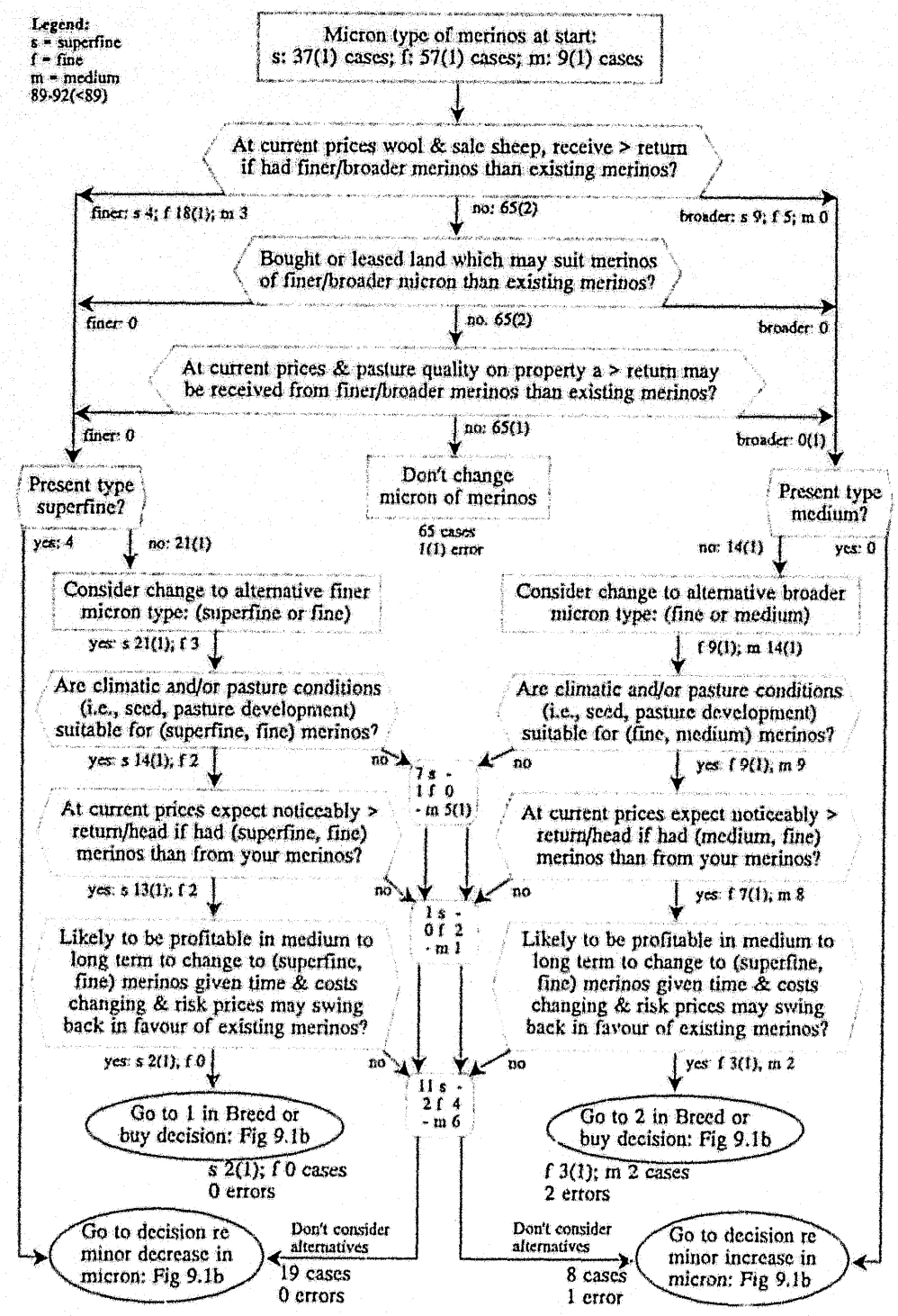
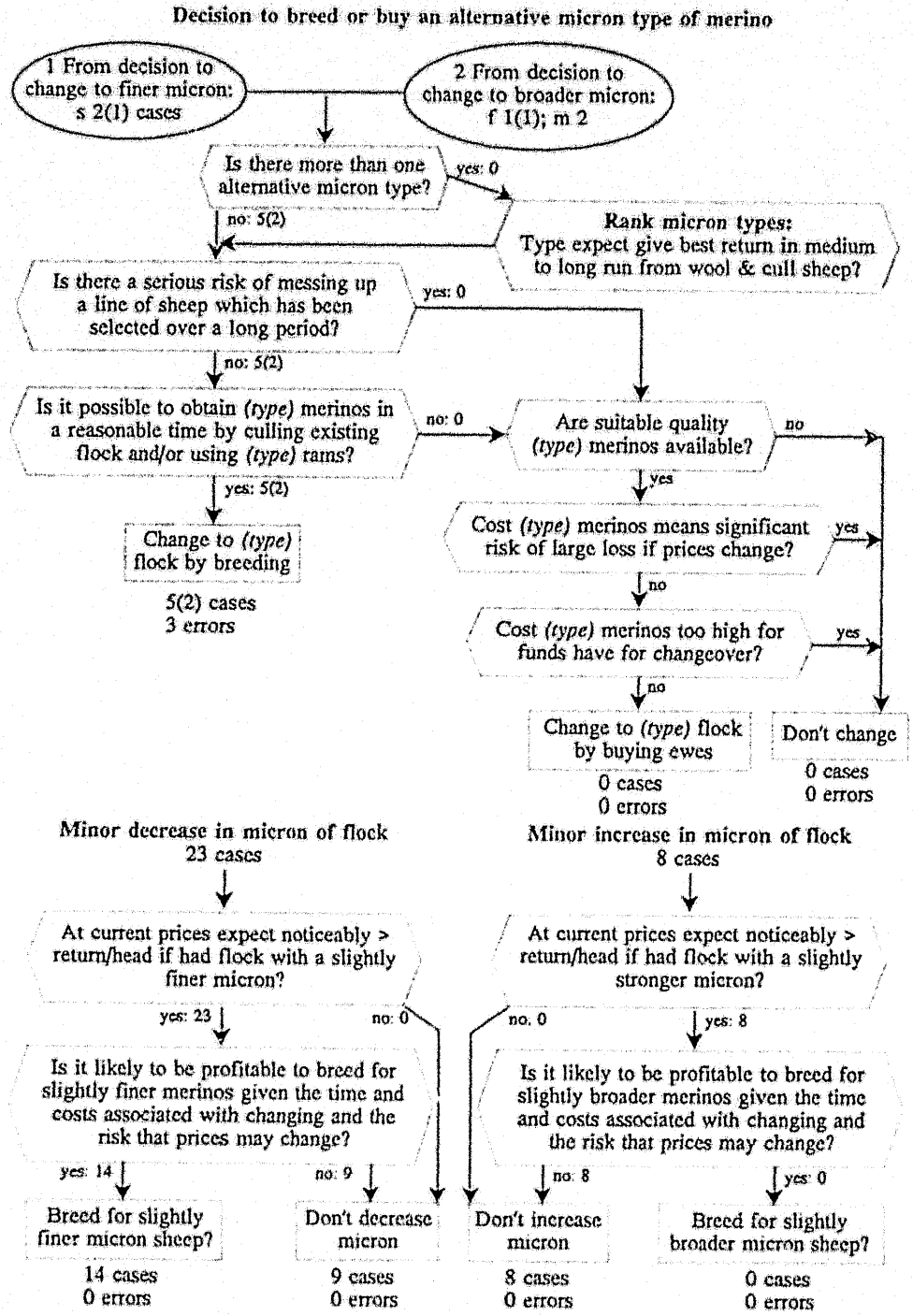


