TOTAL FACTOR PRODUCTIVITY AND SOURCES OF GROWTH IN THE SHEEP AND BEEF FARM IN NEW ZEALAND 1973-74 TO 1990-91

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ABSTRACT

This study examined the productivity of the average sheep and beef farm in New Zealand during the period from 1973-1974 to 1990-1991. The Tornqvist quantity index method was used to construct the aggregate indices for inputs utilized and outputs produced on the farm. Total factor productivity was calculated as the ratio of the total output index to the total input index.

Results of the study indicated an annual rate of growth of 1.6 percent in the productivity of the average sheep and beef farm in New Zealand. This originated from the combined effect of a 1.4 percent annual increase in total output and a 0.21 percent annual decrease in input usage. Farmer terms of trade during the study period has declined by 4.7 percent per year. Returns to costs ratio has, likewise, declined by 3.1 percent annually.

An attempt was made to determine the sources of growth in the output of the farm using regression analysis. The explanatory variables considered included a climate factor, fertilizer subsidy, output assistance and a trend variable. It was determined that the trend variable was the only significant explanatory variable for the growth in TFP of the average sheep and beef farm. It was, thus, concluded that the growth in output of the average sheep and beef farm during the period from 1973-1974 to 1990-1991 has been caused by factors other than the climate, fertilizer subsidy and output assistance.

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1   Introduction

Improving productivity in the utilization of resources lies at the heart of economic growth, no less so in agriculture than in other economic sectors or in the national economy.   Productivity growth enhances standards of living and the quality of life.   Specifically, it improves production efficiency which can translate to increases in incomes that potentially can be reallocated toward improving conditions of social concern such as environmental pollution or poverty.   Advances in productivity also help abate inflation and conserve scarce resources. It stimulates market competition within an economy and between economies, thus improving resource allocation in general (Link, 1987).

As stated by Barker (1987), growth in productivity of resources is a fact generally accepted as being essential to the development of modern industrial economies.   The most important uses of productivity statistics, as determined by the United States Department of Agriculture (USDA Technical Bulletin, 1980) are: 1) identifying the sources of economic growth;   2) justifying the appropriation of agricultural research funds; 3) estimating production relationships; 4) serving as an indicator of technical change; 5) comparing inter-sectoral economic performance;   and 6) justifying price changes.   More

specifically, the USDA report indicated that productivity statistics are used to compare agricultural inputs to outputs in order to measure the performance of the sector.

This study is concerned with examining the productivity of the average sheep and beef farm in New Zealand, being a major component of the country's pastoral industry in particular and the agriculture sector in general. Traditionally, sheep and beef farming has centered on producing sheepmeat, beef, wool and hides. In recent years new types of livestock have been introduced which include deer and goats.

The significance of the sheep and beef industry to the New Zealand economy may be measured in terms of its contribution to the gross output in agriculture. In 1993 the industry contributed an estimated four billion dollars worth of output which comprised about 42 percent of total agricultural output. Table 1.1 shows in detail the various outputs contributed by the sheep and beef industry to the output in agriculture from 1988 to 1993. Over this period, the industry's contribution increased at an average of 2.4 percent per year.

The sheep and beef industry also contributes significantly to the country's export earnings. In 1992 exports of meat and meat products

Table 1.1 Gross Agricultural Production

Year ended 31 March	1988	1989r	1990r	1991r	1992p	1993e
			(in NZ $ million)			
Wool*	1385	1508	1252	832	783	820
Sheep and Lambs**	690	610	865	885	833	949
Cattle**	951	1173	1187	1376	1442	1521
Dairy Products	1431	1902	2166	1641	2203	2496
Pigs**	110	101	125	126	125	130
Poultry and Eggs	186	192	215	208	193	200
Crops and Seeds	260	262	338	313	317	338
Fruit and Nuts	578	549	623	694	821	717
Vegetables	297	373	412	420	430	447
Other Horticulture	122	145	166	160	175	175
Other Farming	211	243	259	255	272	336
Agricultural Services	498	556	620	648	665	709
Value of Livestock Change	45	-67	131	-14	88	113
Sales of Live Animals	601	585	721	671	701	774
Total Output	7365	8132	9080	8216	9027	9725
Less Intermediate Consumption	3851	4255	4800	4657	4867	5101
Agriculture's Contribution to Gross Domestic Product***	3515	3877	4280	3559	4160	4624
Gross Domestic Product	61867	66403	71505	73343	73213	76800
Agriculture as a Percentage of Gross Domestic Product	5.7	5.8	6	4.9	5.7	6

