AGRICULTURAL
ECONOMICS
RESEARCH UNIT

Lincoln College

FERTILISER USE IN SOUTHLAND

by

R. W. M. JOHNSON

Research Report No. 54
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THE AGRICULTURAL ECONOMICS RESEARCH UNIT

THE Unit was established in 1962 at Lincoln College with an annual grant from the Department of Scientific and Industrial Research. This general grant has been supplemented by grants from the Wool Research Organisation and other bodies for specific research projects.

The Unit has on hand a long-term programme of research in the fields of agricultural marketing and agricultural production, resource economics, and the relationship between agriculture and the general economy. The results of these research studies will in the future be published as Research Reports as projects are completed. In addition, technical papers, discussion papers, and reprints of papers published or delivered elsewhere will be available on request. For a list of previous publications see inside back cover.

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Agricultural Economics Research Unit Research Report No. 54

PREFACE

The Agricultural Economics Research Unit's programme of research into the economics of fertiliser use in Southland was initiated in 1966 with the help of a grant from the International Potash Federation. The programme has continued over the last three years and two research reports - Numbers 44 and 46 - have been published on the results achieved. The planned research programme is now complete and the present report summarises and completes our reports on this project.

The two earlier reports were prepared by Mr R.C. Jensen of the Agricultural Economics Department and Mr A.C. Lewis of the Research Unit staff; this report has been written by the Unit's Principal Research Officer, Dr R.W.M. Johnson and is based on the accumulated work of all three members of the departments.

Once again, we acknowledge the value of the grants we have received from the International Potash Federation over the last three years and we would also thank the respective officials of the Southland Co-operative Phosphate Company Ltd., and the Department of Agriculture, Invercargill for their co-operation and help in the preparation of this report.

B.P. Philpott

Lincoln College,
May 1969

FERTILISER USE IN SOUTHLAND

INTRODUCTION

The aim of this report is to bring together all the information collected in the course of this research project and to present a synoptic view of fertiliser use in Southland as a guide to the future. The analysis is concerned with all forms of mineral fertiliser used in New Zealand pastoral farming and concentrates on the most important chemical fertiliser used - superphosphate. After reviewing the pattern of agricultural production in the province of Southland, the report considers livestock number trends, new developments in farming likely to affect livestock number trends, the use of fertiliser in pastoral farming, the production of fertiliser in Southland and fluctuations in the demand for fertiliser by farmers.

The review shows that future fertiliser demand in this important pastoral area is closely tied to trends in livestock carrying capacity. It is important to distinguish between increases in carrying capacity due to the intensification of farming and increases due to the improvement of large areas of low fertility land. Intensification leads to a need for a higher and more balanced return of fertiliser nutrients to

the soil where applications are already regular, whereas land development is dependent on heavy initial dressings of lime and superphosphate followed by regular maintenance dressings. The future amount of fertiliser required will depend partly on heavier applications and partly on new land development, and will change in close relation to the overall increase in livestock numbers in Southland.

FARMING IN SOUTHLAND

The two pastoral counties of Southland province, Wallace and Southland, occupy 7431 square miles, or about 4.75 million acres. Of this area 3.25 million acres (68.5 per cent) are in farming occupation while the remainder is forest or mountain slope. There are roughly 5000 farm holdings in the occupied area, of average size 650 acres.

The topography of these two southernmost counties in New Zealand is determined by the valleys of the four main rivers (the Waiau, Aparima, Oreti and Mataura), which all drain into the sea to the south. Occupation and cultivation follows these valleys and towards the coast the Aparima-Oreti and Mataura valleys form a broad coastal plain. This lowland area was formerly forest and rough swamp but it has responded remarkably over the years to drainage and other improvements, to make it one of the premier lamb production areas of New Zealand. The valley sides were formerly covered in Nothofagas forest to the

west where annual rainfall rises to 100" or more, but were covered in sour tussock in the central, northern, and eastern areas where annual rainfall averages 30-40". With sufficient lime and phosphate and drainage, and where the topography is suitable, this type of country can also be converted to fairly high carrying capacity sheep country.

The farming system is based almost entirely on sheep. Since the winters tend to be severe, with frequent frosts, supplementary fodder crops are usually grown, and in conjunction with these a small amount of cash cropping of wheat is found. Grass seed production is found in several of the inland valleys. In 1967 there were 7.34 million sheep and 168 thousand head of cattle in the two counties. On the basis of 1 head of cattle to 5 head of sheep there were approximately $2\frac{1}{2}$ sheep equivalents per acre occupied. Some 83,000 acres of grassland are set aside for hay and silage production each year, and 147,000 acres sown in green, root and other fodder crops.

The plains and valley floors of Southland are characterised by small, heavily stocked holdings (250-300 acres), with a small amount of cash cropping. The valley sides have developed into larger holdings, with less cropping, carrying capacities of 3-4 ewe equivalents, and with the addition of beef cattle. In the wetter areas to the west and to the south-east of Gore, carrying capacities are somewhat greater

than in the northern Lumsden-Mossburn areas. In the higher areas to the north, properties tend to be very large, with fine wool sheep run on largely unimproved fescue tussock. A characteristic of the whole area is the widespread availability of fattening land so that no marked store stock producing area has emerged.