Figure 1b

Change micron of merino breeding flock (continued)



sometimes considered separately). The influence of the first three of these on decisions and their implications for models of supply will be discussed in this paper.

5.1 Trigger aspects

In the initial stages of the research it became obvious that producers unconsciously filtered, or often deliberately ignored, information about the short-term relative profitability of their major enterprises. Comments such as:

> '. . . not going to change in the short term - a long term strategy is more important. . . .'
>
> '. . . chasing market trends is like shutting the gate after the horse has bolted.'
>
> '. . . don't follow trends - believe in sticking with what I've always done and I won't get into any bother.'
>
> 'We're here for the long term benefit - not going to go chasing the end of the rainbow.'

reflect the long-term orientation of many producers which mainly arose because of the difficulty of predicting prices and their experience of prices being like a 'pendulum' which swung back in their favour eventually. In such an environment producers tended to maintain their existing mix of enterprises unless something occurred that triggered them to begin to consider a change.

Such filtering is consistent with the need for humans to selectively omit information because of the complexity of their environment (Resnikoff 1989) and with the hypothesis of bounded rationality (Simon 1955). In the terminology of Personal Construct Theory, for long periods of time producers were construing the changes in prices and climate as random events that were beyond their power to predict; thus, their best option was to ignore them. This 'view of the world' seemed the dominant view among producers, and information about other enterprise options tended to be ignored - that is, they were eliminated pre-attentively by this construct or aspect. Before they would reconstrue this view, a change had to occur which was not eliminated; which forced them to change their construction of events. These changes have been called trigger reasons.

It is apparent from the response to the trigger reasons in this study that, in some circumstances, producers were insensitive to fluctuations in prices. For instance, in 1989-90, for the decision to begin merino breeding, only four out of the fifteen producers who weren't merino breeding said that, at the prices for wool and cull sheep at the time, the return from merino breeding was noticeably better than from their existing sheep enterprises. At this time wool prices were still very high and on most properties in the New England merino breeding would have been more profitable than other sheep enterprises. One explanation is that it was common for producers to express the view that they did not know if one enterprise was more profitable than another. This appeared to result from two main factors: they had not bothered working it out ('it's no good continually optimising . . . can't calculate profit margins all the time'); and, many producers were not sure of the production details required to calculate the profitability for enterprises with which they had little experience.

