PROFITABILITY, PRODUCTIVITY AND PRODUCTION
IN THE LIVESTOCK INDUSTRIES - THE ROLE FOR TECHNOLOGY

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I. INTRODUCTION

This paper highlights some general principles which might guide the development of technological innovations having significant potential to increase profitability in the livestock industries through changes in productivity and the level of production.

(a) Profitability

The term profitability is used as synonymous with net farm income and it is assumed that maximizing profitability is the prime objective of livestock producers. There are non-technical factors, such as the preservation of preferred life styles and credit availability which will limit profitability. However, this paper is solely concerned with the potential future role for technology in assisting producers meet this objective. The adoption of appropriate technological innovations will affect productivity and the level and type of production.

(b) Productivity

Productivity is simply the volume of output per unit of input. Recent changes in productivity are reviewed in the remainder of this section against the background of deteriorating terms of trade which is the ratio of prices received for output to prices of inputs.

Farmer's terms of trade have deteriorated at an annual rate of 3% in the decade since the mid-1960's as compared with an annual rate of 1.6% during the previous decade. This deterioration has resulted primarily from higher costs. It is presumed that terms of trade will continue to deteriorate although the rate may revert to the long term trend of approximately 1.5% per year. This conclusion is based primarily on the prediction that Australian livestock producers are unlikely to benefit from substantial and sustained increases in the real prices for commodities traded internationally (B.A.E. 1977a).

Productivity has risen at the high rate of 4.1% per year since the turn of the decade whereas the annual rate over the previous 15 years was approximately 0.9% (B.A.E. 1977a). The 0.9 and 4.1% changes represent the differences between annual percentage changes in output and input for each period which were +3.8, +2.9 and +1.5, -2.6 respectively. The importance of the volume component of this negative input change is also illustrated in the percent changes in the volume of items purchased between 1973-74 to 1974-75 viz. labour down 15%, materials 26% and services 27% (B.A.E. 1977b).

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Thus, in summary, the recent rapid increases in productivity primarily reflect a decreased level of inputs, an obvious short term response to an adverse economic situation. The potential for and the effects on net farm income of further reductions in the volume of inputs are examined in a later section of this paper.

(c) Production

Substantial increases in total livestock production cannot be absorbed on the domestic market although significant substitution between products may occur from time to time. In 1976/77 approximately 75% of total livestock products were exported. The future level of livestock exports will be primarily dependent upon the need for Australia to maintain a positive balance of trade, the proportion of total exports contributed by the rural sector and the proportion of existing and developing markets that can be secured by exporters of Australian livestock products.

In the long term, Australia will need greater positive balances of trade so as to balance increasingly negative balances of the net invisible account which will arise due to the need to service foreign capital. To date, the substantial negative balance on current account has been largely offset by the inflow of foreign capital. Foreign capital inflow levels are likely to rise during the 1980's. For instance, it is estimated that $20,000m. will be required in the 1980's for development of energy reserves (Sydney Morning Herald, 1977) and additional funds will be required for mineral developments. Coincidental with the rapid growth of the tertiary sector over the past two decades, gross domestic product (G.D.P) per person in the workforce has risen at only half the growth rate of total G.D.P (Plunkett 1977). It is inferred that this represents a substantial fall in national productivity which, if standards of living are to be maintained, will result in the need for further foreign capital inflows. Alternatively, exchange rates may be varied. However, irrespective of what policies are adopted, the need for increased export income will increase.

It is not possible to confidently predict the precise proportion of total exports that will be contributed by the rural sector. The farm sector contributed approximately 18 and 9% of Australian G.D.P in the early 1950's and early 1970's respectively whereas the corresponding percentage contributions to exports were 82 and 48. The farm component of total exports in each of the 3 fiscal years to 1976/77 was approximately 44% of which livestock and livestock products represented 57% in 1976/77 (from B.A.E., 1977a,c and Plunkett, 1977). The substantial decrease in the proportion of total exports arising from the farm sector has resulted from expansion in mining and manufactured exports and the former would appear to have the greatest potential for future expansion. Barnett (1977) has predicted that mining exports will total $6,000m. by 1980/81 and $8,000m. by the mid 1980's; the former figure is approximately half the current value of total exports and the latter approximately equivalent to the
projected gross value of agricultural commodities in 1979/80. However, the accuracy of these predictions will be dependent upon many factors such as the rate of mining development, demand and prices for mineral exports and the competitiveness 'of the Australian mineral industry. Additionally, unless substantial reserves of oil are found and brought into production, the value of mining exports might be partly offset by a petroleum import bill in the order of $2,700m. by 1985 (Barnett 1977). Thus, it is difficult to predict both the net balance of trade arising from the mining sector and the magnitude of intersectoral pressures proposed by Gregory (1976). Briefly, Gregory's thesis states that, with the rapid growth of mineral exports, the balance of payments equilibrium is no longer tied to the competitiveness of agricultural exports. It is asserted that Australia will need to manage her economy in a way compatible with maintenance of both the rural and mining export industries.