*   Excludes slipe wool and sheepskins

**   Sales for slaughter, including on-farm kill

***   "Agriculture's contribution to Gross Domestic Product" is gross agricultural output measured at the point of first sale including agricultural contracting, less off-farm non-factor inputs. These items (for example, wire, which comes from the metal manufacturing sector) are called "intermediate consumption" items.

****   Includes sales of live animals

r   revised

p   preliminary

e   estimate

Source: Situation and Outlook for New Zealand Agriculture, 1993
              Ministry of Agriculture and Fisheries

earned the country some three billion dollars while wool exports earned about 1.2 billion dollars (Table 1.2). Overall, wool and meat and meat products comprise about 29 percent of total agricultural-based exports or 17 percent of New Zealand's total exports of goods.

In terms of livestock numbers, inventories of sheep were observed to have generally declined while stocks of beef cattle rose. Table 1.3 shows the inventory levels of sheep and beef cattle during the past twenty years. It is noticeable from the statistics that the movements in livestock numbers over this period have been in changing proportions. Specifically, during the early 1970's beef cattle numbers increased to over six million while sheep numbers declined. Over the period 1975 to 1983 the pattern switched with beef cattle numbers decreasing and sheep numbers consistently increasing to reach a peak at around 70 million. Since 1983, there has been a steady running-down of the sheep stock while beef cattle numbers have again increased.

The period from 1973 to 1991 covered in this study was characterized by the combined effects of various factors including inflation, product price variability, weather variability and government policies, which have influenced the environment in which sheep and beef farmers made their production decisions. Specifically, the random effects of these factors have either encouraged or made farmers pessimistic about

Table 1.2 Value of Exports

Year ended 30 June	1989	1990	1991	1992
	(in NZ S million, FOB)			
Live Animals	212.1	193.7	178.9	186.1
Beef and Veal	1279.7	1091.6	1283.8	145.1
Lamb	720.7	957.7	977.8	1177.0
Mutton	130.4	135.8	171.8	170.9
Total Meat and Meat Products*	2424.9	2335.1	2612.1	3031.9
Butter	609.2	710.5	542.1	701.6
Cheese	319.8	341.0	358.0	412.1
Wholemilk Powder	487.1	443.8	668.4	784.0
Skimmilk and Buttermilk Powder	416.9	534.4	415.5	444.1
Casein and Caseinates	343.7	448.7	450.1	490.4
Total Dairy Products*	2234.1	2534.2	2485.0	2897.1
Meat Meal and Pet Food	73.0	69.0	68.8	53.1
Crude Animal Materials	191.1	201.5	217.1	307.6
Animal Oils and Fats	75.0	65.6	67.3	79.9
Greasy Wool	651.7	418.3	261.3	307.9
Slipe Wool	159.2	125.4	87.4	101.8
Scoured Wool	984.7	772.1	613.8	671.7
Tops and Yarns	113.4	98.2	78.7	90.5
Total Wool*	1909.0	1424.1	1043.7	1172.7
Hides and Skins	556.2	494.8	391.0	355.2
Total Pastoral Based Exports	7675.4	7318.0	7063.9	8083.6
Fresh Kiwifruit	455.1	539.1	519.7	501.6
Apples and Pears, Nashi	161.5	218.3	305.2	335.1
Total Fruits and Vegetables*	824.2	998.6	1069.4	1166.6
Cereals and Cereal Products	27.3	15.1	13.9	23.5
Seeds, Other Vegetable Products	205.5	178.8	275.2	336.0
Eggs and Honey	4.8	4.3	6.5	7.1
Carpets	75.2	88.3	70.6	70.3
Leather	177.6	167.1	172.9	201.1
Dressed Skins	13.3	14.0	19.1	25.6
Total Agricultural Based Exports*	9003.3	8784.1	8751.5	9992.9
Fish	819.0	734.9	791.3	1141.6
Total New Zealand Exports of Goods*	14905.4	15163.5	15768.4	17890.6