Conversely, for the decision to stop merino breeding, in 1991-92 only eight out of 36 said they had considered (no matter how briefly) that, at prices prevailing at the time, other enterprises would produce a better return than merino breeding. This was at a time when wool prices had collapsed after the scrapping of the Reserve Price Scheme.

In other words, the overwhelming majority of merino breeders were completely unresponsive, in terms of questioning their continued involvement in merino breeding, to one of the most dramatic collapses in wool prices in history. They did not even think about it! Although they were aware of the drop in wool prices, it had not triggered a reconsideration of their involvement in merino breeding. Most of them were in it for the long haul, and while they may (and only may) consider changes to their enterprises at the margin, it would take a fairly dramatic long-term decline in fine-wool prices to make many of them seriously consider changing to something else.

For those who were breeding merinos in the late 1980s, the biggest incentive to change came from the dramatically higher prices being paid for finer wool. Producers were aware of this development. See Figure 1a,b for an illustration of this decision. For 1989-90, approximately 70 per cent of fine-wool producers interviewed, and all of the medium-wool producers, said they would receive a better return if they had finer

merinos. At this time the differential in prices had endured for a considerable period, it had received considerable media attention and, anyhow, many producers attended the wool sales in Newcastle and were aware of the prices being paid. Even so, some did not consider finer wools would bring a better price on their property. It is not clear exactly why this was the case, although some mentioned they did not know enough about the wool weights of finer flocks to make an accurate assessment.

In addition, it appears producers might have been aware of changes in prices, but these may not have triggered a consideration of the relative profitability of enterprises. Support for this notion is provided by the responses to the model of the decision to stop running their own wethers. Most producers who were breeding and running their own wethers saw little difference in their profitability. Typical responses were:

> 'I'm in wool production and wethers cut you the most wool.'
>
> 'I haven't thought about breeding being more profitable than wethers.'

Yet most comparisons of merino breeding and wethers on a gross margin basis favoured breeding (e.g., Agricultural Business Research Institute, various issues 1977-88). This was even more apparent in the 1980s because of higher prices for cull and cfa stock arising from factors such as the live-sheep trade. Whereas before this period almost all the income in a traditional wool enterprise came from wool, in the 1980s a significant proportion came from the sale of stock. This tended to favour breeding over straight wool production.

It appears many producers had not responded mentally, let alone managerially, to a change in the relative prices for the products produced by the two enterprises. The first comment above is in the nature of a rule of thumb derived from experience. Together they suggest these graziers had taken a long-term strategic decision to be wool producers. Experience from the past had been that in the New England a self-replacing merino flock with a significant proportion of wethers was the best way to achieve this. The main purpose of the merino breeding operation was to provide a reliable source of wethers. Information that might lead to a change in this decision was being filtered out, or ignored, so the question of change didn't arise.

Similar responses to changes in prices and other factors were found for the other models. In general, a situation had to arise which triggered consideration of change. What is more important, it appears it was not enough for a producer to be aware of a change in a factor such as price, this still had to trigger an awareness that the change in price might have ramifications for the relative profitability of enterprises. In other words, it still had to influence the producer's 'view of the world'. The implications of this finding for models of supply are discussed later in this article.

Factors other than price also triggered decisions to change enterprises. For some decisions, these factors were more important as trigger reasons for a change than fluctuations in price (e.g., purchase of land was an important reason for decisions to begin running bought merino wethers).

5.2 Price factors

Not surprisingly, prices for the various products had a major influence in most of the decisions to change enterprises. Their impact in triggering decisions to change has already been discussed. Within the models themselves, expectations of prices for the products were used to eliminate alternatives pre-attentively, to decide between alternatives in Stage 2, and as part of the criteria with which the risks of making strategic changes were assessed.

An example of this range of aspects can be found in the model of the decision to change the micron of the merino breeding flock (Figure 1a,b). The price of wool and sale sheep acted as a trigger to encourage change. At this stage current prices were the main ingredient. If fine wool prices were higher, broader wools were eliminated automatically. Current prices were then used to assess the likely returns from a major change to a finer micron type of merino. If this criterion was passed then a longer-term view of prices was undertaken using a criterion that assessed the benefits to be gained from changing a strategy of 'not chasing prices'.

Other points to be noted with these criteria are that the price of more than one product is considered and that it is the return that is compared rather than the price. While the price of wool has a major influence on prices for stock and other products in the

industry, the advent of the live-sheep trade introduced another variable that influenced the livestock market. Its influence was felt in both the breeding and the bought wether industries.

Return

Return, or return per head, was used in the criteria because return was the term used most commonly by producers when comparing enterprises. It was not necessarily the same as gross margin, although a few producers compared enterprises on this basis. Neither does it imply producers always made detailed comparisons of the likely return from enterprises.

