THE FUTURE PROFITABILITY OF BEEF PRODUCTION IN NEW ZEALAND

by

R. W. M. Johnson, M.Agr.Sc., B.Litt., Ph.D.,
Agricultural Economics Research Unit,
Lincoln College

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In this contribution, the meaning of profitability in the context of future production is first defined, and then some present and future profitability levels are calculated for various North Island farm systems. These farm systems are then examined together in a linear programming framework to assess likely future trends in beef production in the North Island and throughout New Zealand.

Future levels of production on New Zealand farms will be determined by marginal adjustments to farm plans and not by wholesale changes of farm systems. Given that every farmer has a definite management pattern, and a stock of capital and land more or less designed for the specific avenue of production engaged upon, it is most likely that adjustments to new price situations and new technology will be made fairly slowly and where it is easiest to do so first.

The farmer must continue to earn his living from his farm, and he is not likely to countenance big changes to his income as well as to his management system. Biological constraints also slow down adjustment in farming - we only have to think of the time it takes for the effects of a change in breed of ram or herd sire to work through to all breeding stock, to appreciate the slow rate with which violent changes can be accommodated in livestock farming.

The appropriate financial device to analyse profitability for a given farm is the partial budget already explained by Mr McIvor. The partial budget is a forward estimate of farm expenditure and returns which includes all financial items likely to be changed under a new technology or price situation, but does not consider items likely to remain unchanged. A partial budget clearly requires firm assumptions about future production levels, reproduction rates and livestock mortality before calculations can start. Once these are known it is a fairly simple matter to calculate gross revenue earned per unit of an enterprise and to deduct unit costs of items likely to change on the farm in the short-run. It is preferable to call this measure of profitability net revenue per unit of the enterprise, although it is sometimes called a gross margin.

The analysis of future profitability at the national level requires all the possible partial budgets for individual farms to be added together and summarised in a suitable manner. Linear programming is a technique which is suitable for this purpose, and after discussing various levels of individual farm profitability, this paper sets out the programming framework from which the national policy recommendations are obtained.

It will be convenient to introduce this discussion of future profitability in beef production in terms of the three main sheep and beef regions of the North Island - fattening country, medium hill country and hard hill country (these divisions correspond to the Meat and Wool Boards' Economic Service classification of North Island sheep farms). The principles involved in a profitability analysis can be made clear, while at the same time dealing with the area supporting some 72 per cent of beef cattle in New Zealand. Later, all sheep producing regions in both islands are considered together in the programming framework and these account for 90 per cent of all beef cattle in New Zealand at present. Clearly, these three broad categories of sheep/beef farms found in the North Island are being taken as representative of the three tiers of the industry, and many individual variations and combinations are likely to be found in practice. The size of the regions at present can be seen in the following data:

The Three Sheep/Beef Regions of North Island
(1966 data)

	Hard Hill Country	Hill Country	Fattening Country
Effective Area (m.acs)	4.1	4.3	2.5
No. Farms	2,226	5,458	6,407
No. sheep (m.)	7.5	13.2	11.5
No. cattle (th.)	962	1,119	756

On hard hill country in the North Island a breeding herd of cattle is dictated by natural conditions, but on medium country and fattening country it is plausible to examine the relative profitability of a breeding herd and fattening bought-in weaners. This division gives five enterprises for which representative partial budgets are required. Full details of such a calculation for a breeding herd on fattening country is set out in an appendix to this paper for this interested. At this point, we only consider the physical coefficients assumed in the calculations and the net revenues likely in different export price situations.

The following data shows the physical characteristics assumed for a beef breeding herd in each region:

	Hard Hill Country	Hill Country	Fattening Country
Calving Percentage	80	85	85
Time in herd in yrs	7	8	9
Annual losses in herd (per cent)	6	9	9
Annual percentage replacement	17.5	17.2	15.6
Ewe equivalents per cow	7.46	7.43	6.67

The same data assumed for beef fattening enterprise is as follows:

	Hard Hill Country	Hill Country	Fattening Country
Percentage sold at 18 months	-	50	100
Annual losses	-	2	3
Weight at sale (lbs)	-	600	550
Ewe equivalents per beast	-	4.17	4.00

Before presenting the expected net revenues from each of these representative enterprises, we should consider present and future export prices for beef cattle and sheep products. In this paper, no attempt is made to predict future export prices; rather a likely set of high and low product prices has been selected after a consideration of past price trends. The reader can then make his own judgement of the future outlook from the range of results it is possible to predict. In the jargon, these sets of prices provide likely upper and lower bounds to the set of projections.