The extent to which rural exports might be increased will be primarily related to the proportion of existing and developing markets which she can secure. The current economic difficulties being experienced by livestock producers, the closure of some traditional markets, current and proposed alterations to marketing systems and the experience which is being gained from servicing the Middle East markets are all factors which will direct greater attention towards market development. Further, as major changes in Australia's export availabilities can be expected to have little effect in themselves upon world commodity prices, there appears to be no sound basis for advocating arbitrary maximum production levels for rural export commodities.

(d) Effect of Productivity on Production

Before discussing the potential role for technology one needs to examine the effect on profitability of interrelationships between productivity and production level.

Amongst others Musgrave (1977) has inferred that our attention should be primarily directed towards productivity increases which do not result in production increases. Production needs to be considered in the broad context encompassing both the absolute level of production and the quality of the products; that is the total value of production. In so far as productivity increases result from lowered inputs in the absence of changes in the basic relationship between output and input, they will not necessarily result in greater production. As will be discussed later, the potential for productivity gains resulting purely from cost cutting is not substantial. Productivity gains without production increases might also result from rural structural adjustment and, to some extent, structural adjustment in the 'long term will be influenced by technological factors. However it is likely that substantial increases in productivity due to the adoption of technological innovations will result in increased production levels. Technological advances which overcome current production constraints, such as the availability and quality of pasture, will raise the production potential. This link between productivity and production increases becomes even more evident when one examines the concept of productivity in greater detail.
Total productivity is the volume of total outputs divided by the volume of total inputs. Whilst increases in total productivity might be a long term national goal from an economic viewpoint, there are significant social and economic factors operating against its realisation in the short to medium term and, even in the long term, many of the social constraints, such as an individual's inability or reluctance to change location and asset' fixity, remain. At the individual farm level non-economic forces, such as the level of managerial skill available and personal preferences for enterprise type influence resource allocation and decision making. In many instances these forces result in the attention of producers being more directed towards maximisation of marginal productivity (i.e. the volume of output for the last (marginal) unit of input). Thus, it would not seem possible to accept, without qualification, Powell's assertion (1977) that partial productivity ratios are of little value and, whilst efforts are directed towards increasing marginal productivity, production increases will follow as a consequence.

In summary it is suggested that many technological developments will affect farm profitability through increases in both productivity and production. The value of such developments will be greatly influenced by the need for Australia to maintain a substantial rural export industry and her capacity to secure significant proportions of existing and developing export markets.

II ROLE FOR TECHNOLOGY

That technology must play a role in increasing farm profitability is not questioned. Rather principles affecting the realisation of this role are discussed and, for the purpose of the discussion, technological innovations are somewhat arbitrarily categorised into those that assist product development, decrease off-farm inputs, decrease on-farm inputs and alter the inherent relationship between output and input.

(a) Product Development

The development of new export markets and greater diversity of demand within the domestic market, both in terms of product type and quality, will increase the potential for livestock producers to diversify. Technology will play a major role in the development of industries such as those based on ewes milk, goat products and carpet wool. Attention is currently being directed towards the technological needs of the skin and hide industries. There has been no concerted effort to evaluate the demand for hogget sheep meat. However, although there is a need for research into and development of these alternative livestock enterprises, the overall effect of such on farm profitability is not likely to be substantial.

(b) Decrease Off-Farm Inputs

In the absence of increased vertical integration in the livestock industries, technological developments aimed at decreasing off-farm costs or maintaining product quality during transport and processing are unlikely to have direct effects on farm productivity or profitability. However the need for
technological advances in these areas is substantial and will critically affect the competitive position of Australian livestock producers. These aspects will be discussed in other papers.