Typically what appeared to happen was that producers focused on wool prices, calculated a return per head for estimated wool weights, and adjusted it for other factors such as sale price of sheep. A comparison made on this basis had to have an obvious benefit before the criterion was passed. This occurred because of the inaccuracy and uncertainties involved in the comparison. Although the current price of wool might have been known relatively accurately, producers were unsure of the wool weights likely to be achieved by different micron types of sheep, and of sale prices for their cull and cfa sheep. In addition, the process of adjustment for these factors was necessarily inaccurate. Other factors such as changes in lambing percentages, and differences in wool prices between hoggets and adult sheep, were also difficult to allow for.

Long-term price expectations

Usually the decisions also included a criterion in which price of products was part of a long-term view of what was likely to happen in the alternative enterprises. Many producers had little confidence in their ability to predict price in the long term (or anyone else's ability for that matter). Wright (1986) also found many sheep and wheat producers were not confident in their ability to predict the wool and wheat markets. The observations of Munro and Fisher (1982) that wool producers were unwilling to form long-term price expectations and that they tended to rely on their own experience for long term decisions, are consistent with this finding. The results from testing the decision models suggest that to cope with their inability to predict wool prices, most producers adopted the strategy of not changing their enterprises in response to price

fluctuations unless a long term trend was apparent. This criterion will be discussed in the section on strategic factors.

Short- to medium-term price expectations

One class of decision for which short- to medium-term price expectations were found to have a much more important effect was that to mate cull or cfa merino ewes to prime lamb rams to produce 1x lambs. These were generally not major strategic decisions since they tended to involve a small proportion of sheep in the merino flock. Producers who had suitable country for finishing 1x lambs were sometimes tempted to speculate on good lamb prices in the following year. For example, a couple of producers, who had not raised 1x lambs for several years, decided to try some because many producers had left the industry and they expected prices would rise in the next couple of years. Prices for 1x lambs remained poor until 1992, but some producers were still willing to continue the next year since more people were leaving the industry and they thought there was a good chance prices would increase the following year.

Such findings indicate at least some producers were incorporating supply and demand factors when formulating their short- to medium-term price expectations and were reaching conclusions inconsistent with naive expectations. They appeared to be a minority, however, with most people expecting prices for prime lambs to remain low. Many of these seemed to incorporate supply and demand factors also, with the main emphasis on poor demand, but their conclusions appear consistent with naive expectations. This may account for the conclusion of Munro and Fisher (1982) that a naive model provided the best explanation for the formation of producers' short- to medium-term price expectations.

Apart from the price of different micron categories of wool, prices of other products that had an influence on changes in enterprises were: prices of cull, cfa and mutton sheep, prices of prime lambs, and to a lesser extent cattle prices. For the major strategic decisions long-term price trends and historical performance of an enterprise seemed more important than current fluctuations in prices.

5.3 Strategic factors

Perhaps the most important group of aspects in terms of their influence on decisions were strategic factors. The influence of such factors first became apparent in situations where producers said their only reason for not changing to another enterprise was that they did not believe in 'chasing their tail', or that they 'didn't think it actually pays to change . . . if you stick with what you've got it all takes its turn'.

The consequence of this type of thinking is best illustrated by a case where the owners of one property considered selling their medium wool flock and replacing it with a fine wool flock. With the help of a consultant, budgets for the change were worked out based on various expected prices scenarios (this was before there was any hint of collapse of the Reserve Price Scheme). The change appeared (on paper) to be extremely profitable. Yet they did not change. Their reason was that they did not believe in making dramatic changes. They were not prepared to take the risk of departing from this strategic orientation by making such a radical change in their operation; their inherent caution won the day. As it turned out, in retrospect of course, this proved the best decision, and did not threaten the continued viability of their operation. Risk in this sense is being used in its broadest connotation of uncertainty and ambiguity, of threat to survival of the farm business.

This attitude was typical of many producers who took a similar approach when considering a major change in direction. Long experience had shown many that they were incapable of determining, with any reliability, the direction in which the wool market was heading. Not surprising, therefore, that Munro and Fisher (1982) found they didn't like to make long-term predictions about prices. About the only thing many producers felt any confidence in predicting was that, over time, the market would favour each of the grazing industries and each of the different micron types of merinos. Many also took the long-term view that fine wool had an advantage in the New England area because it is one of the few places in the world where it could be produced as a quality product, free from contamination, which would therefore attract a premium price.

This does not imply that producers did not change enterprises or micron types of merinos. It was found that some producers who expressed a belief in not chasing market trends, still went ahead. Belief in such a policy was therefore not a decision criterion. A change in those circumstances involved a reconsideration of strategy.