The projection work starts from the set of export prices received in the 1968/69 season, and then analyses future production trends in a framework of expected prices for 1979/80. The three sets of prices are summarised next:

Price Assumptions of Net Revenue Calculations

	1968/69 cents/lb	Low Expectation cents/lb	High Expectation cents/lb
Heifer Beef (schedule)	17.5	14.0	20.0
Ox Beef "	18.0	15.0	21.0
Fine wool (56-64's)	40.2	53.0	50.0
Medium wool (50-56's)	35.7	29.0	48.0
Xbred wool (48-50's & below)	25.8	22.0	42.0
Lamb (inc. wool pull)	18.2	12.0	20.0
Mutton(" " ")	5.4	4.0	7.0

The net revenue for each broad enterprise type in 1968/69 prices is best expressed in terms of ewe equivalents of carrying capacity as follows:

Profitability of Livestock Enterprises in North Island 1968/69

	Hard Hill Country	Hill Country	Fattening Country
		($ per E.E.)	
Beef cattle breeding	3.81	3.78	4.50
Beef cattle fattening	-	7.55	10.79
Sheep breeding	4.11	4.29	5.26
Buy two tooth replacements	-	4.68	5.21
Buy 5 yr replacements	-	-	4.60

Romney sheep are assumed throughout the calculation and wool price is just under 26 cents per lb. As the appendix details show these net revenues allow for any new capital expenditures involved and possible labour saving aspects of each enterprise. One arbitrary feature of such calculations is that the price of weaners has to be chosen from available market data, and errors in judgement in this can favour one cattle enterprise at the expense of the other.

A brief interpretation of these results is that beef fattening tends to dominate beef breeding in the two appropriate regions, but in turn sheep appear to be a better proposition than beef breeding. These results appear consistent with broad farm management knowledge of North Island conditions and the examples set out in Mr McIvor's paper.

Although we do not necessarily expect all export products to have low price expectations at the same time, it is useful to set out the expected net revenues for each expectation level of prices separately. For the low price expectation we have:

Profitability of Livestock Enterprises at Low Prices

	Hard Hill Country	Hill Country	Fattening Country
		($ per E.E.)	
Beef cattle breeding	2.89	2.88	3.49
Beef cattle fattening	-	5.38	7.52
Sheep breeding	2.85	3.17	3.51
Buy two tooth replacements	-	2.65	3.10
Buy 5 yr replacements	-	-	2.52

Again beef fattening appears most profitable at a schedule price of $14-15, wool 22 cents and lamb 12 cents, but sheep farming has now declined in profit relative to beef breeding and massive changes in the structure of the industry could be expected if ever such a combination of prices emerged (as it briefly did in 1967/68). If the set of high price expectations are considered together, the results are as follows:

Profitability of Livestock Enterprises at High Prices

	Hard Hill Country	Hill Country	Fattening Country
		($ per E.E.)	
Beef cattle breeding	4.33	4.29	5.07
Beef cattle fattening	-	9.02	10.00
Sheep breeding	6.41	6.41	7.72
Buy two-tooth replacements	-	7.14	7.70
Buy 5 yr replacements	-	-	6.88

At this level of price expectations, the sheep industry looks to be in a very healthy state indeed, and breeding cattle would revert to their rôle as agricultural machines as they were not so many years ago. As can be seen already, one's view of future profitability is largely determined by our view of future export trends in our main markets. Clearly, no person can judge this accurately, and a reasonable framework of projection prices must be provided instead which encompasses most possibilities.

In the remainder of this paper the implications of the low and high export price projections for the beef industry as a whole are therefore examined. It is convenient to set 1979/80 as a useful target season, and to estimate the possible size of the beef cattle industry in the decade ahead.

In the linear programming framework it is necessary to set out all the assumptions which are likely to affect the result, so to this task we now turn.

1. Consider the sheep/beef cattle industry of New Zealand can be adequately represented by the eight fairly homogenous regions provided by the Meat and Wool Boards' Economic Service. In 1966, this area totalled 29 million acres, and carried 54 million sheep and 3.3. million beef cattle.

2. That the new enterprises open to farmers in the eight regions are the five enterprises already discussed, plus cropping where appropriate.