A further characteristic of the region is the continuing improvement of virgin tussock land in the inland valleys and moderately hilly areas. Some 8,000-20,000 acres per year of this type of improvement has been undertaken in recent years. The native tussock is heavily grazed, and then oversown with seed and fertiliser from the air, or it is ploughed by heavy machinery and taken through a cycle of fodder crops before being sown to pasture. Radical improvements in carrying capacity from $\frac{1}{2}$ a ewe equivalent per acre up to 5 ewes per acre can be achieved.

The fertiliser requirements of this type of land improvement are relatively high. In the wetter areas to the west in Wallace county and to the southeast of Southland county, one ton of lime is recommended prior to the sowing of the root crop, and another ton prior to sowing pasture. The root crop, commonly swedes, is sown with 4 cwt of serpentine superphosphate and the pasture with 3 cwt of superphosphate before sowing and again 6 months after sowing. Maintenance dressings are 1 ton of lime when sowing new pasture after roots and 2 cwt of

superphosphate per annum. On the yellow-brown earth soils 30% potassic superphosphate is recommended at 3 cwt per acre.

In northern Southland, development of tussock country by oversowing requires 3 cwt of superphosphate in the first spring (with molybdate), 2 cwt sulphur superphosphate in the following autumn and a further 2 cwt every two years after.

LIVESTOCK TRENDS IN SOUTHLAND

In recent years, the expansion of the pastoral industry in Southland has been quite spectacular (see box). Since 1950 sheep numbers have increased at an annual rate of 4.6 per cent compared with the national average of 3.6 per cent for the same period. Expressed another way, sheep numbers in Southland county have doubled since 1949, and doubled in Wallace county since 1955. In the last 10 years beef cattle numbers have increased at an annual rate of 5.5 per cent compared with the national average of 4.2 per cent.

Sheep and Beef Cattle Numbers in Southland 1950-67

	Sheep		Beef Cattle	
	Southland	Wallace	Southland	Wallace
1950	2,781,695	889,210	N.A.	N.A.
1955	3,409,905	1,087,823	70,854	29,383
1960	4,119,428	1,324,938	68,562	33,215
1965	4,862,700	1,905,369	103,427	49,217
1967	5,239,196	2,108,942	107,235	61,316

At the time of the Agricultural Development Conference in 1963-64, the Department of Agriculture was asked to prepare forecasts of livestock numbers for 1965, 1967 and 1972. At that time, the Department forecast that total sheep numbers in Southland would reach 7,667,600 in 1967 and 8,691,900 in 1972; and cattle numbers would reach 136,700 and 156,050 respectively. As can be seen from the data in the box, sheep have not increased quite as fast as expected but cattle numbers have increased somewhat faster than expected. For the 1962-67 period the Department forecast expansion of sheep numbers at 4.7 per cent per annum and cattle numbers at 2.3 per cent per annum. In fact a rate of increase of only 3.9 per cent was achieved for sheep as compared with 6.7 per cent for cattle numbers.

In 1968, the departmental estimates were again revised. In the light of experience the Southland forecasts for sheep for 1967-72 were raised from a rate of 2.6 to 2.8 per cent, and those for beef cattle from 2.7 per cent to 7.7 per cent.

For the period 1972-78, sheep numbers in Southland are estimated as increasing at 3.3 per cent and cattle numbers at 4.1 per cent per year. The resulting estimates of livestock numbers are shown in the next box.*

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* Estimates kindly supplied by Field Superintendent, Department of Agriculture, Invercargill.

Sheep and Beef Cattle Numbers in Southland 1967-78

	Sheep		Beef Cattle	
	Southland	Wallace	Southland	Wallace
1967	5,239,000	2,109,000	107,000	61,000
1972	5,925,000	2,501,000	152,000	93,000
1978	7,074,000	3,181,000	194,000	118,000

Source: Department of Agriculture, Invercargill.

The specific number of either sheep or cattle in Southland will largely depend on further changes in the relative profitability of the two. In the aggregate, however, the Department estimates that the carrying capacity of the two counties will continue to expand at 3.3 - 3.4 per cent per year throughout the 1970's. This estimate provides a satisfactory basis for estimating fertiliser requirements in the 1970's.

DEVELOPMENT OF THE EXTENSIVE MARGIN

Development at the extensive margin is defined as those areas where improved pastoral carrying capacity is brought about by the use of fertiliser for the first time. In the Southland situation this means 2 tons of ground limestone per acre and 4-6 cwt of superphosphate per acre as the initial dressing. Thereafter, an annual maintenance dressing of $1\frac{1}{2}$-2 cwt of superphosphate has been deemed sufficient.

The statistics of farm production in New Zealand carefully distinguish between new pasture sown out of virgin land and new pasture following earlier sown pastures. In the two counties of Southland, the newly improved area has varied from 8,000 to 20,000 acres per year, with a tendency for larger areas to be developed after satisfactory seasons for export prices.