A decision criterion (or criteria) was sought which distinguished between those who believed in not following trends yet changed, and those who didn't change. It needed to be able to predict cases where strategy was overruled. Various types of criteria were experimented with. In the end it was found a criterion that involved a trade-off between the extra expected return and the perceived risk or concern about the consequences of failure was the most appropriate. While slightly different wordings were used for each of the major strategic models, they followed the pattern of the criterion used for the model in Figure 1a. This was:

> Is it likely to be profitable in the medium to long term to change to (superfine, fine) merinos given the time and costs of changing and the risk that prices may swing back in favour of your existing merinos?

This type of criterion was generally effective in distinguishing between those who were willing to change their strategy and those who didn't. Those who didn't change often expressed their reasons in terms of not believing in chasing trends, but most said the criterion above embodied their thinking on the matter.

The apparent lack of response to changes in prices, and the reluctance of producers to change although their budgets showed otherwise, may be empirical examples of the recent experimental evidence of the competence and omission biases. The competence hypothesis is that people avoid betting in areas where information is lacking and they feel ignorant (Heath and Tversky 1990), while the omission hypothesis is that they prefer not to act even when this may produce a change in the status quo (Ritov and Baron 1992). Most producers did not feel competent in predicting wool prices and a number commented on cases of fellow graziers who had followed the trends and got 'burnt'.

Some people, using the spectacles of utility theory, might like to construe these criteria as examples of maximising subjective expected utility. Given the discussion above, it

is probable this would not be the most accurate interpretation of what was occurring, although a cursory glance might suggest it could be interpreted in that way. If anything, they were more in the nature of safety-first criteria. A major change of enterprise, because it often required money to be borrowed, increased the probability of income falling below critical levels. Opportunities were forgone 'because a business cannot "chance" an adverse outcome of some possible event that may or may not happen' (Malcolm 1992, p. 3).

Strategy was an important aspect of wool producers' decision processes in the New England. This is not to suggest they necessarily used formalised strategies, although some did (e.g., one producer, who worked out changes based on budgets and various expected price scenarios, said that even when they made a decision to change, they had a policy of not changing by more than 10 per cent per year).

Strategy and livestock numbers

Another area in which the influence of strategy shows is in the numbers of merino ewes mated to merino rams from 1989-92. Wool prices peaked in May 1988 and although initially the decline was slow, by mating time in 1992, prices for 19 micron wools were around one-third the peak in 1988. Yet between 1990 and 1992, matings of merino ewes to merino rams decreased by only four per cent (Table 2). From 1991 to 1992, 44 per cent of flocks still increased matings to merino rams, while the number that decreased matings was 50 per cent. Reasons for the increases were dominated by decisions to start merino breeding and the build-up following these decisions (see Appendix Table A2). Reasons for decreases in matings were dominated by the drought of 1991-92, with very few indications that ewe matings had decreased because of the decrease in wool prices.

In other words, despite a substantial decline in wool prices, almost half the flocks were still increasing the number of ewes being mated to merino rams in 1992, some four years after the decline in prices began. A large proportion of these increases were the result of long-term strategic decisions to begin merino breeding, generally made several years before when prices were still rising or were near their peak. Even for the remaining half who decreased their mating, the major factor contributing to the decline

Table 2

Matings of merino ewes to merino rams in 'test' series flocks
n=45

Merino ewe type	1989	1990	1991	1992
Superfine				
No. ewes mated	14 245	14 842	17 529	15 930
No. properties	11	11	11	11
% of properties	24%	24%	24%	24%
Fine				
No. ewes mated	19 778	21 651	18 010	19 367
No. properties	16	18	18	18
% of properties	36%	40%	40%	40%
Medium				
No. ewes mated	3 260	3 194	3 293	2 854
No. properties	3	3	4	3
% of properties	7%	7%	9%	7%
Total matings	37 283	39 687	38 832	38 151

was the poor seasonal conditions. A similar pattern can be seen in the reasons given for changes in numbers of bred merino wethers (see Appendix Table A3).

Evidently, though prices and returns to merino breeding had collapsed, most of those who had made a decision to begin merino breeding (and those who were in the industry already), were not ready to make a sudden about-turn and reconsider their position. If a long-term trend becomes apparent, more producers will reconsider their position but, by the middle of 1992, it appears most producers were not yet ready to change their long-term view of the industry.

Just, Zilberman, Hochman and Bar-Shira (1990) provide evidence that simple behavioural rules may explain farmer behaviour more successfully than a model assuming profit maximisation. This is interpreted by Just (1992) to be due, in that case, to habit formation and that practices will be modified in response to profit if the

opportunity costs become sufficiently large. Presumably this partly explains the lack of response of wool producers in this study, but their deliberate strategy of not following trends provides a more compelling explanation than habits. It provides a better explanation of the cases where producers did not respond despite ostensibly quite compelling profit advantages. An implication of this is that producers may be less responsive to change if strategy, rather than habit, is the explanation.

