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Farm benchmarking- the next level

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Abstract

Sheep benchmarking data often show profit differences of more than 50% between average wool producers and the top 20-25% of wool producers. However, interpretation and effective use of such data by consultants and producers is complicated by differences and correlations between performance indicators. Our project was designed in conjunction with benchmarkers to develop a rigorous method for analysis of their data and to determine key performance indicators of the profitability of a variety of sheep production systems. We estimated technical efficiency, which relates all outputs to inputs, and used principal component analysis to identify the most important performance indicators that influence technical efficiency. Productivity for wool enterprises was measured over several seasons, which ranged from very bad to excellent, and varied by up to 30% between farms. The annual improvement in productivity was about 5% for best-practice producers, while the average technical efficiency of less efficient producers declined by 1.4-2.8% per year. Principal components analysis indicated that maximum technical efficiency in south-western Victoria was associated with sheep with slightly finer wool and lower fertility than average, suggesting that emphasis was placed on a higher stocking rate and more wool per ha. Technical efficiency estimates afford producers a more balanced indication of their relative performance than was previously possible. Principal component analysis and regression analysis identify important performance indicators and their relative impacts on technical efficiency, respectively. When used in combination, these analyses represent a powerful tool for diagnosing problems and exploiting opportunities for improved income in Merino wool enterprises.

Farm benchmarking—the next level

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Abstract

Sheep benchmarking data often show profit differences of more than 50% between average wool producers and the top 20–25% of wool producers. However, interpretation and effective use of such data by consultants and producers is complicated by differences and correlations between performance indicators. Our project was designed in conjunction with benchmarkers to develop a rigorous method for analysis of their data and to determine key performance indicators of the profitability of a variety of sheep production systems. We estimated technical efficiency, which relates all outputs to inputs, and used principal component analysis to identify the most important performance indicators that influence technical efficiency. Productivity was measured over several seasons, which ranged from very bad to excellent, and varied by up to 30% between farms. The annual improvement in productivity was about 5% for best-practice producers, while the average technical efficiency of less efficient producers declined by 1.4–2.8% per year. Principal components analysis indicated that maximum technical efficiency in south-western Victoria was associated with sheep with slightly finer wool and lower fertility than average, suggesting that emphasis was placed on a higher stocking rate and more wool per ha. Technical efficiency estimates afford producers a more balanced indication of their relative performance than was previously possible. Principal component analysis and regression analysis identify important performance indicators and their relative impacts on technical efficiency, respectively. When used in combination, these analyses represent a powerful tool for diagnosing problems and exploiting opportunities for improved income in Merino wool enterprises.

Objective key performance indicators of profitability are important tools for the sheep industry

There are currently some 15 known sheep-farming benchmarking services in Australia (I. Rogan, personal communication). A common objective of these services is to provide information to their clients on performance indicators that influence variation in productivity and profit across years within and between farms. Benchmarking involves the collection of data on farm production and finances for calculation of intermediate indicators such as the cost of production (e.g., \$ per kg wool or lamb) and gross margins (e.g., \$ per dry sheep equivalent [DSE] or per ha), which when considered in conjunction with overhead costs (e.g., labour or capital investment), enable estimates to be made of enterprise profit (e.g., wool, lamb, beef or cropping) or whole farm profit (e.g., \$ per DSE or per ha) and percentage return on capital investment.

Notable differences in the profitability of the top 20–25% of wool producers relative to their average counterparts include 68% greater farm operating profit (JRL Hall and Co., 2004), 33% greater gross margin/DSE and more than 100% greater profit than average (Holmes, Sackett and Associates, 2004), 55% greater gross margin/DSE (Victoria Department of Primary Industries, 2004) and, in New Zealand, 55–70% greater economic farm surplus/ha (Johnstone, 1999). Objective identification of key performance indicators that reflect this variation in profitability would be of

value to the industry.

A meeting of farm benchmarkers, consultants and economists was organised by the Sheep CRC in October 2003. Participants at the meeting concluded that benchmarking schemes had the following deficiencies (I. Rogan, personal communication):

- data derived from district farm groups often lack sufficient replicates because of small numbers of participants;
- analysis of data on a within-year basis can lead to erroneous conclusions about profit drivers, which may be influenced by short-term seasonal or market conditions;
- input variables are often strongly correlated but analysis of their relative impact on profit normally assumes independence;
- various benchmarking services use different assumptions and methods of measuring or calculating input variables;
- simplistic interpretations are made of performance indicator influences by contrasting average input and output variables for the average or top 20–25% profit groups.

