COSTS OF STAPLE LENGTH TESTING AND ECONOMIC IMPLICATIONS OF ADDITIONAL MEASUREMENT

ECONOMICS DEPARTMENT
AUSTRALIAN WOOL CORPORATION

Murray Spinks and Bob Richardson

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PREFACE

It is almost a decade since the wool industry began extensive trials to evaluate the feasibility and desirability of applying objective measurements of some fibre characteristics to the pre-sale testing of Australian wool. In conjunction with the Advisory Committee on Objective Measurement (ACOM), and through the concerted efforts of the Australian Wool Corporation (previously the Commission) and the Australian Wool Testing Authority, (AWTA) pre-sale measurement of yield, vegetable matter content and fibre diameter gradually became an established practice at Australian auctions. Known generally as sale by sample (or sale by test certificate), over 95% of wool offered at Australian auctions in 1980-81 is likely to be sold by sample instead of by traditional showing.

Research carried out in recent years, particularly by CSIRO, Division of Textile Physics, in Australia, has made it appropriate to test the technical and logistical feasibility of pre-sale measurement of additional characteristics; notably staple length, strength and clean colour With ACOM charged with the responsibility of planning an implementation program, industry trials were commenced in Adelaide early in 1980 and extended to Fremantle, Sydney and Melbourne during the 1980/81 season, to test the procedures for producing these additional measurements and to introduce the new measurements to local industry sectors, particularly the buying trade.

A parallel but separate project, to evaluate the costs and benefits of additional measurement, was also initiated within the Corporation at the request of ACOM. The work reported in this document represents the current best assessment of the potential economic implications of introducing additional measurement into the selling system. The work was carried out in the Corporation's Planning and Economics Department by Dr. Bob Richardson and Mr. Murray Spinks, in close consultation with ACOM, AWTA, and AWC departments. The report emphasises the preliminary nature of the results and cautions against premature conclusions, but does place many aspects of sale by additional measurement (and, ultimately, sale by description) in perspective.

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SUMMARY AND CONCLUSIONS

This paper reports the current best assessments of the economic implications of pre-sale additional measurement. Part of this involves an investment appraisal of the cost of staple length measurement. The economic implications for Sale by Additional Measurement and Sale by Description (SXD) are then summarized. The information presented provides policy makers with a broad industry perspective on proposed reforms and could be used as one basis for determining implementation strategies for additional measurement.

There are several general features of this report that must be appreciated in its interpretation:

. While pre-sale additional measurement is the main development considered in this paper, commercial options such as post-sale additional measurement and use of AWC/Broker agreed appraised types in catalogues, must also be acknowledged as either complementary developments or alternatives.

. The present paper is necessarily a progress report in the sense that it is based on the best available information at this time. In the future technological developments, changes in measurement standards and further research on economic or cost aspects, are likely to necessitate updating of the results reported here.

. Additional measurement is viewed as an innovation which may facilitate other longer term developments in wool marketing such as centralized selling, sale by description and computerized auctions. However, it should be emphasised that these developments can also occur independently of the introduction of additional measurement.

. At this stage costs are more readily quantifiable than benefits of additional measurement or S x D. Since the most that is possible at this stage is to summarize the sources of many benefits and some costs, it is not possible to derive firm conclusions on benefit/cost ratios or the desirability, in economic terms, of the innovations under consideration.

It is assumed that the first stage of additional measurement would be the commercial availability of Staple Length Measurement (SLM), Staple Strength Measurement (SSM) and Colour Measurement (CM). While detailed cost analysis was directed to SLM, the commercial situation may well result in the introduction of length and strength measurement together, or even of SSM alone. The principal conclusions arising from the analysis of additional measurement may be enumerated as follows:

(1) Costs of Additional Measurement

Cost calculations were made for a five year introductory phase for SLM and were sensitivity tested for differing adoption rates, levels of productivity and investment strategies. If almost complete adoption of SLM was achieved within five years, the average cost per test would be in the range $8 to $15 per lot. The lower estimate assumes a twofold improvement in productivity compared with existing technology. Direct cost to woolgrowers in the longer term are discussed in more detail under (2) below.

The current cost (1980/81) for the first year of additional measurement for SLM would be approximately 3.5 c/kg. greasy with a 5% adoption rate for lot sizes of 10 bales. During the introductory period of additional measurement, adoption rates would be the main factor determining costs. The cost of SLM declines rapidly up to an adoption rate of 10% (25,500 test annually) of the assumed market after which only minor decreases occur.

In the first instance, additional measurement would be cheapest for lot sizes greater than 20 bales. However, only around 26,000 lots greater than 20 bales were sold by sample in 1978/79. Therefore, in order to achieve a significant reduction in the cost of additional measurement there would need to be almost complete adoption by growers with these larger lot sizes. Such a rate of adoption seems unlikely in the short-term, since most growers are unaware of the sources and magnitude of potential gains due to additional measurement.

In the absence of commercial costs for SSM machinery, it was not possible to estimate costs for length and strength as a package of additional measurements. If the two additional measurements were introduced separately, costs would be approximatly double those presented in Section 4. A combined SLM/SSM test, based on a new technology not yet available, could afford some economies, particularly in sampling.

Costs associated with sampling are estimated to account for approximately 70% of the total costs of additional measurement. This mostly results from the high labour input and there is considerable scope for cost reductions in this area. The lower cost estimates above are in anticipation of such developments. Development of other technologies may subsequently reduce the cost of additional measurement, independently of the assumptions used in this analysis.

(2) Costs To Woolgrowers

The direct cost of additional measurement to woolgrowers, is dependent on the lot size tested. This is because charges for additional measurement are likely to be of the same form as those for Sale by Sample, whereby charges per lot are similar and, therefore, inversely related to lot size on a per kg. basis. After a five-year introductory phase, for an average 10 bale lot, the cost of SLM is projected to be in the range 0.9 to 1.5 c/kg. greasy. The actual level of cost would depend on adoption rates and the extent to which productivity improvements enabled charges to be reduced.

In the long-term, increased direct testing costs to growers in the form of testing charges could be offset to an unknown extent by price effects. Such effects could result from benefits arising from testing for processors and due to cost savings, which could partly be redistributed to woolgrowers in the form of a difference in price (ceteris paribus) between additionally measured and other wool.

(3) The Economic Implications of Additional Measurement

The commercial availability of staple length, strength and colour is potentially of direct benefit to woolgrowers and processors. The principal implication for woolgrowers is that there could be scope for further revision of existing objective clip preparation (OCP) guidelines in the long-run. Additional measurement could make it feasible to reduce the amount of wool placed in short (AM) lines and tender (TDR) lines, with reduced classer and shed hand labour costs for growers who adopted these practices. Potential cost savings from changes to clip preparation procedures cannot be considered in isolation from the price effects of amalgamated lines. Further analysis on this aspect would be necessary before net revenue effects could be determined.

Processors could achieve improved prediction of top characteristics from additional raw wool measurements. However, presently there is no information available on the commercial value of the additional measurements. Research to identify the revenue and price effects for processors of SLM and SSM would therefore be of value. Subsequently, the current and future demand for additional measurement could be assessed.

Other benefits argued to result from additional measurement include:

- price premiums in comparison to wool sold SXS,
- more elastic supply response with respect to particular wool characteristics,
- fewer claims for mis-specification,
- reductions in the costs of buying wool, and
- innovations in in-store handling procedures.

At this stage no substantive information is available on these possible effects of additional measurement. It is argued that the benefits to be derived from these factors are either insignificant or indeterminate at present. Further analysis of some of these factors could be undertaken once additional measurement was adopted.

(4) <u>The Economic Implications of SXD</u>

A major implication of introducing SXD is that it may indirectly encourage the innovation and development of a number of parallel technologies. These include trends towards centralised selling, improved in-store handling procedures, transport rationalisation and possibly computerised auctions. Principal direct effects could be reduction in costs of performing buying and selling functions. Buyers costs could be reduced by saving of staff time in inspection and, in the long-term, reduced staff. Saving in selling (broking) costs could result from the elimination of the need to display grab samples. Trade confidence in measurement, which would be implicit in the development of SXD, should obviate the need for grab samples to be inspected by buyers.

A widespread view is that SXD would be logically preceded by the commercial availability of a number of additional measurements still to be developed. These include fibre diameter variability, resistance to compression, cottedness and coloured fibre content. The additional cost of these measurements cannot be estimated at this stage.

An alternate view is that SXD could be implemented with subsequent increases in the number of parameters objectively measured. This could occur through changes to the typing system which enabled agreement between the AWC, brokers and buyers on the use of appraised types. Such an alternative has not been considered in this paper, although it would have important implications for the long term balance between subjective appraisal and objective measurement in the transfer of ownership of Australian wool as well as production and processing.

For SXD there maybe potential for economies in clip preparation and raw wool specification in addition to savings from additional measurement. However, this potential is limited since it is anticipated that most of the benefits in this area will have already been achieved by SXS and additional measurement.

(5) Conclusions

Cost estimates indicate that the cost of pre-sale SLM and SSM will be relatively low in the long-term. However, the immediate cost of additional measurement seems high.

If pre-sale additional measurement is to be implemented several strategies could be considered. The first strategy is to reduce the cost of additional measurement directly through development of new technology. This would require further technical research particularly in the area of sampling techniques for SLM and SSM. Secondly, it is important to determine the level of cost savings growers could be expected to achieve in the long-term with modified OCP guidelines. Research should be undertaken to identify per kg. cost savings in shed labour, the role of parallel innovations and the importance of the level of adoption through time.

Third, the revenue, price and production efficiency aspects of additional measurement for processors should be assessed. The results of this research could subsequently be used in extension and promotion programmes for woolgrowers, processors and the trade in order to stimulate demand for additional measurement if it is judged desirable to proceed.

1. INTRODUCTION

One of the marketing dilemmas presently facing the wool industry is to determine how far and how quickly it should proceed towards a system of Sale by Description (SXD). Full implementation of SXD requires the objective measurement and/or appraisal of wool characteristics such that buyers would no longer need to visually appraise a sample. Additional measurements to those currently available under Sale by Sample (SXS) are seen as one way of progressing toward SXD.

In addition to the main wool characteristics described in the existing SXS package, it is now technically feasible to objectively measure staple length, colour, staple tensile strength and diameter variability and it should eventually become feasible to measure compressibility and coloured fibre content. If any or all these measurements were adopted commercially, this would represent one form of additional measurement. There are, however, differing views within industry and the Corporation concerning possible developments, and the scope for, and timing of, additional measurement becoming a commercial reality.

Possible policy options include introducing only limited additional pre-sale testing of wool, additional post sale measurement and entering AWC/broker agreed types in catalogues. Adoption of SXD would necessitate measurement of sufficient wool characteristics that buyers could confidently purchase wool without sample inspection. The Advisory Committee on Objective Measurement (ACOM) is to prepare an industry report and make recommendations on all aspects of SXD, together with a longer term implementation plan for additional measurement if it is commercially feasible.

The purpose of this paper is to provide information on the economic implications arising from the policy option of the commercial introduction of pre-sale additional measurement. In general terms, the intent is to provide a broad industry perspective on proposed reforms, identifying and where possible evaluating, the economic impacts of additional measurement.

2. BACKGROUND

There has been an increased acceptance of objective measurement of the major wool characteristics since the introduction of SXS and associated Objective Clip Preparation (OCP) in 1972/73. In 1979/80, around 93% of bales auctioned were SXS compared with only 4% in 1972/73. Encouraged by the generally high level of adoption of SXS and objective measurement, the Corporation in July 1978, requested a Specialist Working Group to report on the development of SXD and to recommend further initiatives on various aspects of SXD. The primary function of the Specialist Working Group was to consider the technical aspects of research and advise on an implementation programme.