(c) Decrease On-Farm Inputs

As outlined above, substantial reductions in farm inputs have been effected recently. Future substantial gains in profitability resulting from decreasing input levels will depend to a large extent upon the effectiveness of technology in identifying the long term effects of past and future cost cutting upon farm productivity and in identifying means whereby certain inputs can be completely deleted.

Recent developments, such as is evident in fencing technology, will undoubtedly result in increased productivity through cost savings and little or no effect upon production potential. However, in other areas the effects of reduced inputs are either variable or as yet undetermined. For instance between 1973/74 and 1974/75 there was a 63% reduction in the volume of fertilizer applied. Although in many situations pastures may require continued fertilizer applications to retain desirable species and maintain productivity, there are likely to be large areas in which fertilizer applications can be reduced or eliminated. Ayres et al (1977) have demonstrated that sheep production can be maintained without fertilizing the ley in certain areas of southern N.S.W. and, on the north-west slopes, Hamilton (pers. comm.) has found that the very low animal responses obtained from fertilizing native pastures do no justify the practice. Further technological studies are required to quantify the effects on profitability of input reductions particularly in respect to fertilizer use and the control of internal and external parasites.

Labour is a major on-farm input and it is currently in vogue to suggest further extensification of livestock production so as to decrease the general level of inputs and, in particular, the level of labour inputs. However Dillon (1977), in evaluating the effect of further increases in labour productivity, concludes that even an annual increase of 5% will have only a marginal effect on net farm income by the mid 1980's. Additionally, extensification may decrease the output per unit of such inputs as those required for internal and external parasite control, may result in decreased product diversity and quality with consequent market access limitations and price penalties and, finally, may limit the potential for future productivity gains resulting from technological developments. However, technological studies aimed at the complete deletion of some traditional practices in present enterprises may have significant effects upon profitability. The high cost and recent cost increases associated with shearing and crutching are often cited as major problems. For instance, the cost of shearing and crutching on arid zone sheep properties in S.A. represents 24% of total farm costs (McLachlan 1977). Donnelly is currently investigating the feasibility of overcoming the need to crutch wethers in western N.S.W. These studies primarily involve the evaluation of the effectiveness of combining a number of currently available low cost management options and, if successful, might result in significant input.

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reductions. On the other hand, it is difficult to envisage current research programmes aimed at replacing the traditional method of wool harvesting with an alternative method as having, even if successful/major effects on farm profitability. The benefits are more likely to be reflected in the development of more acceptable work methods.

The potential cost savings resulting from technological innovations will be greatly enhanced by the development of simple, soundly based models aimed at determining the economic consequences of implementing various management options. For instance, work currently being undertaken by Beck (pers. com.) aims to determine the economically optimum rate of pasture improvement on beef properties in northern N.S.W. and the effect of beef prices upon this optimum rate. A related area is the determination of cost effective methods of implementing Government or joint Government/industry funded schemes such as that developed for the brucellosis eradication scheme (Beck 1977). Development and utilization of models such as these will assist producers and Governments in determining the most effective utilization of scant resources and thus raise productivity through decreasing inputs which have little or no effect upon production.

Whilst avenues exist for further cost cutting in areas which will not undermine productive capacity, the essential nature of many farm inputs, the multiplicity of types of inputs, the organisational structure of farming and the recent high level of input reduction will severely limit future profitability gains resulting from on-farm cost cutting.

(d) Inherent Relationship between Output & Input

Technology will play its greatest role in increasing farm profitability through increasing the level or changing the nature of inputs so as to overcome critical production constraints. When either the level of inputs is increased or the type of input altered, profitability gains might result firstly from increased production in situations where the current enterprise is profitable and the increased production does not have a depressing effect on price per unit of output. Secondly, increased profitability might result from alterations in the basic output-input relationship; that is, increased productivity. It is asserted that major productivity gains can be realized by identifying critical output-input relationships and by applying technology to alter these relationships.