While these large spurts in development have been largely related to economic conditions in the pastoral industry, it is not possible to find a direct linkage between them and increases in livestock carrying capacity. The annual increase at the margin is fairly small in terms of the total improved pasture area, and hence may have little effect on total carrying capacity. There is only a fairly uncertain relationship apparent in the statistics which indicates that significant increases in livestock numbers tend to follow three years after the year of sowing down new pasture. Thus Wallace County had large areas of new pasture in 1955, 1959, 1962 and 1967, while sheep numbers rose markedly in 1958, 1961, 1962 and 1965. In Southland County, larger areas were sown down in 1951, 1954, 1955, 1962 and 1967, with larger stock increases in 1953, 1957, 1961 and 1965.

This is an exceedingly tentative basis for projection, and does not provide strong evidence for future changes in stock numbers

and hence fertiliser requirements, in spite of the large per acre fertiliser applications required in such development programmes.

DEVELOPMENT AT THE INTENSIVE MARGIN

Greater stock numbers in Southland can also be gained by small improvements to land which is considered reasonably developed already. The techniques of stock management at higher carrying capacities depend on the more intensive use of fertiliser, drainage, pasture management and the like. For development at the intensive margin, the rate of maintenance dressing of fertiliser must be increased.

This situation has already been explored in two earlier publications in this series; one on past trends on identical intensive farms in Southland in the period 1954-65 and one on budgeting profitability for high carrying capacity on such farms.

In Research Report 44, it was found that the annual use of lime on the sample of intensive farms had declined from 7-8 cwt per acre of farms in 1952-54 down to 2 cwt of lime per acre in 1962-64. Annual liming was recommended for sown pastures up to the early 1950's but more recently this recommendation has been altered to 1 ton of lime per acre at sowing down alone. The rate of application of lime has probably remained the same, but the frequency of application

has declined considerably.

On the same sample of farms it was found that average phosphatic fertiliser usage had been remarkably constant at 2 cwt per acre of farm over the period 1952-65. At the same time carrying capacity of livestock had increased from $4\frac{1}{2}$ ewe equivalents per acre to $5\frac{1}{2}$ ewe equivalents per acre. It seems clear that this increase in carrying capacity had been achieved without a more intensive use of either lime or phosphate. Pasture management and stock management have improved in this period, and it seems reasonable to assume that better use is now being made of fertiliser without any increase in its rate of application.

In the future, further intensive development of such pastures is expected to require greater amounts of fertiliser as well as other inputs. For example as available supplies in the soil become depleted more potash will be required, and a marked increase in fertiliser use per acre may be expected. Thus, to raise carrying capacity to 8 ewe equivalents per acre from $5\frac{1}{2}$ ewes per acre, a 45 per cent increase in carrying capacity, Messrs Jensen and Lewis suggested that overall fertiliser use will have to increase by 100 per cent.*

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* Research Report No. 46, pp. 6 and 30. A clear picture of maintenance requirements at higher stocking rates has not yet emerged and further experience of higher stocking rates is required before this can be predicted with confidence.

The increased stock numbers brought about by development at the intensive margin are difficult to ascertain without details of existing areas and stocking rates. In Southland, stock numbers will increase by both forms of development mentioned here, and it seems likely that fertiliser requirements will increase faster than livestock numbers as long as some farm intensification is involved in the future expansion of the pastoral industry in Southland. More details of this are set out in the following section.

TRENDS IN FERTILISER USE IN SOUTHLAND

As might be expected the use of phosphatic fertiliser in Southland province has increased rapidly in recent years, but the use of lime has almost remained stationary. The statistics of farm production have only collected weights of fertiliser used since 1962, and these figures are shown in the attached table. Over the five years from 1962 to 1967 the physical weight of phosphatic fertiliser applied to pasture in the two counties has increased at an annual rate of 11 per cent, i.e. a doubling in demand every $7\frac{1}{4}$ years. In the 1967-68 season, there was a decline of 9 per cent in fertiliser used and a decline of 40 per cent of lime applied. The annual amount of phosphates required for sown crops has been fairly constant at 34,000 tons per annum for some years.

Weight of Fertiliser & Lime Applied to Pasture Southland Counties 1962-1968

	Mineral Fertiliser	Lime
1961-62	83,003 tons	175,150 tons
1962-63	76,498	144,413
1963-64	97,195	199,852
1964-65	122,222	212,515
1965-66	127,807	158,201
1966-67	140,160	169,347
1967-68*	128,630	120,726

Source: Statistics of Farm Production

The statistics of pastoral areas spread with fertiliser have been collected for many years, and distinguish between three possible ways of applications, phosphatic fertiliser alone, lime alone, and fertiliser and lime together (i.e. both applied in the same year). Trends in areas treated are shown on the attached graph. The area of pasture limed each year in Southland has fallen from the post-war level of about 150,000 acres each year down to 60,000 acres per year. In the post-war period a further 250,000 acres of pasture was treated with both lime and fertiliser - this too has declined to about 120,000 acres in recent years.