The Specialist Working Group Report (1978) discusses the main technical factors associated with the development of new measurement techniques and also considers some broader industry impacts. One conclusion was that the provision of additional information is regarded as being a "vital factor in maintaining the current status of wool as a textile raw material". As a first step towards additional measurement, it was recommended that a pilot trial be established to examine the technical feasibility of the logistics and procedures of additional measurement.

This trial involves a series of sales, each with lots carrying the additional specifications. Staple length and colour were measured initially with a standardized appraisal of staple strength and position of the break. Whilst initially only measurements of staple length and colour were available to buyers, it is planned to progressively incorporate measurements on staple strength, and possibly fibre diameter variability, staple length variability and resistance to compression as the trial proceeds.

Principle concern at this stage is with length, strength and colour measurements. In this paper an investment appraisal of staple length measurement is presented to demonstrate likely costs for that measurement and as a basis for consideration of the general magnitude of costs for additional measurement.

There has been some debate about the technical merits of measuring staple length or fibre length, and techniques for both have been the subject of research. Grignet (1979) suggests several areas where a <u>fibre length</u> measurement could generate economic benefits for processors. The main areas of potential benefits include greater quality control in combing and yarn production and improved processing performance through greater predictability of top results from knowledge of raw material attributes.

The fibre length system developed by Grignet involves the determination of a length distribution based on the performance of a sub-sample under standardised processing conditions. The system may eventually be able to predict noilage and card waste for most wool types. However, it has several technical problems related to the precision tolerances and, as yet, measurements used to predict fibre length in the top cannot be made at the raw wool stage. Currently the system is also relatively expensive although research being undertaken by C.S.I.R.O. may subsequently reduce the cost.

Average staple length can be measured to a precision of ±5mm (confidence intervals) using the C.S.I.R.O. length measuring equipment. This technique is applicable to most wool types but requires a large number of staples to be drawn from each lot in order to achieve accuracy standards.

This is principally due to the wide variation in staple length that exists within single sale lots. The system has the advantage that measurements are based on raw wool samples, giving buyers information which will improve predictions of fibre length in the top prior to bidding at auction.

Research by Downes (1975) and Andrews and Rottenbury (1975) has shown that some account must be taken of staple strength and position of the break to accuratly predict processed length. Recent research by Rottenbury and Smith (1979) has also identified a marked similarity in the shape of the length distribution between tender lines, which suggests that such clips could have similar processing characteristics. Research testing devices have been used for staple strength measurement at present, and a commercial prototype is now being tested.

Testing machinery exists which could specify a clean colour test in a raw wool specification system for processors. The main purpose of such a test would be to predict the scoured colour of a sale lot from its greasy appearance. This test requires no additional sampling, as it can be incorporated as a by-product of the existing fibre diameter test in the SXS system. Although the colour test has been available for some time there is no test standard; it has not been promoted and the demand to date has been low.

Whilst the measurement of staple length, strength and colour appears technically feasible, the question arises as to the most appropriate sequence and timing of commercial introduction. Differing views within the Corporation, ACOM, AWTA and the industry generally range from the early introduction of an individual additional measurements which may be technically more advanced eg. SLM, through to the simultaneous availability of length, strength and colour. Other proposals call for the early introduction of SSM since buyers are already familiar with the appraised measures and, therefore, the objective measure could quickly be accepted by the trade.

Intuitively, the interdependent nature of length and strength measurement would necessitate a joint approach in commercial terms. However, in the absence of any commercial cost data for SSM equipment, joint cost estimates cannot be made. Thus, costing analysis was restricted to SLM in this report. The costs of SLM are expected to provide a guide to the costs of SSM. The cost of colour measurement (CM) was not calculated in this paper since it is relatively cheap and cost is unlikely to be a significant factor preventing commercial adoption.

Cost is only one factor in determining the commercial effects of the introduction of additional measurement. Additional measurement will have economic impacts on all sectors of the industry. An attempt was made to assess these impacts together with their sources and relative magnitudes in order to achieve a broader industry perspective on proposed reforms based on current knowledge.

In Section 3, the objectives are specified and a technique for analysing the costs of SLM is outlined. The assumptions and data used in this section of the report are presented in the Appendix . Section 4 contains the results of the costing analysis for length measurement, including sensitivity to alternate assumptions and a discussion of costs and their impact. The economic implications of additional measurement and SXD are reviewed in Section 5.

3. OBJECTIVES AND METHODOLOGY

The principal objective of this paper is to assess the economic implications of commercial opportunities for change in the area of additional measurement. Part of this was an investment appraisal approach to costing SLM as an example of the likely cost impact for woolgrowers of additional measurement. Specific objectives related to this approach are as follows:

(1) Identification of Cost Parameters for Staple Length Measurement. Presently, there is a little information on the costs of additional measurement. Estimates by the Specialist Working Group (1978), were point estimates based on the very limited information available at that time. Cost estimates for the SAM trial are not based on commercial assumptions . Whilst the SAM trial may indicate the magnitude of some costs, it is primarily designed to resolve technical problems associated with implementing additional measurements.

(2) Discuss and Review the Economic Implications of Additional Measurement. Additional measurement packages (eg. length and strength testing), will have economic impacts on woolgrowers, buyers, brokers, processors and service industry sectors to the industry, such as the Corporation and the AWTA. Commercial demand for additional measurement is unknown at this stage, but an attempt is made to identify the sources and magnitude of economic effects for the various industry groups. The intent is to provide a basis for determining the direction of further research which would resolve areas of conflict.

(3) To Provide an Industry Perspective on Proposed Reforms and their Implications for Progress Towards SXD. It is recognised that some of the potential benefits of additional measurement may not accrue until the complete separation of selling and handling procedures is achieved under SXD and Sale by Separation. Thus the paper summarizes possible longer term catalytic impacts of additional measurement and SXD, in relation to the likely technical and commercial environment.

Additional measurement is seen as an innovation which would change the information state of market participants, both buyers and sellers. This change in information would be one of reducing the relative importance of subjectively appraised attributes and increasing the amount of objective data on individual lots of wool. At the margin additional objective information would become available to buyers in purchasing wool and to woolgrowers in planning wool production enterprises, preparing wool for sale etc. In the long term the improved quality of information should improve the efficiency of the price mechanism as a guide to the activities of buyers and sellers.

The current SXS package provides buyers with objective measurements of yield, vegetable matter content and average fibre diameter. This technical information is readily understood by buyers, processors and woolgrowers. Although there is no published statistical evidence, it is also generally agreed that there are price premiums for SXS wools, or alternatively, discounts on traditionally offered wools.

Since 1972/73, the fee charged for pre-sale testing has deceased by 8.5%. In 1980/81, the AWTA increased testing charges by around 5% however, the new charges are below the 1972/3 level. This primarily reflects improved technology through time and the economies of size associated with larger throughput of tested lots. Adoption rates for SXS of greater than 94% in the 1979/80 season, provide evidence that there is a continued supply of wool for testing by growers and brokers.

For additional measurement, the situation is quite different. A number of technical problems are still to be resolved, there is limited understanding in the trade about interpretation of the information, reliable cost estimates are not available, and the long term impact on woolgrowers and others is unknown. Although there are many unquantifiable factors associated with additional measurement, this does not necessarily mean that commercial introduction should be delayed. From an economic viewpoint, the problem is one of determining the economic impact of adding alternative additional measurement packages to the existing SXS system. Part of this impact will be an immediate additional cost, but it is also important to identify longer term beneficial effects arising from such changes.

In this report different approaches were adopted to achieve the individual objectives. Cost estimates for SLM were made using an investment appraisal approach. Whilst only the cost of SLM was calculated, this does not reflect a view of the order of commercial introduction of additional measurement(s).

Rather, it is an example to illustrate sort of approach which should be taken in assessing the costs of any additional measurement which is offered commercially. When information becomes available on the remaining measurements updated cost analyses could be carried out.

Many of the economic impacts of additional measurement and SXD are difficult to quantify. The impact of improved wool specification for processors for instance, may cause a positive shift in the demand for wool. However, it would be difficult to determine how much of the demand shift was attributable to additional measurement, compared to the influence of relative fibre prices, economic conditions, fashion trends etc. Other possible impacts are more quantifiable, eg. cost savings associated with buyers attending fewer selling centres could be estimated under a SXD system of wool marketing. Thus, the focus of attention is to formalise the relationship between implementation of commercially feasible options and their economic impacts. Such an approach should also be of assistance in determining future research priorities.

4. INVESTMENT APPRAISAL OF STAPLE LENGTH MEASUREMENT

4.1 General Approach

The approach taken in this analysis was to calculate the actual costs of SLM on the basis of a range of assumptions about adoption rates, investment strategies and productivity. Sensitivity tests of these assumptions were also conducted. While actual costs for SXS were available, problems arise when attempting to derive actual costs for SLM based on a technical experiment such as the SAM trial. It was, therefore, considered more appropriate to use budgeted costs and appraise the additional investment that would be necessary for the commercial implementation of SLM. Experience with SXS provides many useful guides in the analysis.

The initial fixed costs of machinery and other capital investments were incorporated in the budgets using the most recent commercial estimates. These included estimates of capital costs, interest charges, depreciation, maintenance and a capital regeneration or 'profit' component,[1] to service further

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[1] This is simply an allowance for a commercial return to capital investments and in this study a rate of 12.5% was assumed. It should be noted, however, that this amount is equivalent to only approximately 1.5% of the total cost of additional measurement.

investment. Other fixed costs such as alterations to laboratory design and retraining of staff were also included in the budgets. In addition to the fixed costs, variable or operating costs were calculated separately and included estimates of sampling, testing and administration components. By adding the fixed and variable cost components of the budget the total cost was obtained. Details of the budget calculations and the assumptions used are outlined in the Appendix.