Furthermore, Fleming et al. (2005) suggested that current benchmarking services do not consider important economic principles such as optimum resource allocation, allocative efficiency, or technical efficiency, which measures the relationships between all farm inputs and outputs on a common basis.

The aim of our study was to develop a rigorous method for adding value to benchmarking data by identifying key performance indicators that will enable benchmarkers to produce better outputs and advice for their clients.

Materials and methods

In 2004, the Sheep CRC constituted a planning group and a project team. The former consisted of four farm-benchmarking service providers (JRL Hall and Co.; Holmes, Sackett and Associates; the Mackinnon Project; the Victorian Farm-Monitor Project) and the latter of researchers from the University of New England, the University of Adelaide and Sydney University. These groups specified the analyses and project design and facilitated data collection. Analyses within and across benchmarking datasets took into account all outputs and inputs for technical efficiency and identified performance indicators that had the most influence on technical efficiency as principal components.

Technical efficiency

Technical efficiency indicates how well wool producers use inputs (e.g., fertiliser, pasture improvement, labour) to generate outputs (wool and mature sheep for sale) and can be used to assess the efficiency of individual producers relative to that of best-practice farmers, who are allocated a technical efficiency score of 100.

A well-established econometric procedure (Coelli, 1996), stochastic production frontier analysis, was conducted using FRONTIER 4.1 software (Working Paper No. 7/96, Department of Econometrics, University of New England, Armidale). The analysis included 1,462 individual farm datasets from 378 Merino wool enterprises. Most data were collected from 1994 to 2004, but for some farms, only five years' data were available. Data were obtained from the following farm benchmarking services: JRL Hall and Co., Darkan, WA; Holmes, Sackett and Associates, Wagga Wagga, NSW; the Farm Monitor Project, Hamilton, Vic.

Principal component analysis

A principal component is an index weighting of groups of variables (performance indicators) in a production system. A system such as a wool enterprise will have as many principal components as it

has performance indicators. Principal components are not correlated with each other. Sheep and wool enterprises have up to 40 performance indicators (e.g., quantity, quality or value of wool, stocking rate, fertiliser application and rainfall).

Principal components were formed by weighting and combining performance indicators (SAS, 1989) and then eliminating performance indicators based on the magnitudes (product of the principal component and regression coefficient weightings) of their influences on technical efficiency until five to 10 of the most important remained. Regression analysis (SAS, 1989) was then applied to identify performance indicators that exerted the greatest effect on technical efficiency. This analysis was conducted using 707 individual farm datasets from JRL Hall and Co. and the Farm Monitor Project.

Results and discussion

Here, we present the production changes of best-practice producers, relative technical efficiencies for all producers and the most important performance indicators grouped as the principal components that had the most influence on technical efficiency. Technical efficiencies are also related to gross margins.

High technical efficiency reflects increased productivity

Technical efficiency estimates can be summarised in various dimensions. Fig. 1 shows that the annual improvement of the best-practice production index of producers with technical efficiencies of about 100% was 5% per year. This index of production includes both optimum production efficiency (maximum technical efficiency) and effective use of technologies such as improved pastures and genetic resources. The mean relative technical efficiencies for all producers (Fig. 2) declined by 1.5% per year over the same period and the ranges associated with the means increased as the means decreased. This trend shows that less efficient producers failed to keep up with best-practice producers and suggests that they did not achieve the same rate of productivity growth. This phenomenon is frequently observed in assessments of technological progress because some individuals adopt new technologies more rapidly than others and are more able to implement them.