Another possible explanation for some lack of response, which is consistent with the strategic explanation, is that limited cognitive capacities mean that producers can only pay attention periodically to the profitability of their enterprises (Earl 1990). Thus, consideration of change will occur if something happens to attract the persons' attention, or the person has a policy of undertaking reviews at regular intervals.

Ambiguity, arising from a lack of information about the formation of prices in the wool market, could have made some wool producers reluctant to gamble. This was particularly apparent in the models of decisions to delay the sale of wool and whether to sell privately or by auction. One producer even said he gambled on the cattle market because he felt he could forecast in this market, but did not bother in the wool market because he had no idea what would happen; a view he shared with many others. Of course, the wool cheque was also considerably more significant than a few cattle sales, so this was probably another consideration. Anyhow, perceived competence in forecasting a market was evidently an element that reduced producers' sensitivity to price fluctuations.

6. Implications of results for econometric estimates of agricultural supply

Econometric methods used to forecast agricultural supply commonly contain linear-additive models which allow tradeoffs between variables and entail assumptions about the manner in which decision makers form expectations about the future value of variables. Many hypotheses about the formation of expectations (e.g., naive and adaptive expectations) involve an assumption that the decision maker has a fixed sensitivity to the value of a variable (Kaine-Jones 1988). Distributed lag models

involve a similar assumption. The additive nature of the models also contains an assumption that people use a compensatory decision process.

Hierarchical models have provided accurate predictions in this study about the decisions of wool producers in the New England area. This implies that a hierarchical decision process is at least as plausible as a linear-additive decision process, since most linear-additive econometric models do not give accurate predictions of individual decisions without the use of dummy variables (Just 1992).

If decisions at the micro-level are made using hierarchical decision processes, then it may not be rigorous to use linear-additive econometric models at the aggregate level. The defence against this argument has been a form of the 'as if' argument based on the assumption that the aggregation of the data will negate the non-additive effects at the micro level. However, as Gladwin H. (1975) has shown, fitting a regression model to aggregated data generated from a hierarchical decision process gave biased estimates of the importance to the decision of the variables in the decision process. The weighting and statistical significance of some variables increased, while others became insignificant.

Because livestock numbers for the wool producers surveyed were extremely slow to respond to the decline in prices and this occurred across the whole of the sample, the 'law of large numbers' is unlikely to render the behaviour identified in this research insignificant in aggregate data. The behaviours were noticeably biased in one direction and were not cancelled by other producers' reactions for other sets of circumstances and other types of country.

Incorrect conclusions about the significance of variables are obviously a problem for policy decisions and for decisions about which variables to include in the models. Another important problem arises when the regression model is used to predict future trends. If a change occurs in the range of the existing variables, or the underlying structure of the model, then the regression model will probably give inaccurate predictions. A possible reason for problems with econometric estimates of agricultural supply is, therefore, that aggregation of the data does not cancel the effects caused by

hierarchical decision processes. When different data sets and estimation techniques are used, the differences in the underlying and assumed structures lead to errors in the estimates and predictions.

A related, but separate issue, is that the final supply of a commodity from an individual farm arises because of a series of major and minor decisions and natural phenomena (not one decision). The conclusion to be drawn from this study is that decisions may often be taken in semi-isolation, perhaps using different decision processes and using different types of expectations about price. Decisions to change the micron of a merino wool flock may involve different aspects from decisions to keep cfa ewes for an extra year. Both will have an impact on the number of sheep and the supply of wool in the current and subsequent years.

Work by Kalaitzandonakes and Shonkwiler (1992), on planting and replanting in perennial crops, has shown there are advantages to be gained from estimating the planting and replanting decisions separately. The continuing influence of the decisions to begin merino breeding on subsequent matings of merino ewes, shows that decisions about changing enterprise are long-term decisions that continue to have effects even when the original reasons for the change have disappeared. This implies a need to treat decisions to change enterprises differently from decisions to change the size of an existing enterprise.

An important conclusion of this study was that producers ignored, or did not react to, quite major fluctuations in prices unless they perceived a long-term trend (e.g., reduced consumption of lamb). When making their decisions they also used decision rules that were in the nature of on/off switches rather than a continuous adjustment process. Response to price fluctuations was shown to be very much context dependant. By this it is meant that some changes in prices in one context led to a change in behaviour, while the same, or even greater changes in another context, had no effect. Different price variables were relevant to different decision makers, or to different decisions made by the same decision maker in different contexts (e.g., prices of prime lambs and/or cattle were relevant to some producers but not to others).

What these imply is that the assumption of fixed sensitivity to the value of a variable may not be appropriate. It is certainly not appropriate at the individual level, and the collective response of wool producers in this study to the collapse of wool prices suggests it may not be appropriate at the aggregate level, either. It provides support for the trend detection approach to modelling response proposed by Wright and Kaine-Jones (1985). It also provides an explanation and support for the suggestion by Just (1992) that the different estimates of short-run elasticities over time may be due to factors not included in the problem; perhaps the contexts in which the decisions are made. Over time these vary and hence the responses will vary.