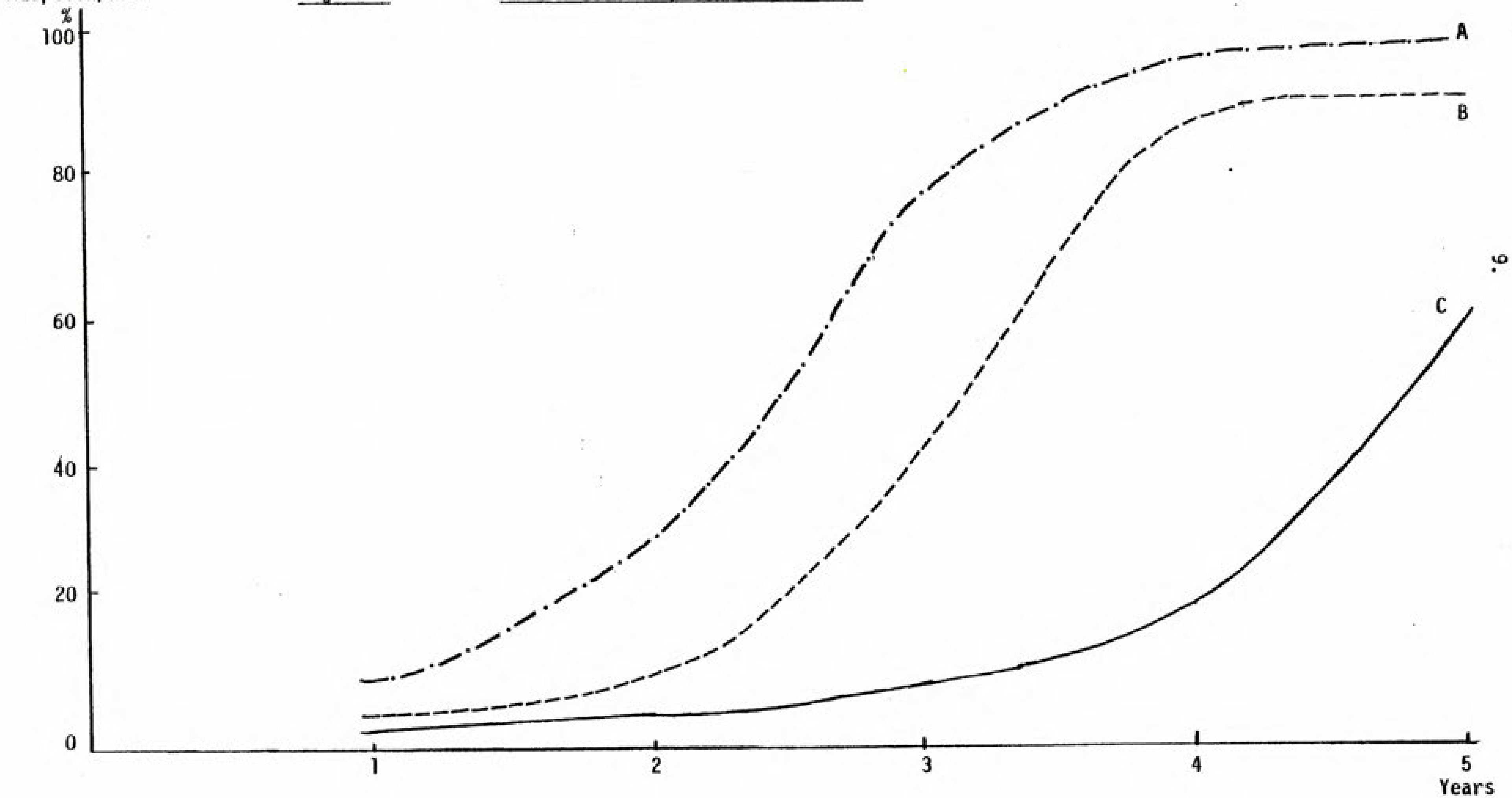
4.2 Adoption Rates

The average or per unit cost of SLM was obtained by dividing the total cost by specified adoption rates i.e. the annual number of tests performed. In the short-term, adoption rates may be low, due to unfamiliarity with the additional measurement, high costs and/or low levels of demand. Previous research on explaining the reasons for adoption levels of SXS (Findlay, 1979) showed that variables which influence profitability, such as average lot size, were significant. Additional variables of importance were sources of information, contact with other growers and the influence woolbrokers have on their clients' marketing decisions.

Since initial adoption levels and the rate of adoption through time are unknown for SLM, likely scenarios were based on cumulative density functions. This technique was first developed by Griliches (1957) in determining the diffusion process of adoption by farmers of a new hybrid corn variety. Subsequently the technique has gained wide acceptance in empirical studies of the diffusion of agricultural and industrial innovations. The basic assumption is that, for any new innovation, there are three phases of adoption. In the first phase, 'innovative' firms are likely to adopt a new technology. As more firms use and become familiar with an innovation, the cost may be reduced and consequently, demand for the service is likely to increase relatively quickly. The final adoption phase involves gradual adoption by other firms, ("laggards"), which are drawn to the innovation more slowly.

In the case of additional wool measurements, the cumulative density function of adoption would refer to lots of wool (by lot size, type category etc), for which measurements would be suitable, rather than solely to firms which might exploit the additional information. The number of lots measured is difficult to project and depends on a variety of factors including trends in average lot

Figure 1 Alternative Adoption Rate Curves



sizes, wool production, the level of pre-sale testing and trends in private buying. A total of 255,000 lots was assumed to be available annually for testing, excluding cardings and very small lots. Allowances were also made for seasonality of testing activity. A detailed discussion of the rationale behind these assumptions is contained in the Appendix.

Adoption rates through time were simulated for three growth patterns (Figue 1). These growth curves are not intended to be definitive, but rather to provide a basis for calculating the costs of SLM under a range of adoption scenarios. The adoption path B, refers to an adoption rate for SLM part of which would be approximately similar to that for SXS over the years 1972/73 to 1975/76[2]. Growth curve A indicates a more optimistic adoption rate, given the current and projected lot size distribution and potential total number of lots available for additional measurement. Finally, growth curve C represents a situation where the additional information provided by SLM follows a slower pattern of growth than was evident during the introductory phase of SXS. Regardless of the ultimate accuracy and choice of the adoption growth curves for SLM, the technique employed enables decision makers to see the implications of a range of possible outcomes.

4.3 Productivity Assumptions

Productivity improvement in sampling and testing can occur through improved use of existing technology and/or the development of new technology. For any additional measurement, both sources are likely to be important and were treated explicitly in all SLM cost calulations.

For any given adoption rate (A, B or C), two separate sampling and testing productivity levels were assumed. Details of these assumptions are reported in the Appendix. Productivity level I assumes current average commercial rates of output based on existing technology. Productivity level II is an assumed rate of increase due to the improved use of existing and new technology. Further increases may occur due to the development of new technology; for example, the development of a machine to mechanically draw samples could drastically alter current rates of input/output usage.

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[2] The exact adoption rate for SXS was not used because there seemed no need to impose a specific distribution when a wide range of alternatives is covered by alternative assumptions used.

for SLM. The objective was to conduct sensitivity tests of all variables considered likely to significantly affect the introduction of additional measurement. Thus, for each adoption growth rate curve and productivity level, differing investment strategies (options) listed below were appraised:

Option 1. The provision of sampling facilities in all thirteen wool selling centres around Australia. Staple length testing facilities would be located in Melbourne, Sydney and Fremantle and samples would be air freighted from other centres. All sampling is assumed to be carried out on the display sample for SXS.

Option 2. Sampling facilities at all centres but testing facilities in only one centre (two staple length machines). As with Option 1, samples would have to be air freighted from the various sampling centres around Australia to a central testing location.

Option 3. Concentrate sampling and testing facilities at selected centres where high demand is anticipated. This would involve two staple length testing machines in one centre and fewer sampling facilities than for Option 2 above. This option was included to gain an appreciation of the effect of sensitive components (sampling costs) on average costs in the initial stages of adoption. However, Section 63 of the Wool Industry Act states that the AWTA cannot 'without reasonable cause withhold its services from any section of the wool industry'. *Consequently, Option 3 may or may not be legally feasible,* depending on how the Act is interpreted by policy decision makers and whether exceptions could be made with ministerial approval.

Option 4. This option allows for the assumptions of Option 3 above but incorporates differing capital cost estimates. The usual 'commercial' allowances for interest, capital regeneration and depreciation were excluded in order to provide basic cost estimates. These estimates may be useful should a decision be taken to subsidize costs of additional measurement in the initial phases of adoption. In addition, sampling facilities were progressively reduced under Option 4 from three to only one centre, in order to determine the impact this would have on costs during th initial adoption phase.

incorporating two productivity levels, for each of three adoption growth rate curves and the four investment options above, provided a total of 24 alternative cost-per-test patterns over the projected five year introductory period for SLM. The costs of SLM were calculated for these 24 scenarios.

4.5 Results

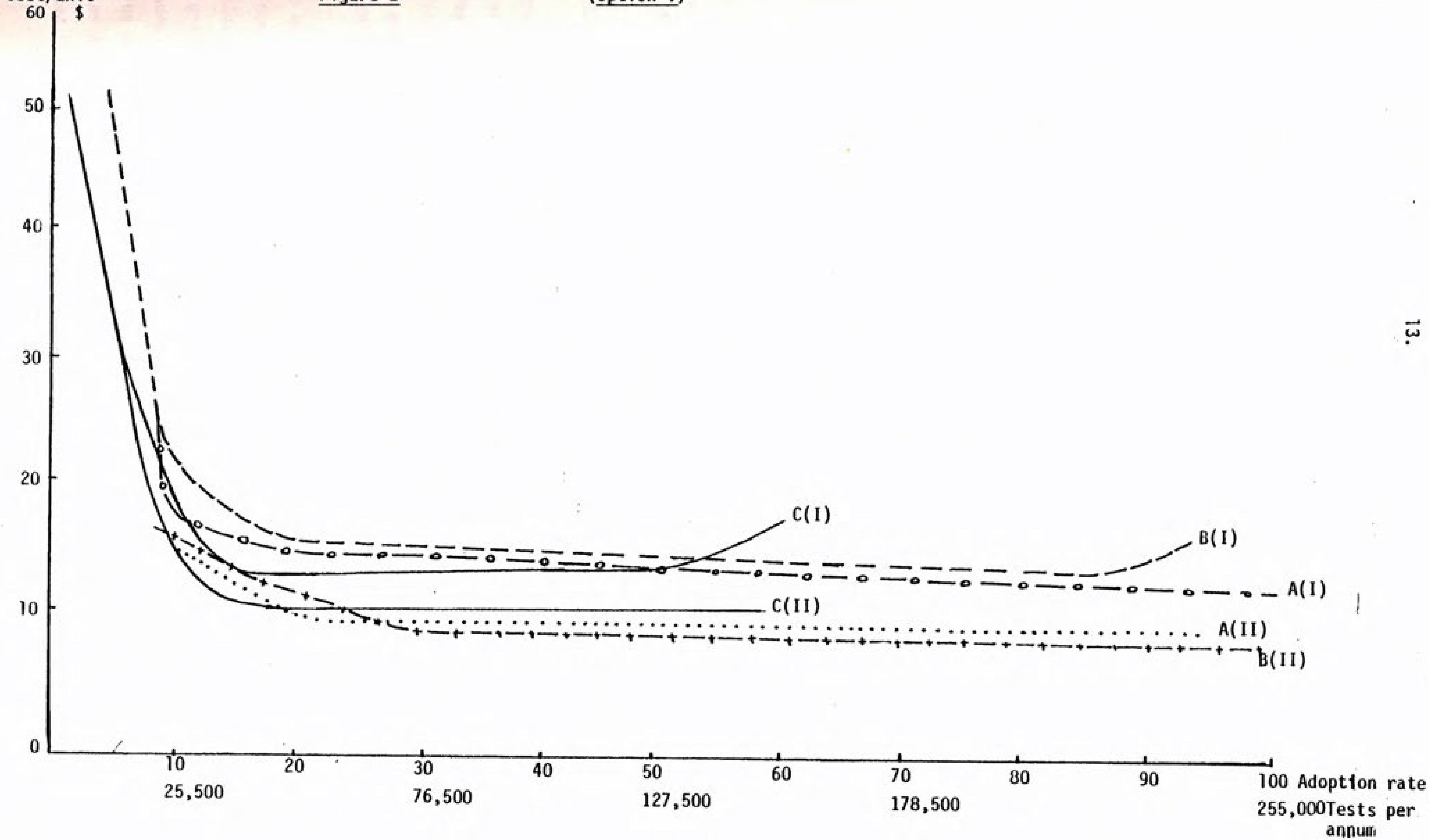
The main results are presented in graphs showing the average cost per test as a function of the annual number of tests performed at various productivity levels (Figures 2 to 5). The cost curves were smoothed to rule out the effects of discrete machinery purchases. As the curves are only general indicators and attention is devoted to broad comparisons, this has no significant effect on the results. In this section, the main results for each individual option are identified and estimated costs are discussed.