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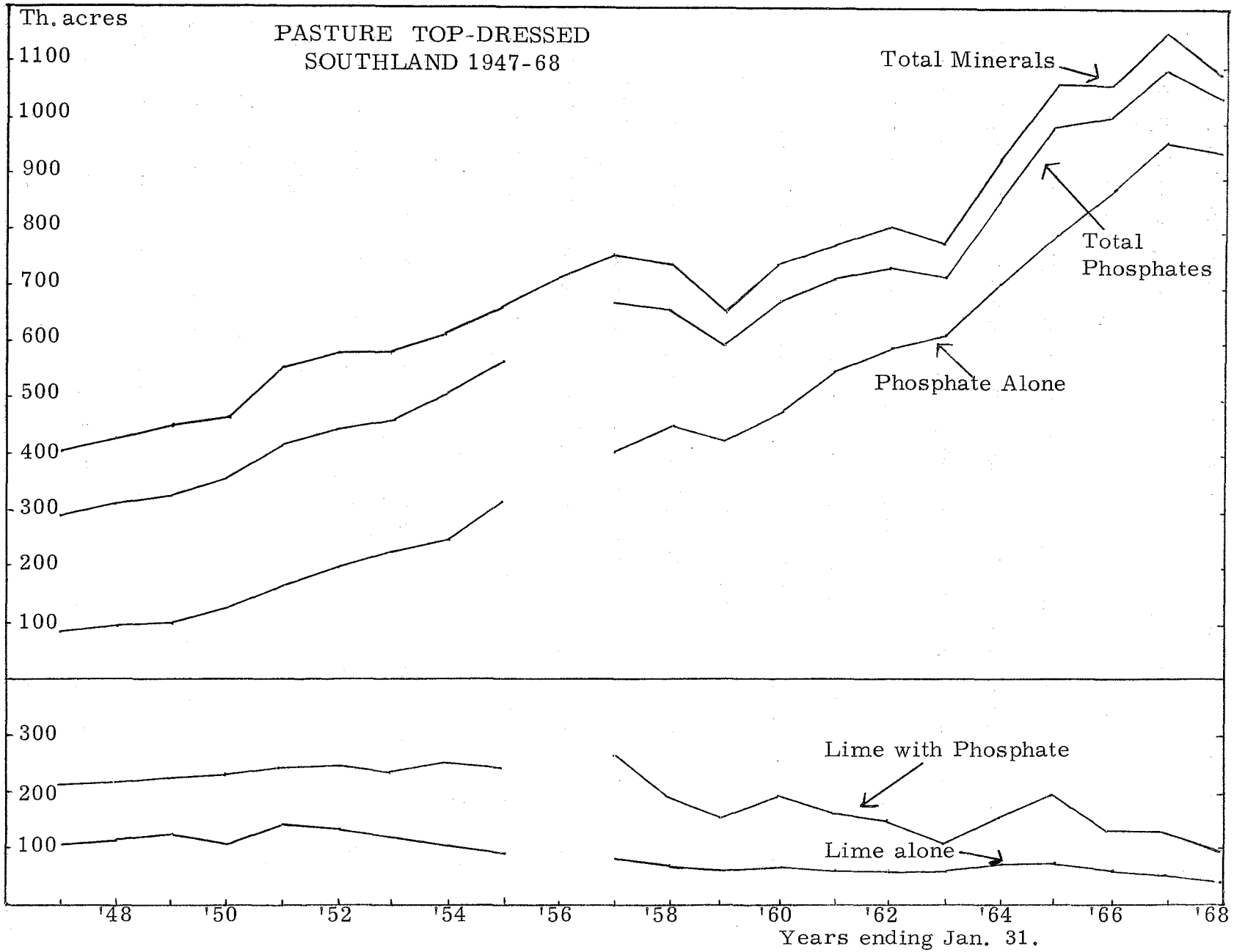
* Data kindly supplied in advance of publication by The Government Statistician.


Th. acres
PASTURE TOP-DRESSED
SOUTHLAND 1947-68
1100
1000
900
800
700
600
500
400
300
200
100
Total Minerals
Total Phosphates
Phosphate Alone
300
200
100
Lime with Phosphate
Lime alone
'48
'50
'52
'54
'56
'58
'60
'62
'64
'66
'68
Years ending Jan. 31.

The most marked increase has occurred in the area of pasture which receives phosphatic fertilisers alone. From barely 100,000 acres in 1947, this area has been increased to 960,000 acres in 1967 - a compound rate of increase of some 12.5 per cent per year. The total area which received lime or phosphates has increased from 400,000 acres in 1947 to 1,156,000 acres in 1967. This is a compound rate of increase of 5.3 per cent per year, which is the more accurate measure of the trend in total mineral use in the province. A large proportion of phosphatic fertiliser which used to be applied in conjunction with lime is now applied alone.

Over the period from 1962 to 1967 the total area of pasture receiving mineral dressings has increased at an annual rate of $7\frac{1}{2}$ per cent, though the area receiving phosphates alone or in conjunction with lime increased at 8.2 per cent. Over the ten year period from 1957 to 1967 the total area dressed with phosphates only increased at 5.1 per cent per year, hence there was a considerable spurt in development after 1962. Fertiliser demand levelled off in 1967-68 hence it would be premature to accept that 8.2 per cent per year was the growth rate for pasture topdressed with phosphatic fertilisers in Southland at this point.