*   Includes items not listed

Source: Situation and Outlook for New Zealand Agriculture, 1993
          Ministry of Agriculture and Fisheries

Table 1.3 Sheep and Beef Cattle Inventory

Year ended 30 June	Sheep	Beef Cattle
	(in '000 Head)	
1973	56959	5694
1974	56147	6171
1975	55562	6238
1976	56643	6034
1977	59363	5809
1978	62478	5487
1979	64166	5105
1980	68772	5142
1981	69884	5094
1982	70301	4906
1983	70263	4497
1984	69739	4531
1985	67854	4613
1986	67470	4881
1987	64244	4804
1988	64600	4858
1989	60569	4526
1990	57852	4593
1991	55162	4671
1992	52568	4676

Source: Annual Review of the New Zealand
Sheep and Beef Industry 1992-1993
NZ Meat and Wool Boards' Economic Service

pursuing investments or expenditures on factor and non-factor inputs used in the sheep and beef farm.

The market environment over the study period was an exacting one for farmers as indicated by the terms of trade indices for sheep and beef products shown in Table 1.4. It is apparent from the indices shown that real sheep and beef product prices have fluctuated considerably during the period from 1973 to 1989, around a long-term declining trend.

There has also been significant variation in the relative terms of exchange between commodities over the period. This has been caused either by the cost of a commodity rising faster, or returns increasing more slowly, than those of the other products. In this case, shifts in the relative terms of exchange indicate changes in the enterprise mix. The change in enterprise mix, however, need not necessarily involve a change in livestock. For example, as beef becomes more profitable relative to dairy, more dairy calves will be raised for beef production. Likewise, as real wool returns rise relative to sheepmeat, more "dry" sheep will be kept, producing wool only. This occurred in the late 80s, with the turnaround in wool returns relative to those from lamb. Prior to 1985, real lamb returns had generally been superior (Sandrey and Reynolds, 1990).

Table 1.4 Terms of Exchange Indices for the Pastoral Industries

June Year	Wool	Lamb	Mutton	Beef	Dairy	Pastoral
(1976=100)						
1973	130	134	136	186	115	137
1974	111	121	111	130	113	122
1975	65	71	49	71	100	86
1976	100	100	100	100	100	100
1977	110	113	154	91	92	102
1978	88	92	110	83	88	88
1979	93	100	103	130	84	103
1980	92	89	95	113	83	96
1981	70	76	75	91	84	88
1982	79	88	65	95	85	94
1983	70	80	59	97	90	90
1984	70	84	68	106	87	98
1985	74	81	75	121	87	105
1986	60	40	24	80	79	77
1987	67 ·	58	37	78	65	76
1988	69	41	47	65	70	71
1989	73	46	39	65	87	79

Source: Farming Without Subsidies: The New Zealand Experience
Edited by Sandrey R. and R. Reynolds (1990)

Because of the critical linkages among export receipts from the pastoral sector, employment and economic growth in New Zealand, the government was compelled to make efforts to encourage output from the pastoral sector. This was undertaken through the institutionalization of policy instruments designed to provide assistance to the pastoral sector. The major emphasis of the assistance was to stabilise farmers' incomes.

The assistance measures were broadly categorized as[1]:

1)   Assistance to outputs - effects of those policies which increase the gross returns by influencing output prices (e.g., price supplementation);

2)   Assistance to inputs - effects of those policies that reduce costs (e.g., fertilizer subsidies); and

3)   Assistance to value adding factors - effects of those policies which increase the returns to, or subsidise the use of, the primary factors of production - land, capital and labour (e.g., taxation concessions).

