DEVELOPMENT OF ECONOMIC VALUES FOR WOOL TRAITS USING FORECASTING TECHNIQUES AND VECTOR SPACE ANALYSIS OF AUCTION DATA

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INTRODUCTION

When selection indices are constructed for the purposes of multitrait selection, the relative economic values (REVs) of traits must be estimated (Hazel 1943). Wool REV estimations should reflect the value of the trait in 2-5 years time, when the effects of selection are expressed in the performance of progeny. This requires forecasting of relative prices. Another problem is that REVs are non-linear and correlated with other wool traits. Response to selection necessitates the recalculation of REVs.

This paper outlines how the database of auction prices/wool characteristics maintained by the New Zealand Wool Board (NZWB) is being analysed to combat these problems.

FORECASTING WOOL PRICES

There are three main categories of forecasting technique that can be used to estimate wool REVs.

1) "Expert" judgements can be accurate, if the combined forecasts of the most accurate experts are used, if iterative feedback allows expert "calibration" and if judgemental methods are made explicit by modelling the decision process (Lawrence et al. 1985).

2) Some extrapolation techniques have provided accurate short to medium-term forecasts (Makridakis et al. 1982). Moving average forecasts are simple to use, although the averaging period must be carefully matched to the volatility of the historical data. A moving average forecast will lag behind in reflecting trends, although this can be partly overcome by heavier weighting of more recent periods. Regression analysis provides a trend line which can be used to forecast. If there are trends in the data regression analysis will generally be more accurate than a moving

average. More complex cyclical decomposition techniques, which incorporate seasonal and cyclical patterns as well as a trend, are also available (Gardner and Dannenbring 1980).

3) Sophisticated models, eg. econometric models (Foster 1986) can forecast value. These are generally expensive to develop (Armstrong 1978a) and are not necessary superior (Marhandru 1976).

TESTING EXTRAPOLATION METHODS

Twelve years of wool prices, for 6 micron types (19-37 microns), were used to forecast prices (c/kg) and micron differentials (c/kg/μm) for 3 recent seasons using moving averages (1-10 years data), regressions (5, 10 years) and cyclical decomposition regression (12 years). The mean absolute deviation between the actual and forecast values (Armstrong 1978b) was calculated across years and microns.

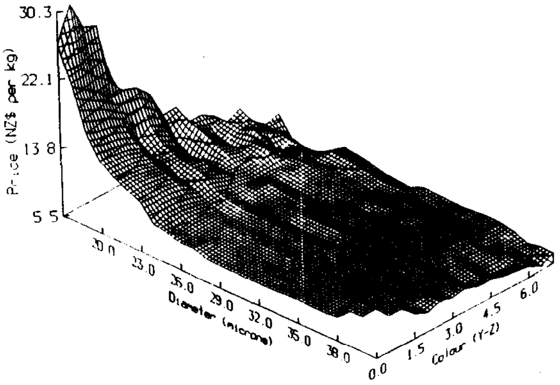
Accuracy differences between the methods were generally not significant. Regression with a cyclical adjustment was least accurate, probably because of irregular wool price fluctuations. Of the moving average periods tested, shorter averaging periods were more accurate due to the reduced time lag inherent in the forecast. The shorter regression trend forecasts "over-responded" to short-term trends. The method with the best overall prediction of both clean fleece weight and fibre diameter REVs was ten year regression. This approach reflected recent changes in REVs while avoiding the undue influence of short-term fluctuations.

VECTOR SPACE ANALYSIS

The NZWB has kept records of auction prices for over 10 years. The 6 wool properties of fibre diameter, vegetable matter, colour, barbe, bulk and medullation can be predicted from the NZWB type using the WRONZ/NZWB CONVERT software (Carnaby 1983). Plots of price versus wool properties (eg. fibre diameter and colour - Figure 1) show that prices do not change in a linear, independent manner.

A theoretical framework for analysing the auction data is to treat the objective wool fibre properties as dimensions in a vector space. Hence $(v_1, v_2, \ldots v_n)$ represents a point or position vector in the wool vector space, where v_n represents the value of the nth property. Points or positions in a vector space may have a scalar or vector associated with them which depend only on the point in space and not the coordinate system.

Figure 1: Price$^+$ versus Diameter and Colour*



+ Contours represent increments of NZ$1.30/Kg
** Collation of 90000 auction lots from the 1986/1987 sale season (but only includes small numbers at extremes and low diameter values).*

Wool vector space has a scalar field of relative price associated with a number of discrete points in the space grouped together according to the INVERT system (Carnaby et al. 1988). This may be differentiated with respect to the wool property coordinates to produce a vector field known as GRAD (relative price):

$$\text{GRAD (P)} = \frac{dP}{d(Y-Z)} \cdot \widehat{Y-Z} + \frac{dP}{dFD} \cdot \widehat{FD} + \frac{dP}{d(\text{barbe})} \cdot \widehat{\text{BARBE}} + \ldots$$

where the symbol $\wedge$ denotes a unit vector in the direction of the axis of the parameter it covers. The GRAD (relative price) vector defines the direction and magnitude of the greatest rate of change of the relative price at all the points within the chosen wool volume. The partial derivatives of the function describing the scalar field associated with a point in the vector space represent the rates of change with respect to the variable of differentiation. These are known as directional derivatives. The use of linear regression coefficients (Stanley-Boden 1985) assumes the partial derivatives in the GRAD (relative price) equation are constant at all points in the chosen wool volume, which is not the case. The components of the gradients are the estimates of REVs which take correlations into account and overcome non-linearity by studying a point rather than a larger area (as occurs with multiple linear regression). The wool price field, which reflects demand and supply, will continually change. However as many sheep breeders use the selection index approach in NZ, estimates of REVs should be made using the best available techniques.

Selection indices solve for the best returns in offspring, but do not reflect the returns resulting from moving from different positions in the wool space in future generations. In theory the best "path" can be determined by dynamic programming (Wagner 1969). The position in wool space, where this approach is most likely to be useful is at transition points. For example, flocks finer than 26 microns were found to be selected in the finer direction, whereas flocks coarser than 26 microns moved in the coarser direction (Cottle and Maddever 1988). Possibly 26-28 micron flocks should move finer, with losses in current economic gain outweighed by larger, discounted future gains.

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