Option 1

In this option sampling facilities would be available at all 13 wool selling centres together with 6 staple length testing machines, two in each of Sydney, Melbourne and Fremantle.This would involve one active and one backup machine in each testing laboratory. This strategy requires greater initial investment than any other option. The unit cost curves for Option 1 and the three adoption paths (A,B and C) and two productivity levels (I and II) are shown in Figure 2. Capital costs account for 50%, 74% and 62% of total costs in year 1 for adoption paths A, B and C respectively. The employment and associated equipment costs for 13 sampling staff constitute around 74% of the total variable costs in year 1. Initial expenditure of this magnitude would enable the adoption rate to increase to 10% or 25,500 tests p.a., before any additional capital investment is required.

Regardless of the level of productivity assumed, the cost per lot would not be less than $20 unless an adoption rate of 8.5% or 21,675 tests per annum was achieved in the first year the service is offered. However, the substantial capital investment in year 1 would reduce the fixed cost per unit component of total costs in subsequent years. For all adoption paths in year 3 staple length testing costs per lot would be less than $19. Further, given productivity II assumptions,average costs would fall to $9.69 and $10.32 in year 3 for adoption growth rate curves A and B respectively.

Figure 2 (Option 1)



Option 2

The purpose of including this option was to assess the impact of purchasing only 2 staple length machines in year 1 (Figure 3). The strategy is analogous to Option 1; with less than 25,500 tests conducted in year 1, two staple length machines would be adequate to test all samples in growth curves B and C. Costs curves for adoption rate A are included in Figure 3 even though six staple length machines would need to be purchased from the outset at adoption rate A. For adoption curves B and C the capital costs in year 1 are significantly reduced and account for 34% and 17% of total cost respectively. In subsequent years, fixed costs account for a slightly greater proportion of total costs compared with Option 1, because the additional machines and ancilliary services are purchased at higher prices.

Variable costs are similar to Option 1, however, additional freight is required to move samples to a central location. Further, there are administration costs incurred in ensuring that length test results are collated with SXS results. This means that, although there is less capital investment in year 1 for Option 2 than for Option 1, the average total cost per test during the initial phases of adoption is similar over the 1% to 5% adoption range. The minimum cost per test at 5% (12,750 tests p.a.)is likely to be around $25,which is higher than the total current SXS package.

Option 3

The analysis of this option (Figure 4) was designed to determine the minimum cost of SLM during the introductory phase (1-10% adoption). The intent in this strategy would be to stimulate demand for the SLM by selecting three centres for sampling and only providing testing facilities in one central location. Thus, total expenditure consists of providing only 2 staple length testing machines and limited sampling facilities.

It is evident that there is no change to the results obtained for adoption rate A, since a minimum of 25,500 tests would be performed in year 1. However, if adoption rate B occurred, the average cost per test would be around $13, which is significantly less than the previous scenarios. This calculation is, however, dependent on the assumption that there is no different costs associated with drawing a sample from 3 selected regions as opposed to the same number of samples Australia wide. For adoption path C, the average cost per test is reduced but remains at around $65.

Figure 3 (Option 2)

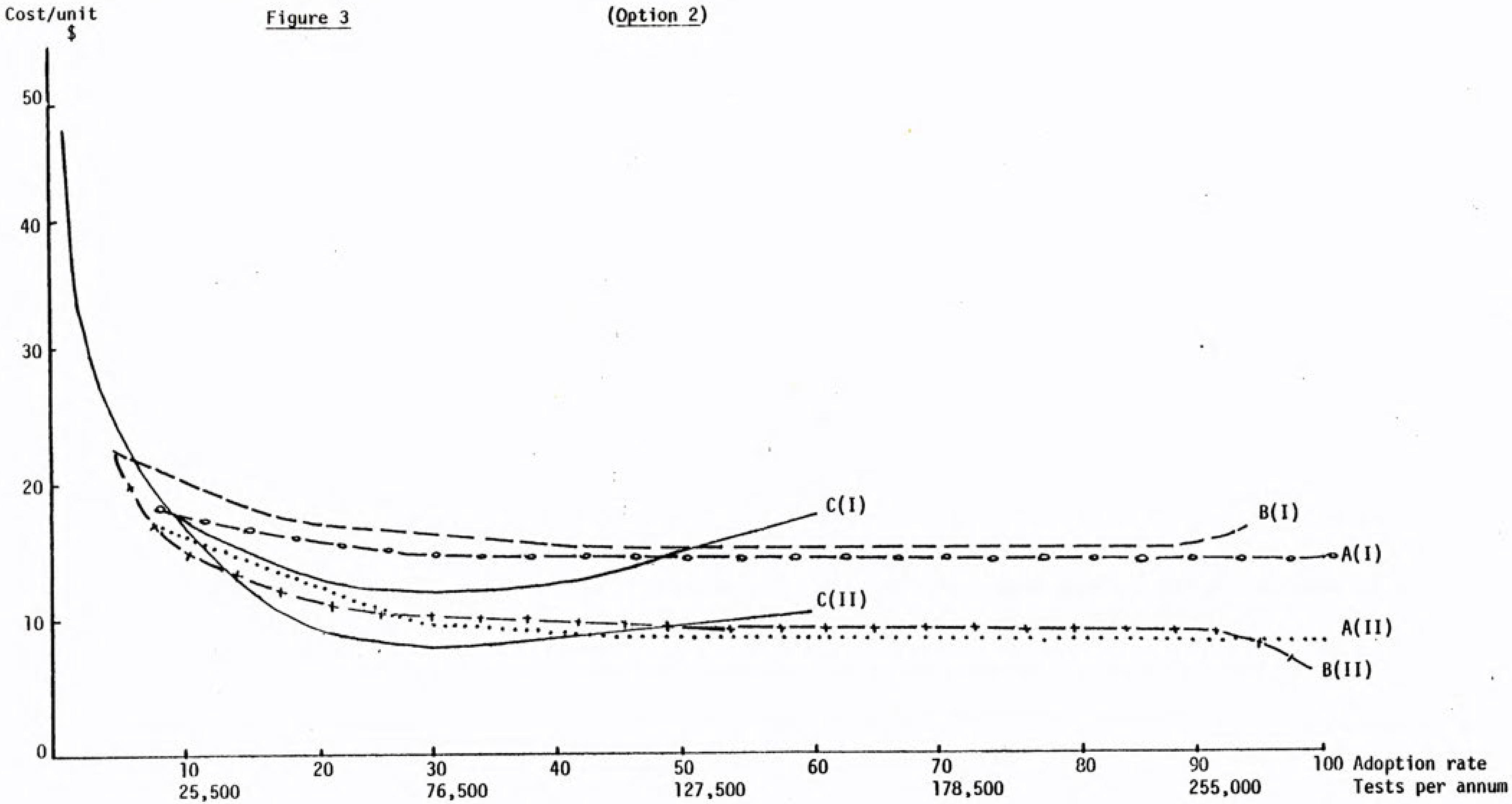
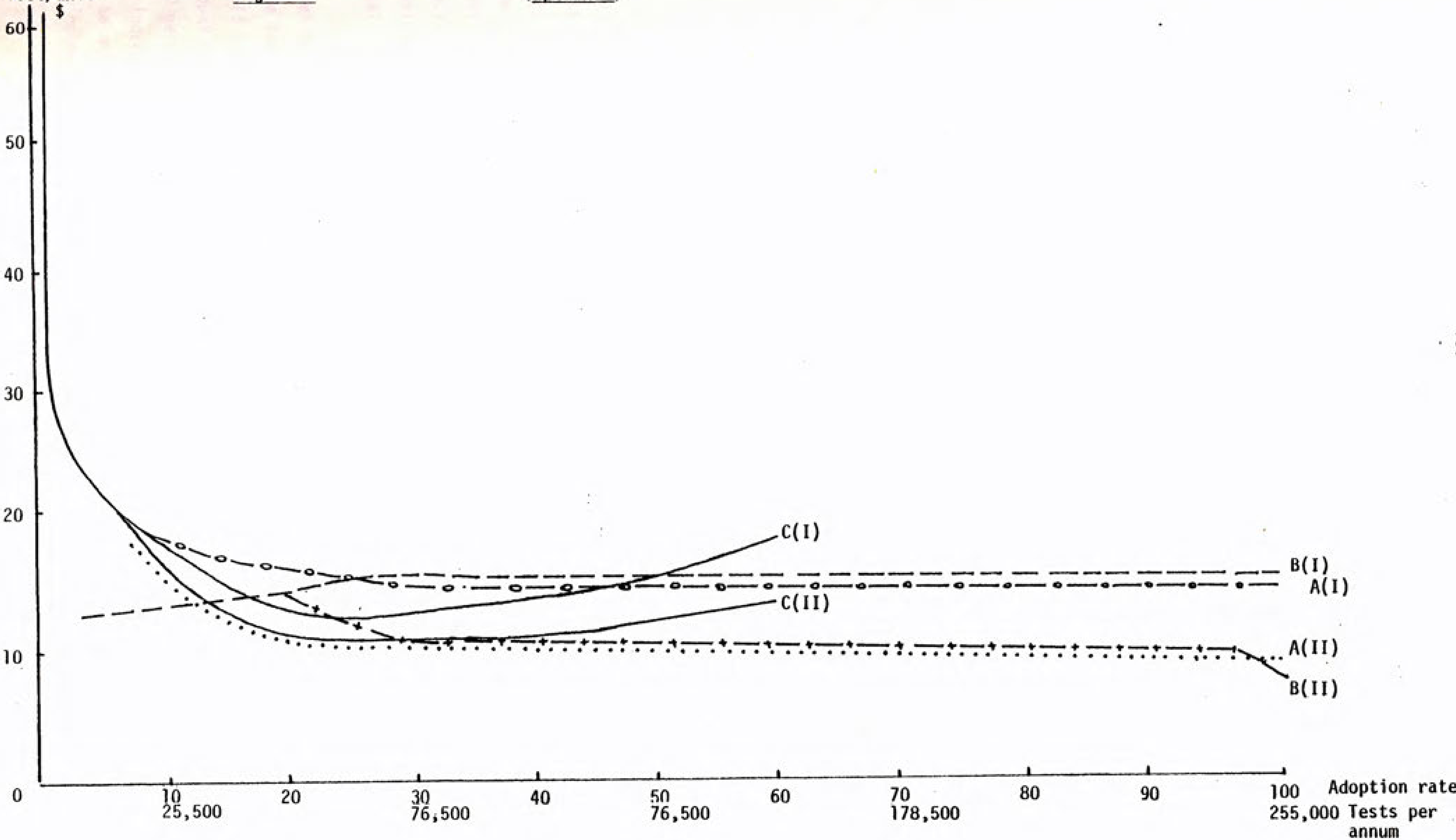


Figure 4 (Option 3)



Option 4

The previous option was further tested by assuming sampling facilities for only one,two or three centres. In addition, the 'profit' or capital regeneration component and interest charges were excluded from capital cost calculations. The purpose of including this option was to estimate the minimum cost per test possible for very low adoption rates (1-5%), see Figure 5. Productivity rates and adoption growth assumptions are not relevant to this option.