A further point of considerable interest is that the quantity of phosphates applied to pasture has been increasing at a faster rate than the area covered (11 per cent compared with 8.2 per cent for the period

1962-67). This difference is made up by a fairly steady upward trend in rate of application from 2.24 cwt/acre in 1961-62 to 2.56 cwt per acre in 1966-67. Expressed another way, the total application per ewe equivalent has increased from $\frac{1}{4}$ cwt to one-third cwt per ewe equivalent. Thus intensity of application of phosphate fertilisers was increasing up to 1967 at a rate of 2.7 per cent per year, and area of application was increasing at 8.2 per cent per year making a total increase in demand of 11 per cent per year. The average application fell back to 2.48 cwt per acre in 1967/68 which is still considerably higher than the rate in the early 1960's.

Taking pastoral and crop demand for fertiliser together, the next box shows total demand for phosphatic fertiliser in the two counties since 1962. Direct measures of the amounts required for cash and forage crops are not available so it has been assumed that the area of cash crops is sown at an average rate of 2 cwt per acre and the area of forage crops is sown at an average rate of 4 cwt per acre.

On this basis, the total demand for phosphatic fertiliser in Southland increased at an annual rate of 8.4 per cent per year from 1962 to 1967, with the pastoral component divided as before into an intensive portion and an extensive portion.

Total Demand for Phosphates in Southland 1962-68

	Pastoral	Cropping	Total
		tons	
1961-62	83,003	33,306	116,309
1962-63	76,498	32,809	109,307
1963-64	97,195	33,901	131,096
1964-65	122,222	34,727	156,949
1965-66	127,807	33,930	161,737
1966-67	140,160	34,126	174,286
1967-68	128,630	34,000	162,630

THE PRODUCTION OF PHOSPHATIC FERTILISER IN SOUTHLAND

Prior to 1958 all Southland supplies of phosphatic fertiliser came from the two manufacturing plants situated in the Dunedin area (Burnside and Ravensbourne). In that year the Southland Co-operative Phosphate Company's new plant at Awarua came into production, and started to meet local demand. As can be seen in the accompanying table, the output of fertiliser from the Awarua works has since increased rapidly and since 1966 output has fully met the requirements of Southland province alone. Comparing December 31 production years with January 31 application years, farmers in the two counties of Southland absorbed just on 100 per cent of the output of the Awarua works (1965-67 data).

Southland Co-operative Phosphate Co. Ltd.

Sales Tonnage Despatched

	Tons
Period ending 31st March 1959	25,649
Year ending 31st March 1960	76,420
1961	93,410
1962	96,703
1963	98,627
1964	129,143
1965	152,394
1966	164,051
1967	163,815
1968	179,823
1969	184,623

Source: Annual Reports and Statements of Accounts.

At this point it should be made clear that detailed analysis of the manufacture of phosphatic fertilisers is not intended, but it is desirable to examine certain aspects of the use of fertiliser in Southland which can only be illustrated from the manufacturing end. This includes details of the seasonal distribution of fertiliser application, types of fertiliser used on farms, costs of fertiliser, and availability of fertiliser.

As the Southland Co-operative Phosphate Company has been expanding rapidly in recent years, larger outputs have been

obtainable from its plant by mixing serpentine superphosphates rather than offering ordinary superphosphate. As the following box shows, about 30 per cent of all phosphatic fertilisers sold by the company has been in the form of serpentine superphosphate, with potash mixtures next most important. Straight superphosphate has been next most important and is now produced in the largest quantities. The various mineral and trace element mixtures make up the remainder of factory output.

Southland Co-operative Phosphate Co. Ltd.

Yearly Analysis of Tonnage Despatched
(calendar years)(Tons)

	1964	1965	1966	1967	1968
Serpentine Superphosphate	41,903	60,190	72,682	45,683	29,776
Potash Superphosphates	32,149	39,158	37,649	35,122	28,623
Straight Superphosphates(0-9-0)	22,309	11,633	641	35,937	63,364
Reverted Superphosphate	11,218	12,431	9,846	10,127	8,015
Boron Mixtures	2,144	2,951	2,906	2,463	2,755
Cobalt Mixtures	4,645	5,092	6,710	3,001	2,787
Molybdate Mixtures	4,689	5,786	4,929	3,435	4,629
Sulphur Mixtures	6,250	6,481	3,187	5,585	4,230
Muriate of Potash	4,423	2,585	4,913	4,203	3,096
Other Mixtures	19,791	25,325	29,615	19,959	25,176
	149,521	171,632	173,078	165,515	172,451

Source: Southland Co-operative Phosphate Company Ltd.