Specifically, the major policy instruments directed at providing assistance to outputs came in the form of an income stabilization scheme and supplementary minimum payments (SMPs). The former scheme, which aimed to encourage farmers to commit sums to an income stabilization fund, was introduced in response to the boom years of 1972-1973 and 1973-1974. As it happened, such a deposit

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[1]Source: Farming Without Subsidies: New Zealand's Recent Experience (1990)

proved beneficial to many farmers in the 1974-1975 season when product prices fell. In 1976, a permanent income stabilization scheme was put up by sheep and beef farmers through the Meat and Wool Boards. This scheme guaranteed a minimum price for meat and wool products and set a trigger price at which level receipts were to be deposited in the stabilization fund. In 1978, the government superimposed on this permanent scheme its own supplementary minimum price (SMP) scheme guaranteeing a minimum price for sheepmeat, wool and beef at the beginning of each season. When international market determined payouts fell below the set minimum, the government made up the difference. The SMPs worked in tandem with the producer board stabilization scheme. The floor price set by the boards was generally lower than that for SMPs. If market prices fell below both set floor prices, government would meet the difference between the SMP and the producer board set minimum, while the producer boards would make up the remainder. The SMP scheme was ended at the close of the 1983-1984 season (although payments were recorded until 1986) while the producer board stabilization scheme, operated through the Meat Industry Stabilization Account (MISA) with the Reserve Bank, ended in 1986. By this time the MISA had accumulated a huge debt as world sheepmeat prices had plunged.

The major forms of policy assistance to inputs were the Livestock Incentive Scheme (LIS), the Land Development Encouragement Loan

(LDEL) scheme and subsidies for the purchase and transport of fertilizer.

The LIS which was introduced in 1978 offered a combination of low interest loans, and/or reductions of loan principal and tax rebates if certain livestock expansion targets were met. The LDEL was introduced in 1978. This scheme included interest free loans and reductions in principal for farmers if certain land development targets were met. The LIS and LDEL schemes were operational during the entire study period although the level of assistance has been substantially reduced since 1986. Fertilizer subsidies, which were paid until 1986, existed mainly to encourage expenditure on this input when farm income was low. Noticeably, fertilizer subsidies were increased during periods when farmers' incomes were low, and reduced when farmers' incomes improved.

The level of assistance extended to the pastoral sector of New Zealand is shown in Table 1.5. This is further presented in detail by commodities in Table 1.6.

As shown in Table 1.6, sheepmeat received the most assistance. The level provided via the SMPs and producer board stabilization in the early and mid 1980s vastly exceeded that for other commodities. This

Table 1.5 Assistance to Pastoral Agriculture

Year Ended March	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
						(Millions of NZ$)							
ASSISTANCE ON OUTPUTS •													
Dairy Board Stabilization	-16	102	116	-23	49	81	0	0	0	0	0	0	0
Meat Industry Stabilization Account	0	0	-44	26	99	270	274	337	176	2	0	0	0
Supplementary Minimum Prices (SMPs)*	0	28	17	1	245	438	346	215	65	0	0	0	0
Inspection, Grading and Hygiene	1	4	34	39	52	60	59	59	63	59	34	35	35
Town Milk Subsidy	3	6	13	10	13	14	15	19	19	23	8	0	0
TOTAL ASSISTANCE ON OUTPUT	-13	141	136	53	457	863	694	630	323	84	42	35	35
ASSISTANCE ON INPUTS													
Fertilizer Subsidies	5	30	62	52	48	44	41	35	12	6	0	0	0
LIS/LDEL	0	0	3	7	14	14	18	10	4	6	7	9	13
Agricultural Pest Control	2	2	5	6	5	5	6	5	4	4	3	3	3
Other	3	1	9	7	7	8	8	7	3	3	4	2	2
TOTAL ASSISTANCE ON INPUTS	9	33	79	72	74	71	73	57	23	19	14	14	18
ASSISTANCE TO VALUE-ADDING FACTORS													
Advisory Services	2	4	7	9	10	12	12	13	14	16	15	13	11
Labour	0	0	9	7	10	11	12	7	6	2	0	0	0
Research/extension (MAF/DSIR)	4	8	27	34	39	44	48	48	51	58	61	46	46
Animal Health and Quarantine	2	8	19	25	30	30	29	29	32	32	32	31	27
Interest Concessions	5	14	45	63	75	92	119	152	242	207	226	92	26
Taxation Concessions	13	25	78	76	79	67	104	96	168	22	17	13	10⁻
Agricultural organizations	***	1	4	2	2	2	2	3	4	3	3	3	3
Rural Bank Debt Write-Off	0	0	0	0	0	0	0	0	0	76	133	0	0
Climatic Relief Grants**	***	***	0	0	0	0	0	0	0	0	0	37	30
TOTAL ASSISTANCE TO VALUE-ADDING FACTORS	27	59	189	216	245	258	326	348	517	416	487	235	153
TOTAL ASSISTANCE	23	233	405	341	776	1192	1093	1035	863	519	543	284	206