When productivity is increased through simple cost cutting measures, such as the adoption of cheaper fencing methods or the abolition of the need to crutch, or when production is increased due to the greater use of the same inputs, the resultant effects on profitability are reasonably easy to ascertain. However, this is often not the case when positive productivity and thus profitability effects are due to alterations in the basic relationship between output and input. In these instances there is a particular need for biological and economic sensitivity tests to be undertaken and this point can be best illustrated by way of an example.
Net reproductive rate in sheep is affected by the frequency of lambing, the proportion of dry ewes, ewe and lamb death rates and litter sizes. It is a necessary but complex task to identify the likely effects upon profitability of alterations in one or more of these parameters. On the basis of studies in N.S.W. and Victoria (Tyrrell pers. corn; Clarke 1976) it is concluded that, for the sheep enterprises in those States, the maximum biological potential for increasing net reproductive rate through decreasing the proportion of adult dry ewes is less than 10%. On the other hand, Large (1970) has examined the effect on biological efficiency (E) for meat production (weight of carcase produced per unit of food eaten) of variation in litter size. His studies, conducted under artificial situations, found that E was increased by 37% and 57% respectively when 2 and 3 lambs were weaned per ewe as compared to E when one lamb was produced. Large also found that the values of E from a small ewe crossed with a large ram can be as large as those obtained by increasing the litter size of large ewes. These are substantial theoretical gains in biological productivity. However, the real situation is a complex one. Changes in one or more of these parameters will also affect the level of wool production and the level of risk associated with the enterprise. Even more difficult is the determination of the effects of these biological changes upon optimum levels and types of inputs required for the various enterprises. The majority of field comparisons of the biological production levels attained by single and twin bearing ewes are of limited value as these two basically different enterprise types have been compared under management situations and environments (inputs) traditionally considered appropriate for single bearing ewes. Simplistic economic analyses which determine the effect of say lambing rate on the gross margin per ewe also have limited application. There is an urgent need for biological and economic sensitivity studies to be undertaken in areas such as this so as to determine the likely effect upon profitability of alterations in the appropriate output - input relationships. A similar situation exists in cattle in respect to the effect on biological efficiency of selection for and against weaning weight. Any correlated changes in reproductive potential are likely to have a significant impact on the productivity changes resulting from such selection practices. The theoretical biological analyses should not necessarily be limited by the absence of known management techniques necessary for, for instance, the attainment of reasonable production levels from non-traditional enterprise types such as those based on multiple litter sizes in both sheep and cattle. The sensitivity analyses should highlight the need for the development of management packages which will enable the productivity gains to be realized.

Preliminary analyses by the B.A.E. (Easter 1977; Kingma 1977) provide some guide as to the relative changes in productivity resulting from changes in specific output - input relationships. The efficiency of conversion of pasture into animal products, the level of pasture production and, with the exception of sheep in the pastoral zone, reproductive rates have been identified as factors in which productivity gain might result in significant increases in net farm income. These analyses need to be refined and combined with theoretical biological
sensitivity studies and assessments of the probability of devising practically adoptable management options.

As stated earlier, technical innovations in these areas are likely to positively affect production levels as well as productivity. For instance, the utilization of better adapted breeds or breed crosses will result in productivity gains. However, unless stocking rates are concurrently reduced, and there will be little incentive for this, then the increased profitability will reflect both increased productivity and increased production. Similarly the adoption of selection based upon objectively measured production has the potential of increasing the rate of gain in wool weight over and above that attainable from visual assessment by approximately 0.5% per annum. Although this is a low rate of gain, it is well to remember that such gains may apply across the total industry although the technological innovations need only to be implemented in a small portion of the total industry and are thus, on a total industry basis, of low cost. Again, if stocking rates are not altered, then the increases in farm profitability will reflect the increased level of production resulting from the raised genetic potential.

Finally there are numerous examples for which technological innovations are required so as to increase profitability by altering the quality of products. For instance, management packages are required to minimize vegetable fault in wool and grass seed contamination in sheep carcasses. It is likely that these innovations will necessitate either upward changes in input levels or alterations in input type.

III CONCLUSIONS

The most significant future increases in farm profitability resulting from technology will result from innovations which remove major production constraints through either the utilization of additional inputs or by changing the nature of inputs. Biological and economic sensitivity studies are required to identify such production constraints. Subsequent studies should aim at providing appropriate management strategies. These technical innovations will affect profitability by increasing productivity and, in many instances, by increasing production levels or by improving product quality. The export of the resultant increased production will be necessary for Australia to maintain her balance of payments but will only be possible if her share of existing and developing export markets are expanded. Realization of useful gains in productivity due to past and future input reductions will require technological studies to identify the effect of these reductions upon productivity and also to identify traditional management practices which can be profitably deleted. However, in the short term, future productivity gains from further cost cutting are unlikely to have major positive effects on farm income.

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