The production run of the Company's plant in calendar years approximates fairly closely to the January 31 year on which farm production statistics are based. It is clear that the large increase in output in 1965 and 1966 was almost entirely in the form of serpentine superphosphate, and this in turn was cut back in 1967. The demand for the remaining mixtures has stayed remarkably constant and only the production of straight superphosphate has fluctuated markedly, as the policy with regard to serpentine has changed. Special mixtures prepared for clients also dropped off markedly in 1967, which seems to bear out the view that in times of economic recession, farmers cut back on their total requirements of fertiliser (i.e. serpentine) and also fancy mixtures. In general, there is no marked evidence in the plant output data for more intensive farm use of fertiliser mixtures (including potash) as opposed to phosphate in its traditional forms.

The use of imported potash in recent years by the Awarua Company has closely followed sales of potash superphosphate and muriate of potash. From 1960 to 1963 the Company was importing around 10,000 tons per calendar year, and from 1964 to 1967 about 15,000 tons per year. Present indications are that 13,500 tons were required in 1968. While the Department of Agriculture recommends the use of potash superphosphate on highly intensive farms, there is no evidence of any upward trend in manufacture at the moment to

forecast larger imports of potash in the future.* In view of the present world over-supply of potash, and cheaper landed prices, some price incentive might yet be available to interest farmers somewhat more in this particular mixture.

The analysis of monthly despatch figures from the Southland Co-operative Phosphate Company's plant also provides clear indications of the seasonal use of artificial fertilisers by farmers. As the following data shows, the peak month of despatch is August, followed about equally by March and November. August demand is created by spring top-dressing of pasture and March by autumn requirements. In November, all root crops and new pastures are sown down.

Compared with the South Island as a whole, autumn application in Southland is considerably less, made up by the above average spring application and the late November application. Compared with New Zealand as a whole, these differences are even more defined as the North Island evidently puts 60 per cent of its requirements on the land in the autumn compared with Southland's 41 per cent.

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* There is some evidence that the yellow-brown earth soils have not been getting sufficient potash in recent years; correction of this trend seems to be closely linked with current economic conditions.

Southland Co-operative Phosphate Co. Ltd.

Monthly Despatch of Fertiliser 1964-67

Month	Awarua[1]		All S.I.[2]	All N.Z.[2]
	Weight tons	Per Cent	Per Cent	Per Cent
January	7,475	4.5	6.4	7.6
February	8,800	5.4	8.6	9.5
March	19,224	11.7	12.9	14.7
April	12,600	7.6	9.1	12.3
May	11,625	7.1	6.9	8.4
June	8,550	5.2	5.5	5.2
July	13,775	8.4	7.5	4.4
August	28,000	17.0	12.4	7.4
September	13,575	8.3	8.4	8.6
October	10,075	6.1	6.9	8.5
November	19,850	12.1	8.4	7.1
December	10,800	6.6	6.4	6.7
	164,349	100.0	100.0	100.0

Sources: 1. Southland Co-operative Phosphate Co. Ltd.
2. "Statistical Review of Fertilisers in N.Z. 1966-67" Biometrics Section, Department of Agriculture, Wellington, N.Z.

The pattern of seasonal demand for fertiliser in Southland is also related to the desirable plant capacity required for the area and its relation to delays in executing orders. Roughly speaking, the present sulphuric acid plants of Awarua have an annual capacity

of the equivalent of 120,000 tons of superphosphate each. This gives an average monthly capacity of 20,000 tons of superphosphate. At present this capacity rating is only exceeded in August, and this follows four months of very low demand.* The Company's management can claim that all orders are filled as required at present, hence there is no evidence of a shortage of capacity to deliver fertiliser as it is required.

A more even distribution of demand would have other advantages, however, if the weather and other conditions permitted. If present total yearly productive capacity could be utilised more fully, considerable savings in the price of fertiliser manufactured could be achieved. According to the Annual Statement of Accounts for 1968, the sale value of each ton of fertiliser produced is $23.75. The cost of production is $20.77, made up of $16.15 for materials and other proportional costs, and $4.62 of overheads. This is based on an output of 180,000 tons. The remainder goes to the annual rebate to farmers, currently at $3 per ton. Let us assume output is increased to 200,000 tons and then 220,000 tons. Materials will presumably go on costing $16.15 per ton, but overheads will be spread over a

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* An output of fertiliser of 36,800 tons was achieved in August 1968.

greater output and overhead costs per ton will fall from $4.62 to $4.16 and $3.77 respectively. There is thus a cost saving of 2% of the cost of production for every extra 20,000 tons produced.

These figures are very approximate and not all overheads will stay constant with greater working hours of the plant, but the calculations do point to the advantages of achieving a more even spread of demand throughout the year even if agricultural routine is not flexible in this respect. Perhaps the Southland Company could explore the implications of cut-price (or high rebate) fertiliser in the winter months so as to keep their plant more fully utilised throughout the year?

FLUCTUATIONS IN THE DEMAND FOR FERTILISER IN SOUTHLAND

In the post-war period the annual use of fertiliser in Southland has fluctuated considerably with changes in economic conditions. The graph of trends in fertiliser use on pastures (p.13) shows marked set-backs in 1958-59 and 1962-63 particularly and fairly rapid increases in application in 1950-51, 1956-57, 1961-62, 1963-64 and 1964-65. Economic knowledge indicates that there may be two fairly different reasons for these fluctuations.