*   Includes government grant for meat and wool stabilization in 1975
**   In most years, climatic relief was in the form of interest concessions, and is included in that category
***   less than one million
Source: Farming Without Subsidies: The New Zealand Experience
         Edited by Sandrey R. and R. Reynolds (1990)

Table 1.6 Assistance to Pastoral Agriculture, by Commodity

Year Ended March	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SHEEPMEAT													
Stabilization	0*	0	0	0	72	269	278	346	176	0	0	0	0
SMP	0	26	0	0	53	183	264	201	65	0	0	0	0
Other	*	1	21	22	31	35	34	34	37	35	20	21	21
Total Assistance to output	*	27	21	22	156	486	576	582	278	35	20	21	21
Apportioned Factor**	9	18	49	56	60	61	81	72	64	71	76	28	24
Total Assistance	10	45	70	80	216	548	657	654	342	106	96	49	45
WOOL		..											
SMP	0	2	0	0	148	197	82	14	0	0	0	0	0
Total Assistance to Output	0	2	0	0	148	197	82	14	0	0	0	0	0
Apportioned Factor**	7	22	84	84	96	88	108	111	151	134	157	75	42
Total Assistance	7	24	84	84	244	285	190	125	151	134	157	75	42
BEEF													
Stabilization (MISA)	0	0	-44	26	27	1	-3	-9	0	2	0	0	0
SMP	0	0	0	1	43	58	0	0	0	0	0	0	0
Other	*	1	9	10	14	16	15	15	16	15	9	9	9
Total Assistance to Output	*	1	-35	37	84	75	12	6	16	17	9	9	9
Apportioned Factor**	9	18	64	57	60	70	79	94	110	107	107	57	36
Total Assistance	9	19	29	94	144	145	91	100	126	124	116	66	45
DAIRY													
Stabilization	-16	102	116	-23	49	81	0	0	0	0	0	0	0
SMP	0	0	17	0	0	0	0	0	0	0	0	0	0
Town Milk Subsidy	3	6	13	10	13	14	15	19	19	23	8	0	0
Other	*	2	5	7	8	9	9	9	9	9	5	5	5
Total Assistance to Output	-13	111	151	-6	69	104	24	28	29	32	13	5	5
Apportioned Factor**	11	35	71	89	103	110	131	127	216	124	160	89	69
Total Assistance	-2	146	222	83	172	214	155	155	244	156	173	94	74

*   Less than one million

**   Apportioned factor includes assistance to inputs and assistance to value-adding factors

Source: Farming Without Subsidies: The New Zealand Experience
          Edited by Sandrey R. and R. Reynolds (1990)

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reflected the relatively poor international prices and high SMP and producer board stabilization levels for sheepmeat during this period.

Assistance to wool, mostly in the form of SMPs, peaked in 1983. Assistance to beef remained at moderate levels over the period. In 1984 and 1985, when support to sheepmeat production was exceedingly high, beef producers were actually paying levies into the board stabilization fund as a consequence of strong international beef prices.

Given these myriad of market forces and institutional changes that have occurred during the period covered in the study, it is interesting to know how the average sheep and beef farm in New Zealand fared in terms of changes in the productivity of the enterprise. In addition, the dearth of information on the changes in the productivity of New Zealand's sheep and beef farms gave impetus to this study.

1.2   Objectives of the Study

The general objective of the study is to determine productivity growth of the sheep and beef industry of New Zealand for the period covering 1973-1974 to 1990-1991. Specifically, the study aims to:

i)   measure total factor productivity on the average sheep and beef farm in New Zealand from 1973-1974 to 1990-1991;

ii)   identify the sources of growth in the productivity of the average sheep and beef farm;

iii)   determine the effect of changes in productivity to the sheep and beef farmer in terms of implicit prices received and prices paid; and

iv)   examine the effect of assistance to inputs and outputs on the performance of the sheep and beef farm.