3. That land productivity increases in each region according to best technological estimates, i.e. rates of total E.E. increase of 2 to 4 per cent per year in the different regions. The average rate of increase works out to be 2.8 per cent per year in total E.E.

4. That farmers have the necessary incentives to invest capital in pasture improvement so that condition no. 3 is attainable. It is assumed that an average capital expenditure of $2,500 per farm per year can be financed satisfactorily.

5. That the price expectations already discussed are known to farmers for most of the decade ahead. It must be assumed that farmers have time to make the necessary adjustments to their management policies.

6. That some beef cattle will always be required in some regions to control pastures and secondary growth and that in some areas there is a maximum limit to the number of beef cattle which can be run because of soil conditions and the like.

7. That for both sheep and cattle, buying of replacements and fattening animals cannot exceed the supply of such animals within or between regions. The South Island is assumed to be quite separate from the North Island for this purpose.

8. That whatever quantities New Zealand farmers produce of each product, the price expectation does not change as a result.

9. That no more than 250,000 dairy bred calves will be available as fattening stock to this section of the beef industry in 1979.

10. That there is a biological limit to the rate of expansion of the beef cattle industry. This is a severe restriction on the expansion of the beef industry of New Zealand as a study of the physical coefficients of reproduction demonstrates. If the following equation shows the

rate of growth of the breeding herd of beef cows,

$$K_t = (1 - a)K_{t-1} + bK_{t-2}$$

where K_t = the stock of breeding cows in year t,

a = the annual culling rate of breeding cows

b = the replacement rate of heifers born to cows, then the following table shows the percentage rate of growth of the national breeding herd under various values of a and b:

Growth of National Breeding Herd (Percentages)

		1	2	3	4	5
Calving Rate)		80	80	80	80	80
Heifer mortality)	= b	3	3	3	3	3
Heifer culling rate)		30	25	20	10	20
Old cow culling rate	= a	20	20	20	20	15
Percentage growth permirted		5.6	7.1	8.6	11.4	12.7

This table brings out very clearly how the rate of expansion is controlled by the level of culling of female replacement stock and the length of life in the herd. On a subjective basis, a seven per cent long term growth rate of the beef breeding herd in New Zealand was chosen for the project described here. Under very favourable assumptions the 8.6 per cent growth rate might possibly be achieved, though this would be hard to justify on a long-term basis.

The actual projections of stock numbers in each region in 1979/80 are worked out on the computer by providing the appropriate linear programming tableau of basic data. Here, we turn to the results obtained without further discussion of the programming methodology involved.

In the context of this symposium the results set out the likely expansion rate of the beef cattle industry during the coming decade under certain assumptions about future export prices and productivities. So far in the contribution, these assumptions have been made as explicit as possible. Let us now look at the future

structure of the industry itself.

To illustrate the range of results possible, consider the position if 1968/69 price levels prevail throughout the 1970's. Taking into account the eight regions specified by the Economic Service, there are 35 enterprise levels whose separate profitabilities will determine whether farmers move into more sheep or more beef cattle or a mixture of both. As already outlined, the numbers of fattening cattle cannot exceed the breeding surplus in each island and replacement sheep breeding stock cannot increase faster than surpluses generated in other areas. In terms of 1968/69 price levels, the programming result is obtained that farmers will shift towards beef production in the 1970's as much as the biological maximum permits. This means the beef cow herd will expand from the 1966 level of 1.1 million cows (in the regions described by this model) to a total of 2.6 million cows by 1979, and that sheep numbers will increase from the 1966 level of 54.4 million to 68.8 million by 1979, an annual rate of increase of 1.8 per cent per year.

Further projections at different price expectations are summarised in the following table:

Projections of Sheep/Cattle Industry for 1979/80

	Sheep Nos. (m.)	Shorn Wool (m. lbs)	Beef Cows (th.)	Crop Area (th.ac.)
All prices high	90.9	984	673	500
All prices low	68.5	732	2600	700
Wool only low	68.9	734	2600	649
Beef only high	68.4	727	2600	700

It can be seen that the high set of expected prices favours a rapid expansion of the sheep industry with an absolute decline of the beef industry. Sheep numbers could rise at an annual rate of 4 per cent. Conversely, if all prices emerge at the low expectation, or if wool only is low, or if wool and lamb are both low, then the future lies in beef production and sheep numbers will expand at the basic rate of 1.8 per cent per year forecast earlier.