In the first place, the price of fertiliser itself has been changing, and it might be expected that when its cost per unit increased farmers would tend to be parsimonious in what they use. Secondly, the level

of prosperity of farming is likely to be influential in determining farmers' demand for fertiliser. Maintenance dressings of fertiliser can be postponed in the short run and made up at a later date. Capital expenditure can be delayed indefinitely.

To obtain specific information on this aspect of fertiliser economics, the Agricultural Economics Research Unit has taken a small sample of farms from intensive production areas and studied their purchases of fertiliser over a twelve year period. The full details of the analysis are shown as an appendix to this paper.

Over the period from 1953-54 to 1964-65 the 22 farms in the sample used about 600 tons of fertiliser per year, but in the 1955-56 season they used 690 tons and in the 1962-63 season they used 480 tons. We are interested to find out whether these farmers were more influenced by changes in the cost of fertiliser or changes in their net income position, i.e. the general level of farm prosperity.

The first step in the analysis was to relate the annual use of fertiliser to its cost per unit. It might be expected that as the cost of fertiliser increased farmers would have a tendency to use less. Over the twelve years it was found that farmers did in fact vary their purchases of fertiliser in proportion to its cost, buying more when cost per unit fell and less when cost per unit increased. Furthermore it was established that for a one per cent change in the cost of fertiliser,

the quantity demanded by farmers changed by 3 per cent. Evidently, farmers react fairly sharply to changes in the cost per unit of inputs such as fertilisers.

The prosperity of intensive farming in Southland depends largely on trends in fat lamb selling prices and auction prices for cross-bred wool. Investigation of the farmer purchases of fertiliser over the twelve year period showed that there was a correspondence between purchases and product prices - when product prices were good, purchases of fertiliser were higher and vice versa. Lamb prices were found to be more influential than wool prices - one per cent change in lamb prices being associated with 0.4 per cent change in fertiliser use and a one per cent change in wool prices being associated with 0.2 per cent change in fertiliser use. Taking the two prices together - and giving lamb prices a weight of 75 per cent - a one per cent change in the weighted price index was associated with a 0.62 per cent change in fertiliser use. Thus the level of prosperity of farming does have an important effect on the purchases of inputs such as fertiliser, but the effect is not a sharp one and tends to be less dramatic than changes in the cost per unit of fertiliser.

Finally, the weighted price index and the cost per unit of fertiliser were considered together. In this case, the relationships were not as clear-cut as previously as there happens to be a marked

inverse relationship between the cost of fertiliser and the weighted price of wool and lamb over the period concerned. Nevertheless, both influences should be measured in combination as the previous estimates for one could be partly measuring influences caused by the other. Taken together, a one per cent change in the unit cost of fertiliser is associated with a 1.8 per cent change in fertiliser use while a one per cent change in weighted product prices is associated with a 0.4 per cent change in fertiliser use. The effect of changes in the unit cost of fertiliser is thus still relatively sharp compared with the effect of changes in product prices.

The Southland Co-operative Phosphate Company has not yet experienced a sharp fall in the demand for fertiliser as it has been supplying fertiliser in an expanding market ever since its inception. In the future, however, with most of the requirements of Southland province supplied from Awarua, the annual output of the plant will be determined by farmer demand for its product. As long as raw materials can be obtained for reasonably steady prices, the cost of fertiliser may not fluctuate much. But product prices tend to be outside New Zealand's control with pronounced fluctuations as well. On the tentative evidence available from the sample of farms studied, a ten per cent fall in product prices could cause a 4-6 per cent fall in the demand for fertiliser in any given year.

On the national level the following data shows the relationship between export prices and fertiliser deliveries:

Season	Export Prices (1960=1000)	Per Cent Change	Fertiliser Deliveries (m. tons)	Per Cent Change
1961-62	936	- 2	1.21	- 4
1962-63	1009	+ 8	1.34	+11
1963-64	1138	+14	1.77	+20
1964-65	1119	- 2	1.77	+10
1965-66	1113	- 1	1.98	+12
1966-67	1048	- 6	1.75	-12
1967-68	1020	- 1	1.58	-10

Source: Statistical Review of Fertilisers in New Zealand 1967/68, Dept. of Agriculture, Wellington.

The export price index and the fertiliser deliveries are for June years. As well as falling and rising in sympathy with export prices, fertiliser demand also changes by greater percentages than export prices. This evidence on a national scale thus tends to suggest that the small sample of farmers analysed in Southland have provided a result which is an under-estimate of the true position. The sample estimate relates to farm intensification in Southland only, while the national figures will include a higher proportion of demand from new land. These results would be consistent with farmers holding back development plans in periods of low prices,

and expanding in periods of better prices.

In general, the fertiliser industry in Southland must expect fluctuations in demand at least equal to the percentage change in product prices, if account is to be taken of fluctuations in extensive land development as well as fluctuations at the intensive margin.