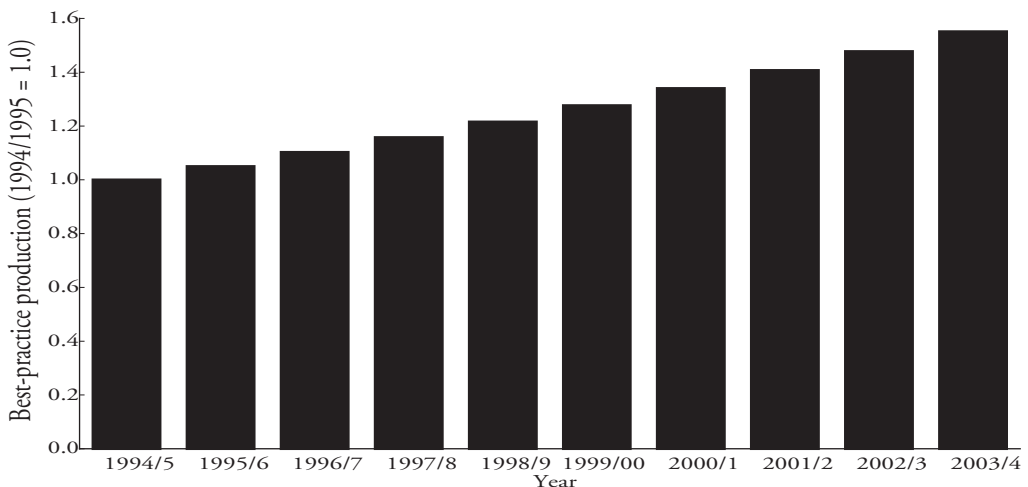


Fig. 1. Best-practice production indices for producers with technical efficiencies of about 100% over a 10-year period for the JRL Hall benchmarking group.

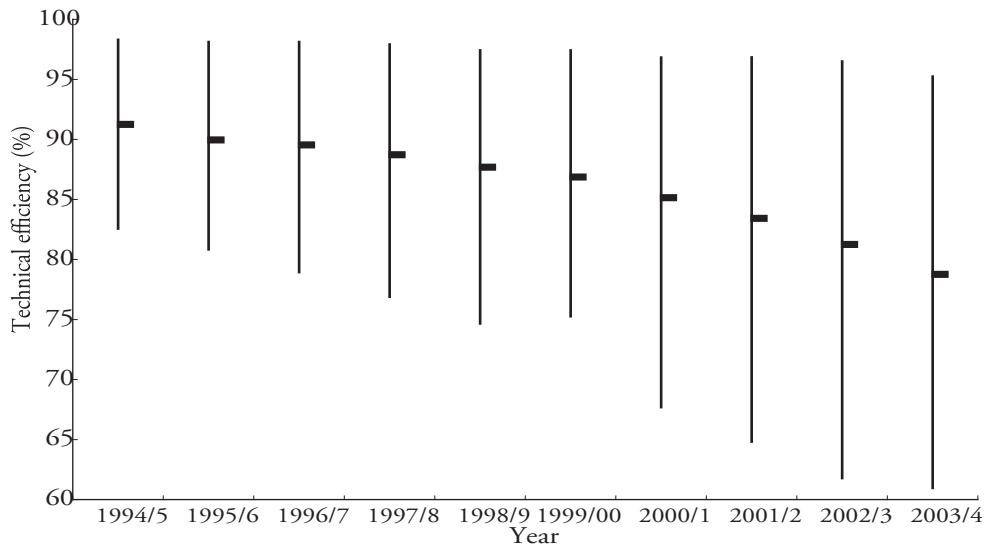


Fig. 2. Best-practice production indices for all producers over a 10-year period for the JRL Hall benchmarking group. Vertical bars indicate ranges in technical efficiency.

Corresponding changes for data supplied by Holmes, Sackett and Associates were: 5.1% increase per year in productivity for best-practice farmers; 2.8% per year decrease in technical efficiency of all producers. The latter decrease in technical efficiency was greater than that illustrated above, which may be due to the effects of drought across some regions and the wide range of environments. In particular, only five years' data were available and many of the farmers experienced drought over much of this period. Variation in productivity between seasons, which were classified as very bad to excellent, for best-practice producers participating in the JRL Hall and Co. and Farm Monitor Project surveys was between 23% and 30%. Summaries of technical efficiency distributions according to region and seasonal conditions for the three benchmarking groups were reported by Fleming et al. (2005).

Technical efficiency is not closely related to gross margin

Benchmarkers often calculate gross margins. Although positive correlations between gross margins and technical efficiencies exist, they vary considerably (Fleming et al., 2005). This is to be expected because technical efficiency reflects only the physical components of economic efficiency while gross margin reflects income from a single performance indicator and does not take allocative efficiency (i.e., how well producers allocate inputs to generate additional outputs such as meat; Fleming et al., 2005) into consideration. The average correlations between technical efficiencies and gross margins for the JRL Hall and Co. dataset and the Farm Monitor Project dataset were 0.51 and 0.52, respectively. The correlation was very low (< 0.2) for the Holmes, Sackett and Associates dataset, perhaps because they encompassed a broader range of enterprise types and regional environments.

Principal component analysis identifies important performance indicators

Analysis of the Farm Monitor Project dataset revealed that three of the five simplified principal components were important in explaining variation in technical efficiency ($r^2 = 0.65$). The component weightings and their interpretations are given in Table 1.