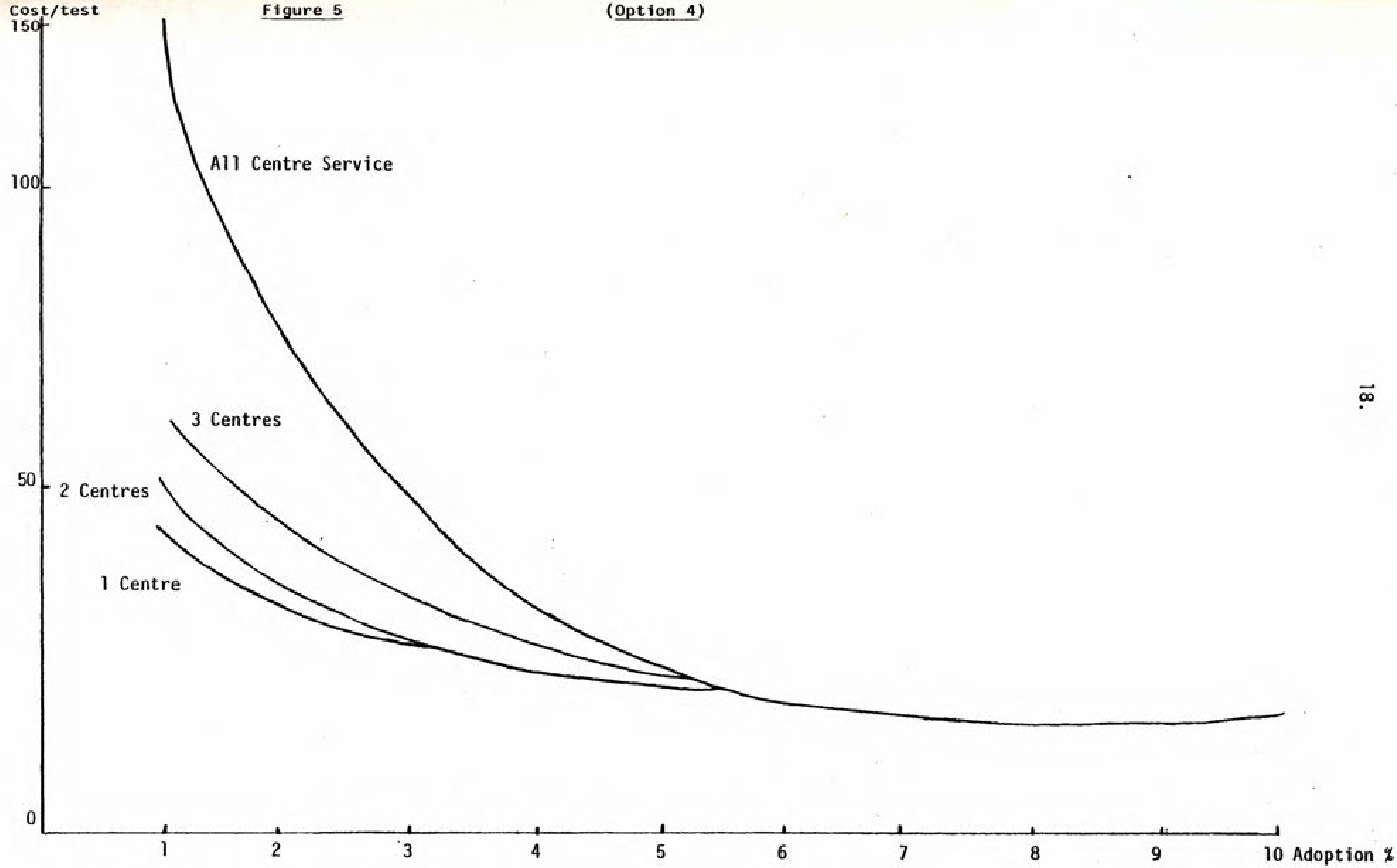
The results further emphasise that the SLM cannot be provided cheaply at very low adoption rates. An implementation strategy of one sampling centre and 2 staple length test machines would operate at a minimum average cost per test of $48. In this system, the variable costs are reduced by 75% compared with Option 1 and represent only 54% of total costs at 1% (2,550 tests p.a.) adoption rate. This decrease is due principally to savings in sampling costs; however, testing costs, provision of materials and supplies and supervision and administration remain constant on a per lot basis. Capital costs are reduced slightly by the exclusion of commercial 'profit' and interest, but fixed costs still account for around 46% of total costs.

4.6 Costs of Staple Length Measurement

For all the options considered, the level of adoption is the critical factor when calculating average costs per test for SLM during the introductory period. At low levels of testing ie. less than 5% adoption, fixed costs such as machinery investment, changing laboratory design and depreciation, account for more than 50% of total costs. In addition, most variable costs cannot be significantly reduced since certain minimum sampling and administrative functions must still be performed. Thus, a commercially oriented staple length testing service would have a relatively high cost at the low adoption rates likely during the introductory period.

Given an annual throughput of 1% (2,550 tests) the cost of SLM would range from $48 to $129 per test depending on the implementation strategy. This cost would fall, to $20 to $45 per test at an adoption rate of 5% (12,250 tests). At around 10% adoption (25,500 tests) the cost per test falls to approximately $20 per test and thereafter gradually declines providing the rate of adoption is increased through time. Thus, a principal conclusion is that SLM would have to be adopted at a significant rate, say close to 10%, before the likely costs are commercially attractive.

Figure 5 (**Option 4**)



If complete or close to complete adoption is achieved within five years, the average cost per unit of staple length testing is likely to be in the range $8 to $15. The specific cost within this range would depend on the rate of productivity improvement through time. At higher rates of throughput, productivity is the critical factor in reducing average cost levels. During the initial phase of adoption, productivity is relatively unimportant and the gap between the average cost estimates, as a result of varying productivity assumptions, approaches zero for less than 12,250 tests annually. Thus, if an additional measurement becomes established it is important that significant productivity gains are made in order to achieve economies and hence promote further demand for the service.

The costs associated with sampling for SLM account for around 90% of variable costs.[1] Most of the expenditure in this area is absorbed by labour and, while these costs are high at present, considerable scope could occur for reducing the labour component through productivity improvement. Innovations such as the mechanical drawing of random staples could significantly reduce both operator fatigue and the cost of sampling, thereby improving productivity. This may also enable sampling to occur on the SXS line, depending on the level of capital costs and the impact this would have on sampling efficiency.

4.7 Possible Developments and Their Impact on Costs

(i) New Technology

Given existing technology, the costs of SSM would be simlar in magintude to those of SLM, if the two measurements were regarded as separate. The capital cost of SSM testing equipment is unknown at this stage, but is likely to be similar to that for SLM. Sampling costs for SLM account for around 70% of the total costs and, since the sampling procedures are the same for SSM, sampling costs would be similar to SLM sampling costs.

Some economies could result from the combined introduction of the two measures as a package. Machinery which could combine measuring staple length with staple strength would result in greater efficiency in the use of sampling resources.

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[1] These calculations were based on wage rates applicable prior to the work value award of $8.00 per week on 29.10.79 and $2.75 per week on 31.3.80.

Such developments would further reduce the costs of joint SLM and SSM to the current estimates for SLM plus testing charges associated with SSM. However, is should be emphasised that this technology is <u>not</u> available at present and, therefore, has not been included in cost estimates.

(ii) Additional Measurement and the Number and Size of Lots

A critical factor which will influence the cost effectiveness of SLM is the trend in the number of lots, since the costs of providing measurement increase as the annual number of tests performed declines. One of the factors which has enabled the charges for SXS to be held constant since 1976/77, has been the overall increase in number of lots tested. This is pricipally due to changes in the lot size distribution with greater numbers of small lots currently being tested. The number of lots tested of less than 4 bales in 1978/79 was 63,577 or 21.9% of the total market, compared to 37,295 lots or 17.6% in 1976/7 (Table 1). Conversely, the number of larger lots tested (greater than 20 bales) has remained approximately the same and, in 1978/79, was 9.0% of the total market with 26,082 lots being tested.

Table 1 Lot Size Distribution for Wool Sold by Sample 1976/77 to 1978/79 (a)

Lot Size	1976/77		1977/78		1978/79	
(No. of bales)	No. of lots	% total tests	No. of lots	% total tests	No. of lots	% total tests
<4	37,295	17.6	50,410	20.2	63,577	21.9
5-10	93,403	44.1	120,354	48.2	137,280	47.3
11-20	n.a.)		55,612	22.3	63,508	21.8
21-50	n.a.)	38.3	22,910	9.1	25,778	8.8
> 51	n.a.)		624	0.2	304	0.2
Total lots tested	211,653	100.0	249,910	100.0	290,447	100.0

(a) Data obtained from AWC and AWTA statistical records 1976/77 to 1978/79.

It is assumed that the number of lots tested for additional measurement is similar to SxS. It should be noted that the section of the clip for which additional measurement would be cheapest initially, has always been a relatively small section of the lots tested under SxS. While there is scope for increasing the number of small lots tested, virtually all lots greater than 20 bales are already sold by sample. A situation could arise whereby there would be an insufficient number of larger lots to achieve operational economies in testing. Present indications are that it would require all growers selling their wool in greater than 20 bale lots to adopt before costs of additional measurement would decline significantly.

4.8 Impact on Woolgrowers

The preceding budget calculations have cost implications for woolgrowers marketing their wool with additional measurement(s). Individual growers could be expected to pay a different charge for SLM in cents per kg. greasy according to the size of the lot tested.

The cost to woolgrowers of SLM was calculated for varying lot sizes and adoption growth rate curves for Option 1, (Table 2). These data were obtained by multiplying the number of bales per lot by an average bale weight of 160 kg., to provide an average greasy weight for each lot. The average cost per test was then divided by this figure to obtain the cost in cents per kg. greasy.

During the initial stages of adoption, the cost of pre-sale staple length testing would be relatively cheap (on a per kg. basis) for larger lots compared with small lots. This is because charges for additional measurements are likely to be of the same form as SXS, whereby a standard charge is applied to lots tested regardless of their size (at least up to 39 bales). Such a pricing system is used because the costs of sampling do not increase in proportion to the number of bales per lot. There is also a standard charge for testing because the sample size for each individual lot is usually similar.

Thus SLM would be most attractive initially for wool sold in large lots. At an adoption rate of 10%, the cost of SLM would be 3.5c per kg. greasy for 10 bale lots. Lots of 10 bales or more represented 30.8% of tests performed during 1978-79, so there would be ample scope for achieving 10% adoption with lots of 10 bales or more. The cost would decline to around 0.7c pr kg. greasy for lots of 50 bales or more. Conversely, for 5 bale lots, which are a large proportion of the total offering, (see Table 1) the cost of SLM would be around 7c per kg. greasy (Table 2).

Table 2 — Cost in cents per kg. (greasy) of Staple Length Testing for Varying Lot Sizes (OPTION 1)[a]

Lot Size	Growth Curve	A					B					C				
	Year of Adoption	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Bales (kg)		cents per kg. (greasy)					cents per kg. (greasy)					cents per kg. (greasy)				
2 (320)		6.0	5.1	4.9	4.9	4.9	17.6	6.5	5.0	5.0	5.5	48.6	9.7	5.3	4.0	5.2
5 (800)		2.4	2.0	1.9	1.9	1.9	7.0	2.6	2.0	2.0	2.2	21.9	4.4	2.4	1.8	2.3
10 (1600)		1.9	1.6	1.5	1.5	1.5	3.5	1.3	1.0	1.0	0.9	11.0	2.2	1.2	0.9	1.1
20 (3200)		0.9	0.8	0.5	0.5	0.5	1.8	0.7	0.5	0.5	0.6	5.5	1.1	0.6	0.5	0.5
50 (8000)		0.2	0.2	0.2	0.2	0.2	0.7	0.3	0.2	0.2	0.2	2.2	0.4	0.2	0.2	0.2

(a) Assumes 160 kg. per bale and productivity level I.