SUMMARY AND CONCLUSIONS

Without doubt, the future demand for fertiliser in the Southland area is closely linked with the expansion of pastoral production. The dynamic element in the pattern of farming is pasture production and not crop production. The best indicator of the expansion in pastoral production to be expected is livestock numbers. Fertiliser demand must be some progressive proportion of livestock numbers.

In the past, the demand for fertiliser has expanded at twice the rate of expansion of livestock numbers. That is, in the period 1962-67 particularly, the weight of fertiliser used for all purposes in Southland increased at an annual rate of 8.4 per cent while ewe equivalents increased at an annual rate of 4.2 per cent.

The demand for fertiliser for crops is relatively constant. But the amount of fertilisers used for pastoral production has been increasing at an annual rate of 11 per cent over the period 1962-67.

Of this total requirement for pasture production, part is

required for new land being improved and part for increased dressings on pasture sown down in the past. Thus it can be calculated that nearly 3 per cent of the past increase in demand for pasture top-dressing is due to farm intensification and 8 per cent is due to new areas being developed.

Future demand will depend upon the rate of increase of carrying capacity that farmers achieve, which in turn depends upon how farmers react to changing economic conditions. The Department of Agriculture at Invercargill suggests a rate of expansion of livestock numbers of 3.4 per cent per year might be achieved in the decade ahead. With reasonable prospects for the selling of meat products overseas, this estimate appears to be slightly conservative but fairly realistic in view of the 4.2 per cent rate achieved in 1962-67.

The long term rate of increase of fertiliser demand in the region, therefore, is likely to be between 7 and 8 per cent per year. If intensification increases relative to extensive development, demand could increase slightly faster. On top of this the fertiliser industry must expect fairly marked fluctuations in demand from year to year. In terms of the national totals as well as by the analysis of a sample of intensive fat lamb farms in the area, the industry can expect a 10 per cent change in demand for every 10 per cent change in export prices. In periods of lowered income farmers can postpone maintenance dressings

and they also hold back on re-investment in new improvements. These drops in demand are then made up in subsequent periods when funds become more freely available out of current income. In this way farmers pass on to other sections of the community some of the burden of fluctuating international prices of our main export products.

STATISTICAL APPENDIX

Let Q_t = Amount of phosphatic fertiliser bought in June Year t

A_t = Area of productive land in year t ($\bar{A}_t = 274$)

P_F = Works price of fertiliser in bulk in year t.

P_L = Price of 29-36 lb. prime lamb January of June year t.

P_W = Price of crossbred wool (average auction) for December of year t.

P_{WL} = A weighted price of lamb and wool according to relative weights in average gross farm income.

$$\text{i.e. } \frac{P_W + 2.75\, P_L}{3.75}$$

N = 12 (1953-4 to 1964-5)

(1) The demand equation

$$\text{Log } \frac{Q_t}{A_t} = \underset{(1.11)}{5.14 - 3.31 \text{ Log } P_F} \qquad r^2 = 0.47$$

(2) The income equation for lamb and wool prices

$$\text{Log } \frac{Q_t}{A_t} = -0.99 + \underset{(0.18)}{0.42 \text{ Log } P_L} + \underset{(0.20)}{0.18 \text{ Log } P_W} \qquad r^2 = 0.52$$

(3) The income equation for weighted lamb and wool prices

$$\text{Log } \frac{Q_t}{A_t} = -0.98 + \underset{(0.19)}{0.62 \text{ Log } P_{WL}} \qquad r^2 = 0.50$$

(4) Combined demand and income equation

$$\text{Log } \frac{Q_t}{A_t} = 2.56 - \underset{(1.46)}{1.78 \text{ Log } P_F} + \underset{(0.26)}{0.39 \text{ Log } P_{WL}} \qquad r^2 = 0.57$$

Note: Standard errors of β coefficients in parenthesis.

GLOSSARY

Superphosphate (0. 9. 0) is the product of mixing rock phosphate with sulphuric acid. Insoluble tricalcic phosphate is converted to monocalcic phosphate which is more readily soluble.

Aerial Superphosphate (0. 8. 0) is superphosphate with 10 per cent added ground serpentine rock to obtain desirable spreading properties.

Reverted Superphosphate (0. 7. 0) is made by mixing 25 per cent carbonate of lime with superphosphate to convert monocalcic phosphate to dicalcic phosphate, making the phosphate less soluble in water - though still readily available in the presence of weak soil acids. Does not "burn" sensitive seedlings, e.g. brassicas.

Serpentine Superphosphate (0. 7. 0) results from mixing 3 parts of freshly made superphosphate with one part of finely ground serpentine rock. The magnesium silicate material in the rock produces di-magnesium phosphate as well as dicalcic phosphate and produces a magnesium enriched reverted superphosphate.

Potash Serpentine Super (0. 5. 12 and 0. 5. 16) is made by mixing serpentine superphosphate with muriate of potash in 3:1 and 2:1 proportions respectively.

Sulphur Super and Sulphur Serpentine Super are made with either 224 lbs. or 448 lbs. of raw flowers of sulphur included in a ton of mixture.

Mineral Mixtures of Phosphates available include Boron, Cobalt, Copper, Molybdate and D.D.T. supplementations.

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