Table 1. Principal component weightings for the Farm Monitor Project dataset.

Performance indicator	Principal component 1	Principal component 2	Principal component 3
Fibre diameter (μm)	0.48	0.43	-0.64
Clean wool production (kg/ha)	0.57	-0.13	-0.08
Clean wool production (kg/DSE)	0.47	-0.47	0.41
Lambs marked per ewe mated (%)	0.45	0.38	0.48
Lambs born alive per ewe mated (%)	-0.12	0.65	0.43
Interpretation of principal components	heavy fleece	light fleece	heavy fleece
	coarse wool	coarse wool	fine wool
	fertile ewes	fertile ewes	fertile ewes

Principal component 1 with its weightings was the most influential, explaining 41% of the variation in the five performance indicators. Differences in types of sheep were evident for principal component 1: positive values for the weightings are indicative of large, heavy-fleeced South Australian types; negative values are indicative of small-framed, fine-wool, light-fleeced Saxon types. Principal component 1 had a quadratic association with technical efficiency; maximum technical efficiency was attained at -1.2 units (Fig. 3).

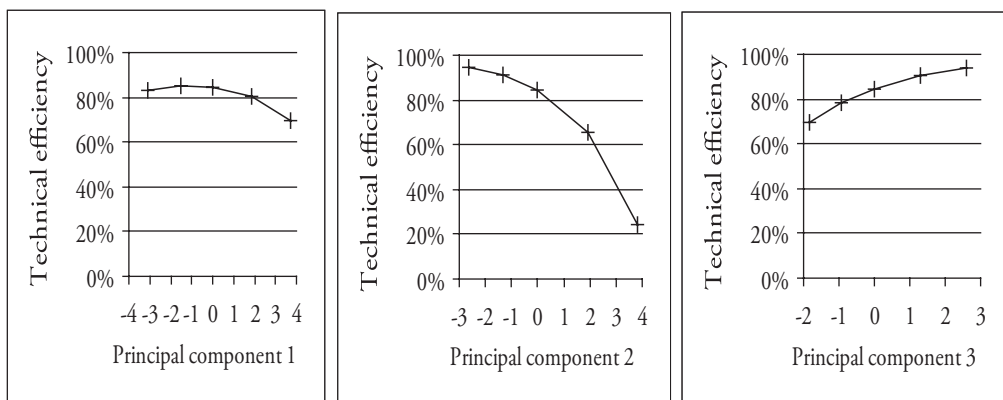


Fig. 3. The effect of important principal components on technical efficiency. Technical efficiency: $(0.030 \times (\text{principal component } 1)^2) + (0.072 \times \text{principal component } 1) - 1.864$; $(0.414 \times (\text{principal component } 2)) - 1.864$ or $(-0.369 \times (\text{principal component } 4)) - 1.864$.

This optimum suggests that the most efficient wool production in south-western Victoria was derived from sheep that had a slightly lower fibre diameter than the average for the dataset, produced less wool than average and had a lower lambing percentage than average. The implication for management is that more sheep per ha with lighter fleeces of finer wool will result in relatively higher profits. The use of principal components for this analysis demonstrated that an ideal value for a performance

indicator such as fibre diameter cannot be determined without taking other performance indicators into account.

Principal component 2 with its weightings explained 30% of the variation in the performance indicators. The positive value for fibre diameter indicates coarse wool, but light-fleeced sheep were associated with maximum flock fertility, indicating that fertility was afforded greater emphasis than wool production. However, the optimum value of -3 (Fig. 3) indicated that the highest technical efficiency for wool production would be derived from fine-wool sheep that produce more wool and in which wool production is afforded a higher priority than fertility. Principal component 3 only explained 9% of performance indicator variation and the optimum of $+3$ was associated with finer-wool, heavy-fleeced, fertile sheep.

Conclusions

Estimates of technical efficiency provide producers with a more powerful benchmarking tool than previously available. Knowledge of the relationship between technical efficiency and principal components including key performance indicators will enable producers and their advisors to diagnose problems more effectively and exploit opportunities. These initial studies have shown for instance, that reducing fibre diameter alone does not improve profitability as much as when fleece weight, size of sheep and fertility are also considered. It was concluded that comparisons of technical efficiencies across a range of environments are not effective and that more sophisticated statistical methods required for this purpose. Further research is required to develop methods for comparing data from farms with various combinations of enterprises and environmental conditions and for analysis of large datasets.

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