Closely allied to the above issues is the question of the use of expectations in econometric models. Many models of the formation of expectations use past observations of the variables that are assumed to have a consistent weighting. They imply persistent sensitivity of response to changes in the past observations of this variable. The same problems raised in the previous two paragraphs are thus also applicable to expectation models.

Another implication emanating from the recent literature on ambiguity, and from this research, is the effect of the ambiguity of expectations on decisions. Even if information about producers' expectations was collected by means of a survey, the level of confidence of producers in their expectations could influence their decisions in the same way that it has been shown to affect the use of elicited probabilities. In this study evidence was found of a reluctance to bet (or gamble) on expectations about wool prices. Additional complications are that this research, and that of Munro and Fisher (1982), have found that the long-term history of prices is an important factor in producers' decisions. Yet, they do not like to make long-term predictions about price, although some decisions are based on a view of what is likely to occur in the long term.

A further debate is whether the significance of the lagged variables is due to price uncertainty or the costs of adjustment. Based on data collected from producers in the three wool-producing regions of the state, Munro and Fisher (1982, p. 222) argue the distributed lags 'are attributable more to the costs of adjustment than to the effects of price uncertainty'. Their argument is not necessarily valid, and anyhow the evidence

from the decision models suggests it may be an unresolvable 'chicken or the egg' problem.

The lack of significance attributed to prices lagged more that one period may be due to the assumption of fixed sensitivity, not lack of influence in the formation of expectations. If the effect of past prices depends on the context in which the change takes place, then the further removed the period, the more variable the influence is likely to be. Sometimes it may be relevant, in other cases, possibly not at all.

It is also the case that costs of adjustment meant that producers were still responding to prices that occurred several years before, viz. many producers in this study still increased their matings to merino rams in June 1992. One main cost of adjustment occurred because producers were not willing to take the risk of making a dramatic change. A dramatic change cost more money up front, which may have resulted in failure of the business. They were not willing to make a dramatic change because they were uncertain about the prices, so they adjusted slowly and therefore were responding to past levels of prices.

Studies such as this may also help econometricians and their aggregate supply models through building an understanding of the behavioural rules, habits and variables that have a bearing on producers' production and marketing decisions. They should help with decisions about which variables to include and improve the structure of the models. This may be especially important if, as discussed earlier, tests of statistical significance and size of the coefficients do not provide a good estimate of the importance of a variable in a decision, because the decision process is hierarchical rather than linear-additive.

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Appendix

Table A1

Accuracy of decision models

Decision model	Cases	Errors	Success rate
Begin merino breeding[a]	33	6	82%
Type to breed	13	1	92%
*Stop merino breeding[ab]	22	1	95%
Change micron of merino flock[a]	43	5	88%
Breed or buy new micron sheep	7	3	57%
Minor increase/decrease in micron	31	0	100%
Keep seconds to reduce micron of clip[a]	48	0	100%
Run own wethers after begun merino breeding	11	1	91%
Keep own wethers past 4T	12	1	92%
*Stop running own wethers[a]	20	3	85%
Mate own merino ewes to sell 1x lambs	110	6	95%
*Raise own 1x ewes from own merino ewes	10	3	70%
Begin to buy merino woolcutters[a]	37	5	86%
Micron type to buy	14	1	93%
Buy another micron type of woolcutter[a]	21	1	95%
Stop buying a micron type of woolcutter[a]	38	3	92%
Delay sale of wool	252	12	95%
Sell by auction or private	272	2	99%

* Models at a preliminary stage of development at testing.

[a] The number of cases listed in these models includes those producers who answered yes to one of the trigger reasons listed in the models plus those who considered change for reasons not listed in the models (who are also included as errors of the model).

[b] Since no-one stopped merino breeding in the 'initial' series of interviews, only very basic criteria were available. The answers from the 'test' series of interviews were used to expand the model so this model has not been tested with a separate group of interviews.

Table A2a

Reasons for change in matings of merino breeding flocks to merino rams 'test' series 1989-92

Reasons	Times mentioned[a]			
	89-90	90-91	91-92	Total
Reasons for increase				
Decided to start merino breeding - see model.	2	2	0	4
Build-up following decision to begin merino breeding.	4	6	6	16
Decided to change to this micron type of merino - see model.	0	1	0	1
At prices of wool and stock, expect better return from increasing merino breeding compared to other enterprises e.g., cattle, 2x lambs, bought wethers.	2	1	2	5
Expect better return from merino breeding compared with 1x lambs this year.	1	1	0	2
Sale price of cfa ewes poor, season OK, better return if keep, mate and shear.	0	1	0	1
Seasonal conditions good, decided could carry more stock.	1	0	0	0
Mated more to decrease age structure of flock by replacing larger number of cfa ewes or wethers.	1	1	2	4
Mated more so can cull heavier and improve wool quality.	1	0	0	1
Need to make up replacement numbers because of a poor lambing.	0	0	2	2
Increased carrying capacity due to fertilising, pasture improvement and/or improved grazing control.	4	1	2	7
Increased numbers because leased, bought or planning to buy another property.	3	4	0	7
Reasons for unplanned change or no change				
No significant change and/or reason for change.	6	5	3	14
Result of replacing bought ewes with own ewes after begun breeding.	1	1	0	2
Result of differences in lambings, proportions of ewes, deaths, and culling of young and old sheep.	5	5	4	14
Drought resulted in loss of ewes and poor lambing.	0	0	1	1

[a] More than one reason was allowed and a producer may have commented on more than one merino flock e.g., if changing from one micron type to another.