When interpreting these results it should be remembered that, in the short term, costs are primarily sensitive to adoption rates. As noted earlier, if SLM and/or SSM are introduced commercially, efforts must be made to ensure that adoption rates are sufficient to enable the service to be supplied as cheaply as possible. On a more general level, extension and promotion to woolgrowers must be based on the expected commercial value of additional measurement. While some growers would adopt because they see long-term benefits, the vast majority would be attracted to adopt in anticipation of increased profitability in the short-term. An alternative is to delay introduction until further technical innovations and developments enable the commericial introduction of additional measurements at lower cost.

5. REVIEW OF THE ECONOMIC IMPLICATIONS OF ADDITIONAL MEASUREMENT

The purpose of this section of the paper is to present a broad outline of the anticipated economic effects of additional measurement and SXD. Many of these aspects are not quantifiable and may not be in the future. However, it is useful to summarize the economic effects, apart from costs, believed at this stage to be relevant to the innovations under consideration. The effects of additional measurement and SXD are discussed separately and each section contains a summary table which identifies expected economic impacts for major industry groups. While it is not possible to estimate the magnitude of many of these impacts, further research is recommended to clarify understanding of the issues.

An important point in the following discussion is that as soon as an additional measurement or package of measurements is introduced commercially, the costs of wool marketing will increase. However, beneficial effects arising from additional measurement may not acrue until some time in the future. Thus, the timing of the introduction of additional measurement must be related to the timing of the impact on particular industry sectors.

A further aspect is that there are a number of innovations and reforms which are influenced by, but are not directly dependent upon, the introduction of additional measurement. For example, industry benefits which may result from computerised auctions and changes in clip preparation associated with handling innovations, may be facilitated by, but not solely attributable to, additional measurement. In an attempt to avoid double counting, a distinction is made between the direct impacts of additional measurement and those which are indirect ie. interrelated with associated innovations. .

Finally, since woolgrowers will bear the costs and risks of additional measurement in part, consideration of the distribution of benefits is important if measurement packages are to be promoted from the woolgrowers' viewpoint.

5.1 Economic Implications of Additional Measurement

The commercial introduction of pre-sale additional measurement would make available alternative measurement strategies for woolgrowers. Staple length and colour measurements are available through the SAM trial, and it is anticipated that staple strength will also be available in the 1980/81 season. For the purposes of this discussion it is assumed that length, strength and colour would be measured. Further, given the interrelationship in processing of length and strength, it is likely that these measurements will be introduced together, despite their present differing stages of technical development.

Economic impacts are summarised for two alternative additional measurement packages which are (a) staple length and strength and (b) length, strength and colour. A summary of the expected economic effects of these two packages is presented in Table 3. Experience with SxS is a useful guide to the effects and we have noted whether effects seem likely to be small(S), medium(M), large(L) or indeterminate(I). As in the preceeding section on the costs of SLM, the magnitude of currently assessed economic impacts arising from sale by additional measurement will be influenced to a large extent by adoption rates.

(a) Woolgrowers

(i) Price Effects.

Presently it is not possible to determine the price effects of additional measurement prior to the its introduction. Moreover, there are no reliable statistical time series analyses of SXS which could be used for estimation purposes. However, it is generally agreed that, although SXS wools were discounted in the early stages of adoption, they now attract a premium compared to wools sold traditionally. Various unpublished studies have estimated a premium for SxS wool of around 10-15c/kg. When assessing the price effects of additional measures the following factors should be considered:

Table 3 Economic Impacts of Sale by Additional Measurement on the Wool Industry[(a)]

ADDITIONAL MEASUREMENT PACKAGE	Woolgrowers	Brokers	Buyers	Processors	AWTA
STAPLE LENGTH & STRENGTH					
(1) Direct Effects	. Possible price premiums (I)		. Reduced inspection costs (S)	. Improved raw wool specification (M)	. Increased demand for services (S)
	. Improved clip preparation practises (M)		. Fewer claims (S)		. Increased investment (S) . Need to engage in promotion (S)
(2) Indirect Effects	. Increased demand for all wool/types (I)	. Reduced warehousing costs (S)	. Reduced 'Averaging' of small lots (I)	. Substitution of wool for synthetics at the margain (S)	. Closer liaison with processors (S)
	. Promotion of OCP changes (I) . Reduced number of small lots (I) . Supply Response (I)				
STAPLE LENGTH, STRENGTH & COLOUR					
	. as above (S)	nil	. as above	. as above but marginal improvements in specification (S)	. as above (s)

(a) Current subjective assessments were made about the order of magnitude. The suggested notation is as follows: I = Indeterminate, S = Small, M = Medium, L = Large.

- Analyses by the AWC Economic Department suggest that up to 70% of the variation of auction prices is explained by the measurements in the current SxS package. While more accurate specifications could result in prices more closely reflecting the demand and supply for a particular type, there is significantly less potential for doing so than before the introduction of SxS. At the margin, additional measurement should increase the proportion of price variation explained by objective measures.

- There would be an initial learning period for the trade to become familiar with the new measurements. Buyers use subjective appraisal of staple length in wool valuing. However, they have little experience of how such appraisal on individual lots would relate to the objective measurement. Calibration of this relationship is a major link in promoting the value to processors of length measurement and defining its relationship with staple strength measurement. In the short-term, buyers are unlikely to pay a premium for wool sold with additional measurements, in comparison to wool sold by sample.

In summary, the absence of any price premiums and/or perceived discounts for new innovations frequently means that adoption is restricted. This could happen with additional measurement since the potential for a price premium is less than with SXS. It therefore seems essential that research undertaken to determine the impact of additional measurement on processors, with a view to assessing its value as to them as information. This would facilitate estimates being made of the price effects of additional measurement.

(ii) Objective Clip Preparation.

The introduction of a staple length and strength package may provide further scope for reducing the costs of clip preparation through revision of existing OCP guidelines. Recent research by the Research and Development (R & D) Department of the Corporation and the CSIRO Division of Textile Physics (Ryde) indicates that length and strength measurement could reduce the need to skirt or to place as much wool is short (AM) and tender (TDR) lines. This could result in reduced classer and shed labour costs for growers who adopted these practices. The actual level of savings realised by growers would vary depending on how shed operations were reorganised to take advantage of reductions in labour input.

Cost savings arising from changes to OCP guidelines would not accrue immediately since there could be initial broker and buyer resistance. Changes to existing procedures would have to be preceeded by extension and promotion services to woolgrowers and the trade.

Whan (1973) estimated that for SXS, there was a cost saving of about 1 c/kg greasy in clip preparation procedures. Savage (1978) claims a direct saving of 7 seconds in classing time for an individual clip at 1977/78 wage rates. Savings in classer times would be some 2c/kg. Further, assuming around 30% of the pressers time is involved in carrying fleece lines to the press, a saving of 0.6c/kg. could occur. Determination of the level of cost savings for additional measurement would require further research. Particular aspects to consider are per kg. savings in shed labour (including classers), the role of parallel innovations eg. new systems of wool harvesting and the level of adoption through time.

Potential cost savings from changes in clip preparation procedures which could ultimately flow from additional measurement cannot be considered in isolation from the net revenue effects. There seems no reason to assume that negative net revenue effects would occur since the lower price on amalgamated lines should yield a similar revenue to the weighted average of prices for lines sold separately. However, further analysis of this aspect would be necessary before changed clip preparation guidelines were formulated.

(iii) Impact on Lot Size.

In Section 4 it is shown that the cost of additional measurement decreases (in cents/kg. greasy) as lot size increases. However, there is no likelihood that growers would respond to this charge structure for additional measurement tests, until it was demonstrated that there was no evidence of price discounts for wool sold with additional measurement. To the extent clip preparation practices changed as a result of additional measurement, lot sizes could increase in the long-term.

Because of small lot sizes at auction, buyers have the opportunity to use the 'averaging' principle to reduce the risks of subjective appraisal of length and strength and other factors. Conversely, it is argued that, even with additional measurements buyers would still 'average' over small lots since lot size is dependent principally on the size of flocks. Approximately 53% of growers produce clips of less than 35 bales and of these there are a large proportion of lots less than 3 bales. Consequently, even with additional measurement, buyers would still 'average' lots in order to obtain a mill lot consistent with processors mill lot size requirements. In the short-term, additional measurement is assessed as having an insignificant effect on average lot size or lot size distributions.

(iv) Supply Response.

Theoretically, more objective information on length, strength, colour etc. would enable growers to respond more readily to market requirements for these characteristics. However, there are several factors which would limit the extent of such response:

- Woolgrowers have no information on the price effects of individual objective measurements within SXS eg. tenth of a micron. Analyses are not yet available for SXS and are not possible for other measurements until after commercial introduction.

- Even assuming information was available on the individual price effects of additional measurement, it would still be difficult for woolgrowers to respond. For example, it is not possible to alter supply patterns in response to market movements for say, tenths of a micron, position of the break etc., and would not be easy for other measurments.

- The objective information for length and strength is unlikely to be presented in a form woolgrowers can interpret. Measurement would ideally be a guide to predicted top length for processors. Growers may have difficulty relating this to breeding requirements. Moreover, even if it is possible to guidance test sires for any one characteristic, say length, interaction effects would be important.

(b) Brokers

There are few immiediate economic implications for brokers arising from additional measurement. In the short-term, sample boxes would still be required and therefore no reduction in warehousing charges could be expected. Similarly, since average lot sizes would not change, there is unlikely to be any significant reduction in handling costs.

(c) Buyers

(i) Reduced Inspection Costs.

Currently, about 30-40 appraisers examine individual lots for strength appraisal, colour etc. On average, inspection takes around 20 seconds per lot. With additional measurement fewer appraisers would be required, resulting in lower inspection costs. Present indications are that, by itself, this cost reduction would not significantly reduce the overall costs of buying wool.

(ii) Fewer Claims.

In general, more comprehensive specification would be expected to result in reduced claims from processors. Conversely, it could be argued that, with the introduction of additional measurements, there is increased scope for claims and potentially reduced opportunities for buyers to average over lots entering a mill consignment. There seems no basis at this stage for discriminating between these contradictary views. With SxS there is increased scope for use of information on mean micron down to tenths of a micron; however, the effect on claims is unknown. It should be recognised that more claims would not necessarily be of disadvantage to wool, since the ability to claim in isolated cases should improve the confidence of processors in using wool. In summary, it would be difficult to foreshadow trends in the rate of claims under additional measurement. Improved understanding in this area of wool marketing requires closer liaison with buyers and processors.

(d) Processors

(i) Improved Raw Wool Specification.

The commercial availability of additional measurement, provides processors with the opportunity of improving the accuracy of predicted top length based on raw wool characteristics. This could improve the confidence with which processors use wool as a raw material in the long term. Whilst there is considerable technical evidence to support this view, (eg. Rottenbury et. al., 1979) little is known about the commercial impact of additional measurement. In particular, there is no objective information on the demand for additional measurements and the extent to which processors are prepared to pay a price premium for that information.

The introduction of SXS measurements was aided significantly by the prior acceptance of post sale measurements by processors and knowledge of what was being measured. A similar approach could be adopted for additional measurement whereby in addition to technical liaison with processors, the price, cost and production efficiency effects of additional measurements are identified. It is anticipated that these costs and revenue effects can be analyzed and an assessment could be made of the current and future demand for measurment by processors.

(ii) Substitution of Wool for Synthetics.