Clearly, there will be intermediate situations where different outcomes will be possible. In the case of all prices at low levels, a faster rate of biological expansion of the beef herd to 3.2 million would lower the sheep population to 62 million in 1979. This seems unlikely of course for the reasons already mentioned. If the number of dairy-bred beef calves increases from 250,000 per annum to 500,000 per annum, the high price projection gives an even smaller national beef herd - at low prices throughout sheep are displaced and numbers fall from 68.5 to 67.4. Finally, of course, projection models of the sort described here can be used to establish break-even prices for beef production. In the jargon this is the normative supply curve.

Two interesting situations are analysed:

(a) the beef schedule prices necessary to achieve maximum beef production with other products at 1968/69 price levels, and

(b) the beef schedule prices necessary to achieve maximum beef production with other products at high price expectation levels.

The results can be summarised as follows:

(a) Beef Supply Curve with Prices of Other Products at 1968/69 Levels

Schedule Price /100 lbs	Beef Cows (m.)	Sheep Numbers (m.)
$13.0	1.24	83.84
13.9	2.01	75.44
14.8	2.12	74.21
15.7	2.36	71.59
16.5	2.60	69.68

(b) Beef Supply Curve with High Expected Prices of other Products

Schedule Price	Beef Cows	Sheep Numbers
20.5	.67	90.89
21.4	.95	87.89
22.5	1.71	79.92
23.3	2.01	76.69
24.2	2.45	72.13

We now have the most interesting result that at 1968/69 export price levels, a beef schedule price of $16.5/100 lbs would be sufficient to swing farmers over to a national beef policy (Xbred wool 26 cents, lamb schedule 18.2 cents, mutton 5.4 cents). But if wool prices recover to the levels of the early 1960's (42 cents Xbred), and lamb reaches 20 cents schedule, then the national beef policy would require a beef schedule set at around $25/100 lbs.

For a tentative selection of a particular outcome, this author favours a low wool price and high meat prices for the 1970's. Under these circumstances sheep numbers on sheep farms will expand at some rate just under 2 per cent per year and farmers will put a considerable proportion of their resources into expanding the national beef herd. For biological reasons, the beef breeding herd can only double in the decade, but this will nevertheless cause considerable marketing and disposal problems for a large quantity of beef.

Appendix

Partial Budget for Beef Breeding Enterprise on North Island Fattening Country

1. Ewe Equivalent System

Ewes	1.0	Weaner heifer	3.5
Ewe hoggets	0.6	Yearling heifer	4.0
Rams	0.8	Yearling steer	4.0
Cows	6.0	Bull	5.0

2. Information Required

Assume that calving percentage is 85, that cows have 9 seasons in herd, that first calf is born at 2 years, that annual culling is 3 per cent and cow mortality is 6 per cent and a weaner selling policy is followed; then for every 1000 cows 156 weaner heifers must go into the herd, 694 weaners will be for sale and 70 cull cows will be sold each year. Total herd size is completed with 25 bulls per 1000 cows.

3. Total ewe equivalents

1.000 cow at 6.0	= 6.000
0.156 heifer at 3.5	= 0.546
0.025 bull at 5.0	= 0.125
	6.671

4. Capital Requirements

	$
1.000 cow at $95.00	= 95.00
0.156 heifer at 80.00	= 12.48
0.025 bull at 360.00	= 9.00
Beef yards, $1000/100 beasts	= 10.00
Fences & water, $500/100 "	= 5.00
Working capital, $1000/100 "	= 10.00
Hayshed, $500/100 beasts	= 5.00
	$146.48
Interest on capital at 6 per cent	8.79

5. Net Revenue Calculation

	$	
Sell 0.070 works cow at $90	= 6.30	
Sell 0.694 weaners at $52	= 36.38	$42.68
Costs of selling cows 0.070 at $1.3	= 0.09	
Costs of selling weaners 0.694 at 3.0	= 2.08	
Variable costs of cows 1.000 at $1.00	= 1.00	

Variable costs of bulls 0.025 at 65.00 =	1.63	
Variable costs of heifers 0.156 at 1.70 =	0.26	
Interest on extra capital employed =	8.79	
Total	13.85	
Less savings on labour management	5.00	8.85
Net Revenue per head		$33.83
Net Revenue per E.E.		$ 5.07