Table A2b

Reasons for change in matings of merino breeding flocks to merino rams 'test' series 1989-92 (continued)

Reasons	Times mentioned[a]			
	89-90	90-91	91-92	Total
Reasons for decrease				
Decided to stop merino breeding - see model.	0	2	0	2
Phasing out following decision to change to another micron type of merino - see model.	0	1	0	1
At prices of wool and stock, expect less return from merino breeding than other enterprises e.g., cattle, 2x lambs, bought wethers.	1	1	2	4
Expect better return from increasing 1x lambs compared with merino breeding this year.	2	0	1	3
Expect better return from increasing self-replacing flock compared with merino breeding this year.	0	0	1	1
Uncertain wool market and/or talk of quotas.	0	1	0	1
Lower prices for wool means more economic and less risky to decrease stocking rate.	0	1	0	1
Dry/drought conditions, shortage of feed: culled ewes heavier, pitted ewes, and/or didn't mate maiden or other ewes.	0	5	11	16
Been above optimum long term stocking rate.	0	0	1	1
Sufficient young sheep and less cfa ewes or wethers to replace.	0	0	1	1
Higher culling rate because trying to improve quality of flock.	2	1	1	4

[a] More than one reason was allowed and a producer may have commented on more than one merino flock e.g., if changing from one micron type to another.

Table A3a

Reasons for change in bred merino wethers 'test' series 1989-92

Reasons	Times mentioned[a]			
	89-90	90-91	91-92	Total
Reasons for increase				
Decided to carry own wethers after beginning merino breeding - see model.	2	2	3	7
Build-up following decision to begin merino breeding and to carry own wethers.	3	3	6	12
Changed to breeding this micron type of merino - see model.	0	1	0	1
Build-up following decision to change to breeding this micron type of merino.	0	0	1	1
At prices of wool and stock, expect better return from increasing bred wethers compared to other enterprises e.g., cattle, 2x lambs.	0	0	1	1
Expect better return from increasing wethers compared with 1x lambs this year.	0	1	0	1
Expect better return from increasing wethers compared with breeding this year.	0	0	1	1
Bred merinos give better return than bought merinos - replace bought as own available.	2	2	1	5
Sale price of cfa/cull wethers poor, expect better return if keep and shear.	0	3	0	3
Good wool prices and seasons OK, decided to carry more wethers.	2	0	0	2
Seasonal conditions good, decided could carry more stock	1	0	0	1
Seasonal conditions poor, mated less ewes, maintained total numbers with wethers.	0	1	1	2
Increase to make up for lower numbers of breeding and/or young stock.	1	1	1	3
Increased carrying capacity due to fertilising, pasture improvement and/or improved grazing control.	3	2	1	6
Increased numbers because leased, bought or planning to buy another property.	2	3	3	8
Reasons for unplanned change or no change				
No significant change and/or reason for change.	7	5	2	14
Result of differences in lambings, proportions of wethers, deaths, and culling of young and old sheep.	6	6	3	15

[a] More than one reason was allowed and a producer may have commented on more than one merino flock e.g., if changing from one micron type to another.

Table A3b

Reasons for change in bred merino wethers 'test' series 1989-92 (continued)

Reasons	Times mentioned[a]			
	89-90	90-91	91-92	Total
Reasons for decrease				
Phasing out following decision to change to breeding another micron type of merinos - see model.	0	1	0	1
At prices of wool and stock, expect less return from bred wethers than other enterprises e.g., cattle, 2x lambs.	0	0	1	1
Expect better return from increasing 1x lambs compared with wethers this year.	1	0	0	1
Expect better return from increasing merino breeding compared with self-replacing flock this year.	0	1	1	2
Uncertain wool market and/or talk of quotas.	0	1	0	1
Dry/drought conditions, shortage of feed: sold or pitted cfa/cull and/or extra wethers to decrease stocking rate.	0	0	7	7
Decreased numbers because have been above optimum stocking rate.	0	0	3	3
Lower prices for wool means more economic and less risky to decrease stocking rate.	0	1	2	3
Higher culling rate because trying to improve quality and/or decrease age of flock.	1	0	2	3
Needed to make room for higher numbers of breeding and/or young stock.	0	1	1	2

[a] More than one reason was allowed and a producer may have commented on more than one merino flock e.g., if changing from one micron type to another.