Increased pricing efficiency in the wool market, through improving the quality of information available to processors, may mean substitution of wool for synthetics at the margin. Alternatively it could prevent wool's current market share from being eroded. This is a potential benefit for wool which may follow from (i) above.

In summary, the principal economic implications arising from additional measurement are the potential for further modification of existing OCP guidelines and more efficient use of raw wool by processors. It is anticipated that these changes would occur partly as a result of additional measurement being available but also due to related developments. Further research is necessary to determine the magnitude of economic effects attributable to additional measurement and the impact this would have on woolgrowers and processors. Subsequently, the information could be used in extension programmes designed to promote demand for additional measurement, if it seems desirable.

5.2 Economic Implications of Sale by Description (SXD)

As in the previous section, the sources of economic changes arising from SXD are identified. It is recognised that the evolutionary nature of additional measurement will require a number of intermediate stages between additonal measurement and SXD. For example, trading regulations would have to be redefined, technical measurement standards adopted, parallel innovations developed and socio/political problems asssociated with changes would have to be accommodated. However, for the purposes of this paper, it was assumed that SXD is a commercial reality which implies that buyers can confidently purchase wool solely on the basis of pre-sale information ie. without the need to visually

Table 4 Economic Impacts of Sale by Description on the Wool Industry[(a)]

SALE BY DESCRIPTION	Woolgrowers	Brokers	Buyers	Processors	AWTA
(1) Direct Effects	. Price premiums (or discounts for SXS wools) (S) . Possible reduction in brokerage charges and other marketing costs (S)	. Fewer selling centres. (S) . Reduced costs of grab sample display (S) . Salvage value of redundant centres. (S)	. Reduced staff (buyers) (S-M) . Fewer claims (S)	. Improved specification (S) . Greater production efficiency in to-making (S) . Reduced claims (S)	. As above but possible increases . Increased market share (L)
(2) Indirect Effects	. Increased demand for all wool (I) . Greater awareness of market requirements (n.s.) . Parellel innovations (M) - clip preparation - computerised auctions . Possible reduced price competition (I)	. Reduced staff (S) . Investment in (S) alternative technology . Transport rationalisation (S)	. Investment in capital eg. computers (n.s) . Possible reduced competition (I)	. Substitution of wool for synthetics at the (S) margin.	. Economies of size (S). . Innovations and productivity improvement (M)

(a) Current assessments were made about the order of magnitude. The suggested notation is as follows:
I = Indeterminate, S = Small, M = Medium, L = Large, m.s. = not significant.

appraise the sample. Table 4 provides a point assessment of the possible effects of SXD on the various industry sectors. The bracketed letters S, M, L and I indicate subjective views of whether the impacts concerned are views as "small", "moderate" "large" or "indeterminate."

(a) <u>Woolgrowers</u>

(i) Price Effects.

If SXD became established on the basis of pre-sale additional measurement, increased processing predictability of raw wool should result in prices more

closely reflecting the demand and supply for a particular type. However, this should not be interpreted as a willingness by processors to pay a premium for wool sold by description. Such effects are difficult to analyse and statistical analysis based on observed data would be necessary.

A further aspect for consideration is that, if SXD encouraged trends toward centralised selling, there may be scope for reduced price competition at auction. Fewer buying firms may be required as a result of economies of size in purchasing, thereby increasing the market share of the remaining firms. With fewer firms it is possible that these firms could influence the level of market prices through collusion. Conversely, it has been argued that centralised selling will result in increased competition since buyers will be bidding at only one centre and orders could be channelled into a more centralized market from around the world. The potential for structural change in competition within the market would seem to be greater with SXD, but its net effect on competition is unpredictable.

(ii) Other Implications.

Under SXD, there will be scope for the development of related innovations in the selling system. These include centralised selling, computerised auctions and possibly economies in store handling procedures. Such changes would result in greater operational efficiency in wool marketing. However, the extent to which woolgrowers directly benefit is dependent upon the proportion of cost savings passed back to them in the form of higher prices, lower brokerage charges etc. The net effects, given attendent structural changes in the market, are not identifiable at this stage. Close attention to such issues would be necessary at the market evolved toward SXD.

(b) Brokers

In the long-term SXD could result in cost savings to brokers and further economies of specializing in broking, the benefits of which may be passed back to growers. Such economies could arise from the elimination of the need to display grab samples. The direct cost savingwould be in the form of reduced labour requirements to set up sample displays and space savings could also occur (see below). With SXD and the associated additional measurements, buyers would have sufficient confidence in available measurements to purchase wool without inspecting grab samples.

To the extent that SXD is a stimulus to centralised selling, this could have some long-term implications for broking firms. If SXD and centralised selling encouraged decentralised storage in regional facilities, there could be marginally lower utilisation rates of centralized stores.

Finally, investment in alternative, in-store technology may be encouraged, accelerating costs saving innovations by brokers. There could potentially be benefits passed back to woolgrowers, although brokers must earn a return on investible funds sufficient to attract further investment in cost saving technology.

(c) Buyers

Provided buyers are confident of using the additional measurements, fewer staff would be employed under SXD. It is considered that the extent of staff reduction is dependent upon the additional information buyers would require apart from measurable characteristics. This information could include style, presence of tippiness, cots, stain and skin pieces. If buyers use their own appraisers to assess these characteristics, staff reductions would not be significant. An alternative is for skilled and impartial appraisers to provide the information along with other characteristics such as wool category, breed, sex and age of sheep. To the extent that buyers developed the confidence to purchase wool without inspection, the number of buyers could decline significantly. While this could reduce marketing costs, the distribution of benefits back to growers would be uncertain and remaining buyers would probably have increased bargaining power.

(d) Processors

The economic implications of SXD for processors are similar to those for the current assessment of additional measurement, in that there is technical potential for improved control of noil and fibre length in combing. The essential difference is that, under SXD, alternative measurement packages may include characteristics such as fibre diameter variability, resistance to compression, cottedness and coloured fibre content. An assessment of the commercial value to processors of these additional measurements would require a similar approach to that adopted in Section 4 above. However, the investment appraisal would have to be directed at the package of investments considered.

(e) Summary

In summary, there are likely to be significant indirect economic implications due to the evolution of SXD. These include trends towards centralised selling, improved in-store handling procedures, substitution of capital for labour in broking activities,some transport rationalisation and possibly computerised auctions.

It is difficult to assess the magnitude of the direct effects of SXD on woolgrowers and processors. This is because movement toward SXD would be preceeded by a period of commercial additional measurement. The commercial value of length, strength and colour to processors has not yet been demonstrated. Similarly, woolgrowers would need information on cost savings in wool preparation due to these additional measurements. However, it should be noted that the potential for direct gains in OCP and raw wool specification will be progressively reduced with the commercial introduction of increased measurement. Consequently, following SXS and additional measurement the direct effects of SXD for woolgrowers and processors will decline for further increases in numbers of characteristics objectively measured.

APPENDIX

An Investment Appraisal of Staple Length Testing Machinery

Currently, machinery is available to objectively measure staple length, strength and colour in addition to the existing SXS package. In this analysis only staple length sampling and testing was appraised. However, subsequent analyses on the remaining options could supplement the information in this report if and when they become commercially feasible.

The AWTA is the only testing organization likely to perform additional measurements since they can be incorporated in its present operations at low marginal cost. On the other hand, any competitors would be forced to set up entirely new sampling, testing and administrative facilities and accordingly incur higher fixed costs. Nevertheless, the assumptions detailed below and resultant data calculations, are designed to reflect realistic commercial conditions. Therefore, in order to ensure confidentiality, detailed cost data are not released in this report.

Following sections include an explanation of assumptions about lots suited to staple length measurement budget design, machinery productivity assumptions and fixed and variable cost assumptions.

(1) Total Market Size

Calculations in this report are based on the most likely maximum potential for SLM of 255,000 tests annually. This figure was obtained by assuming the maximum demand for SLM will be the same as for SXS less any unsuitable wool types. Currently, there are around 360,000 lots tested annually compared with about 250,000 tests in 1977/78. This increase in the number of lots tested is due primarily to an increase in the number of smaller lots tested. Further, it is conceivable that if three, two and even one bale lots become relatively cheaper to test, the potential number of lots for SXS and possibly additional measurement could increase through time. Another variable of importance is the total level of wool production, since this has an impact on the amount of wool offered at auction. Trends in private buying will also influence the level of auction offerings and hence the demand for pre-sale testing. Offsetting factors include the relative price differentials for interlotted wool vis-a-vis small lots and future changes in sampling requirements by the Standards Association.

Following discussions with a number of industry people it was decided to assume an average future market for SXS of 300,000 tests per annum. Carding wool types account for approximately 15 per cent of this amount and, as many of these types are, at present, less suited to additional measurement, a total market of 255,000 p.a. for SLM was assumed. However, it should be emphasised that this figure will not have a large impact on the conclusions of the analysis since a range of differing adoption rates and implementation options were simulated. The reader may alter total market size by specifying a different adoption rate at any point in time For example 10% of 255,000 tests is 25,500 tests per annum; if the total market size was 100,000 tests per annum, 25,500 tests would be equivalent to an adoption rate of 25.5%.

From an analytical viewpoint, the seasonal pattern of demand for additional measurements is of critical importance in deriving input/output relationships and costs for SLM. In any particular year, the number of tests performed per week is highly correlated with supplies of wool at auction. This has implications for the management of capital and labour requirements for sampling and testing facilities, since systems must be designed to reliably service the peak demand periods at minimum cost.

Individual AWTA laboratories have their own management plans to service testing demands during peak periods. In some cases this involves overtime, while in others, extra staff and/or resources are employed. The assumptions used in these budgets reflect the 'average' commercial means of employing capital and labour to cope with differing seasonal demands throughout the year. In general, there is a policy of investing in extra machinery (capital) as opposed to labour which, although this may mean some excess machinery capacity, is cheaper overall.

The seasonal distribution for the number of additional measurements performed for any given adoption rate was assumed to approximate the pattern for SXS tests. Average monthly SXS test distributions were obtained for 1977/78 and 1978/79, (Figure 6). The monthly average of the two seasons was converted to average percentages of total market size so that, for any given adoption rate (total number of tests performed each year as a percentage of 255,000), the number of tests that would be performed was calculated, (Table 5). It is evident that there is a distinct peak load demand in the September, October, November period and, consequently, the following assumptions and calculations reflect this pattern.

Table 5 — Test Distribution for Varying Adoption Rates of Staple Length Measurement [(a)]

Adoption Rate	1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Monthly Distribution												
July	70	350	699	1,398	2,097	2,796	3,459	4,194	4,893	5,592	6,291	6,990
August	202	1,010	2,020	4,040	6,060	8,080	10,100	12,120	14,140	16,160	18,180	20,200
September	367	1,836	3,672	7,344	11,016	14,688	18,360	22,032	25,704	29,376	33,048	36,720
October	343	1,712	3,425	6,850	10,275	13,700	17,125	20,550	23,975	27,400	30,820	34,250
November	335	1,672	3,345	6,690	10,035	13,380	16,725	20,070	23,415	26,760	30,105	33,450
December	251	1,257	2,514	5,028	7,542	10.056	12,570	15,084	17,598	20,112	22,626	24,140
January	154	769	1,538	3,076	4,614	6,152	7,690	9,228	10,766	12,304	13,842	14,380
February	228	1,138	2,275	4,550	6,825	9,100	11,375	13,650	15,925	18,200	20,475	22,750
March	220	1,100	2,200	4,400	6,600	8,800	11,000	13,200	15,400	17,600	19,800	22,000
April	136	679	1,351	2,714	4,071	5,428	6,785	8,142	9,499	10,856	12,213	13,570
May	133	667	1,334	2,668	4,002	5,336	6,670	8,004	9,338	10,672	12,006	13,340
June	111	560	1,121	2,242	3,363	4,484	5,605	6,726	7,847	8,968	10,089	11,210
TOTAL	2,550	12,750	25,500	51,000	76,500	102,000	127,500	153,000	178,500	204,000	229,500	255,000

(a) Market size is assumed to be 255,000 tests per annum.

(2) Staple Length Testing Budget

The investment appraisal technique was used to determine commercial returns on SLM equipment and to calculate an average cost per test for differing adoption rate, productivity and investment scenarios. Fixed and variable costs were calculated using the budget outlined below and the total cost was then divided by the assumed number of tests per annum to derive average costs per lot. Allowance was also made for a commercial return on the funds invested. In the budget the fixed cost item 'capital regeneration' was included in order to finance future investment. This is analagous to an allowance for return to capital and management in commercial accounting.

All costs were calculated over a five year time period commencing in 1980/81 and are based on current commercial valuations and productivity assumptions. There is some difficulty in projecting costs over this time period since rates of inflation and productivity are unknown. However, estimated fixed and variable costs were inflated by 10% annually to approximate actual costs through time. For all calculations, two different productivity levels were assumed reflecting current input/output usage and a twofold improvement. The budget layout, major categories and individual components are shown in Table 6.

Capital Costs

- The total capital investment consists of staple length testing machines, E.D.P. ancillary services, staple length feed systems and laboratory redesign in the first year of testing. The number of staple length machines required depends on the number of tests performed during the peak load period, (see Section 3 Machinery and Labour Productivity assumptions below.) A back-up instrument in each laboratory is included.

- A depreciation rate of 25% was assumed on the above capital items with zero salvage values at the end of year 4. This is because new innovations in testing technology are continually superseding current models. Moreover, the lack of other testing firms means that there is no Australian market for used equipment.

- Interest rates were assumed to equal 10% per annum which is an average rate used in most commercial investment appraisals.

Table 6 Staple Length Testing Budget

ITEM	1980/81........1984/85 $ $
A CAPITAL COSTS	
- Interest on Borrowed Funds	
- Depreciation	
- Capital Regeneration	
Total Fixed Costs per annum	
B VARIABLE COSTS	
(a) Sampling component	
- sampling labour	
- " uniforms	
- travelling	
- materials and supplies	
- sampling grids	
- cases	
- trays	
- repairs & maintenance	
- freight to laboratory & return	
Total Cost of Sampling	
(b) Testing Component	
- testing labour	
- uniforms	
- light & power	
- repairs & maintenance	
Total Cost of Testing	
(c) Administrative Component	
- clerical (printing & stationery)	
- labour (clerical)	
- initial labour costs	
- supervision & administration	
Total Administrative Component	
Total Variable Costs ((a) + (b) + (c))	
TOTAL COST = A + B	

- The capital regeneration component was included to simulate commercial budgeting where allowance would be made for 'profit'. The testing authority would, have to finance further investment and,therefore, a rate of 12.5% return on annual average capital investment was assumed.

Variable Costs

(a) Sampling component.

If the testing authority is to service all wool selling centres, the minimum sampling labour requirement is one senior sampling officer in each location. Senior sampling staff would be employed initially to ensure standards are maintained and for further training of junior staff as and when required. Permanent staff who are capable of working without close supervision must be employed in sampling operations. Consequently, the number of staff employed was based on the need for reliable service of peak requirements. Inevitably this will result in some 'slack' in the system; however, this is reduced to some extent by ensuring staff take their annual leave during periods of low demand. Finally, an allowance was made for supplying staff uniforms,travelling expenses and various other materials supplies.

The total cost of employing permanent staff was calculated by obtaining the current weekly award for a senior sampling officer and dividing by 40 hours to provide an operating cost per hour. This cost was then inflated at the rate of 10% annually for the years 1980/81 to 1984/85 to allow for anticipated work value decisions and wage indexation effects through time. In addition, loadings were applied for recreation leave and public holidays (17.5%), sick leave (2.5%) long service leave (2.5%)and payroll tax (5.0%). These loadings were added to the operating cost per hour to provide the total cost per hour, (Table 7).

The sampling grids , cases and trays are capital items which are written off in one year and were, therefore, treated as variable costs of sampling in the budget. Repairs and Maintenance of sampling equipment are likely to be a relatively low components of total sampling costs; however, a 5% allowance was made for repairs to cases, trays etc. which may be damaged or broken in transit.

Table 7 Senior Sampling officer - Total Cost per hour 1980/81 to 1984/85

Year	Annual Salary	Operating Cost per Hour	Recreation Leave, Public Hols.	Sick Leave	Long Service Leave	Payroll Tax	Total Cost Per Hour
	$	$	$	$	$	$	$
1980/81	222.09	5.55	0.97	0.14	0.17	0.34	7.17
1981/82	244.30	6.11	1.07	0.15	0.18	0.38	7.89
1982/83	268.73	6.72	1.18	0.17	0.20	0.41	8.68
1983/84	295.60	7.39	1.29	0.18	0.22	0.45	9.53
1984/85	325.16	8.13	1.42	0.20	0.24	0.50	10.49

Samples must be freighted from the sampling centre to the testing laboratory and the empty trays, cases etc. returned. This cost will vary with the proximity of the sampling centre to the testing laboratory and the total number of samples freighted. The initial freight cost was assumed to be $0.50 per lot and this was also inflated at 10% annually for the period 1980/81 to 1984/85. Allowances were subsequently made for cost savings due to economies in having more samples freighted and these are discussed in the various implementation options.

(b) Testing Component

Unlike sampling labour, permanent testing staff would not be required to operate the SLM machines. This is because staff can be employed on SXS testing operations and shifted to SLM as and when the need arises. Consequently, average hourly testing wage rates were calculated, (Table 8), and multiplied by the number of hours required to perform the tests. An allowance was also made for uniforms, light and power.

Table 8 Testing Salaries - Total Cost per hour, 1980/81 to 1984/85

Year	Annual Salary	Operating Cost per Hour	Recreation Leave Public Hols.	Sick Leave	Long Service Leave	Payroll Tax	Total Cost Per Hour
	$	$	$	$	$	$	$
1980/81	211.80	5.30	0.85	0.13	0.16	0.32	6.76
1981/82	233.00	5.83	0.93	0.15	0.17	0.35	7.43
1982/83	256.30	6.41	1.03	0.16	0.19	0.39	8.18
1983/84	281.90	7.50	1.13	0.18	0.21	0.43	9.00
1984/85	321.10	8.03	1.28	0.20	0.24	0.49	10.24

Repairs and maintenance to machinery were assumed to equal 5% which is normal for electronic equipment. This cost represents labour and any spare parts that may be required, but does not include any allowance for down time i.e. not servicing clients.

(c) Administration Component

The introduction of a staple length test measurement requires additional printing and stationery, clerical staff and supervision and administration. During the early phase of adoption, the principal additional costs would be printing and stationery and collecting and collating the sample. Staple length test results must be collated with the presale result, otherwise there would be industry problems of collation and therefore additional cost. There would also be some additional supervision and training of testing and sampling staff.

It is anticipated that clerical staff would initially be existing staff resources. However, as adoption rates increase, a feature of the administration cost component is the discontinuous labour input pattern as new testing centres are established. Further, the cost of supervision and administration is likely to increase with higher adoption rates since the overall number of staff and resources employed would be greater.

Equipment and Labour Productivity

(a) Equipment

Staple length testing machines were assumed to operate for 8 hours per day and for 20 days per month, with an output of approximately 15 tests per hour. Thus, on average, a SLM machine will perform around 2400 tests per month. The number of machines required for any adoption rate was then derived by dividing the maximum monthly test demand assumed for any option by average machinery throughput per month. There must be a minimum of two machinery units available at any one location in the event of breakdowns, unforseen demand, industrial disputes in other states etc.These factors together with the testing authority's requirement to reliably service clients orders means it is necessary to incorporate a 40% extra capacity factor. For example, 6 staple length testing machines performing 2400 tests per month equals 14,400 tests per month. After deducting the 40% extra capacity factor this would enable 8,640 tests to be budgeted for in the peak demand month.

In the future it is considered likely that there will be significant productivity advances in the development of new equipment for testing procedures. In an attempt to capture this influence, the allowance for extra capacity was reduced through 1984/85. By referring to the appropriate extra capacity factor and the number of tests demanded in the peak month, at current productivity levels, the number of equipment units required can be calculated for all adoption rates, (Table 9).

It should be noted that equipment units do not have to be located in equal numbers between centres providing there are at least two in any one centre. In the first instance, with a minimum of 6 staple length machines (Option 1), there would probably be 2 machines each in the Melbourne, Sydney and Fremantle testing laboratories.

Table 9

Staple Length Testing Units Required for Varying Adoption Rates [a]

Total Tests p.a.	2,550	12,750	25,500	51,000	76,500	102,000	127,500	153,000	178,500	204,000	229,500	255,000
Adoption Rate (%)	1	5	10	20	30	40	50	60	70	80	90	100
Number of Tests in September	357	1,836	3,672	7,344	11,016	14,638	18,360	22,032	25,704	29,376	33,048	36,720
Extra Capacity %	40.0	40.0	30.0	30.0	25.0	25.0	25.0	25.0	15.0	10.0	5.0	5.0
Number of Staple Length Instrument Units	2	2	6	6	9	9	12	12	12	12	15	15

(a) Total market size is assumed to be 255,000 tests p.a.

(b) Sampling

If the testing authority is required to provide staple length testing services in all thirteen wool selling centres in Australia (Option 1), a minimum of 13 sampling staff would be required. It would also be necessary to provide sampling grids, trays and cases for all centres. A minimum of 1 grid per centre would be required; however, it is assumed a minimum of 2 would be purchased per centre in the first year of operations, since the initial demand by centre would be unknown (and there are many stores in each centre). Around 3 trays per test must be purchased and with repeated use may have to be replaced annually; therefore initially 6000 trays would be purchased.

Cases are required to freight sampling trays to the testing facilities. Since samples are normally sent to testing laboratories on the day they are sampled at least 2 sizes would be needed, a minimum of 6 cases would have to be purchased for each centre.

Current sampling procedures enable approximately 1.25 lots per working hour (10 lots per day) to be sampled. This figure is an assessment of average performance under commercial conditions. However, the technical maximum sampling performance, with current equipment is around 20 lots per day. In practice, this productivity level may not be achieved for a variety of reasons such as industrial disputes, lack of throughput, machinery down time etc. It should be emphasised that these assumptions are intended to provide discussion makers with a range of likely outcomes and not forecast future productivity improvement.

(c) Testing

It is generally considered that staple length testing could be incorporated relatively easily in existing SXS testing arrangements. Productivity currently ranges from an average commercial estimate of 15 lots per working hour (120 lots per day) to a technical maximum of around 30 lots per working hour (240 lots per day).

Labour is required to calibrate the equipment, place the samples on the staple length machines, check that staples are correctly aligned and samples correctly identified. The variable nature of the work load and relative ease of job training would mean that testing labour would probably be drawn from existing staff and was, therefore, treated as a variable cost.

In the analysis, the costs of staple length measurement were budgeted for each implementation option using average (PRODUCTIVITY I) and technical maximum (PRODUCTIVITY II) assumptions for sampling and testing above. This was done in order to establish parameters of current commercial and technical performance.

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