AGRICULTURAL ECONOMICS RESEARCH UNIT

Lincoln College

PROFITABILITY OF A RECOMMENDED STRATEGY FOR DEVELOPMENT ON TWO BANKS PENINSULA FARMS

by

A. T. G. McArthur

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THE AGRICULTURAL ECONOMICS RESEARCH UNIT

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PROFITABILITY OF A RECOMMENDED STRATEGY FOR DEVELOPMENT ON TWO BANKS PENINSULA FARMS

A.T.G. McARTHUR

Senior Lecturer in Rural Education

Lincoln College
(University of Canterbury)

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P R E F A C E

The Agricultural Economics Research Unit has in progress a series of case studies of the profitability of farm development in various parts of New Zealand. The present paper represents the results of one of these studies referring to two hill country farms on Banks Peninsula.

The high profitability of development reported by Mr McArthur in this study is encouraging. However, it must be appreciated that development on these two farms has been made on a groundwork provided by research and extension of the Department of Agriculture.

The research underlying this paper represents part of a research programme by Mr McArthur on the economic and human aspects of farm development on Banks Peninsula. His interest lies in extension planning, one of the aims of which is to allocate advisory officers to districts in such a way as to maximise the response in national farm efficiency. In this problem both human and economic factors have to be considered. The profitability to the nation and to the individual farmer are obviously important and this is reported here. Equally important is the rate at which farmers are likely to adopt the development programme advocated by advisory officers.

Further work which will be published in later reports concerns the rate of adoption of development recommendations and the factors which influence the speed of this process.

Lincoln College
January 1965

B. P. Philpott

PROFITABILITY OF A RECOMMENDED STRATEGY FOR DEVELOPMENT ON TWO BANKS PENINSULA FARMS[1]

INTRODUCTION

Rational decisions by New Zealand on national development depend on information on the economic outcome of the use of scarce resources. Data on the efficiency of capital use for farm development can be used to make decisions upon the degree of encouragement to be given to the agricultural sector of the economy in relation to the degree of encouragement to be given to other sectors. Furthermore, within the agricultural sector, information on the economics of farm development is one of the factors

[1] The author is grateful to Dr. J.T. Ward for advice on the method of economic analysis and to Professor B.P. Philpott, Mr. C.J. MacKenzie, R.J. Townsley and R. Court for helpful criticism and suggestions.

I am extremely indebted to Mr. D.L. Johns and Mr. W.A. Newton of Akaroa for making their records available for analysis and going to great pains to find the records needed for this analysis and for helping to make estimates from their experience. The community owes them a debt for pioneering new methods of farming in a static area in the face of social pressure towards conformity and uncertainty about the outcome. The cost of similar information from a state research farm would be considerable.

Finally to Mr. Brian McSweeney, Farm Advisory Officer, Akaroa and Mr. A.G. Barwell, Farm Advisory Officer (Economics), Department of Agriculture, for information and help in preparing this bulletin.

which should be taken into account when making institutional decisions on research, extension and lending.

The case studies of two Banks Peninsula farms which have carried out a programme of development as recommended by the Department of Agriculture are reported in this bulletin.

This report gives some background information about farming on Banks Peninsula, sets up the hypothesis which is tested by the case study farms, describes the technical changes made on these farms, discusses the methodology of the economic analysis designed to test the hypothesis, presents the results, and finally discusses the interpretation and use of the results.

FARMING ON BANKS PENINSULA

Barrer and Johns (1954), Stuart and Tocker (1955) and Barrer and Stuart (1960) have published excellent descriptions of Banks Peninsula farming. Readers who are unfamiliar with the district are referred to these articles. However, the following notes give a brief outline.

Area: The area of the three Peninsula counties, Mt. Herbert, Akaroa and Wairewa is 221,000 acres, lying South East of Christchurch on the East Coast of New Zealand's South Island.

Geology: The Peninsula was formed by volcanic action, the Lyttelton and Akaroa Harbours are believed to be the remnants of the two main craters. The underlying rock is basalt.

Topography: The hills are steep with only a small ploughable area. The highest point, Mt. Herbert, is 3,000 feet. The land used for farming varies in altitude from 2,000 feet to sea level.

Soils: Loess covers 80 percent of the basalt rock particularly on the tops of the hills and ridges and fills the gullies. Loess formed soils are classified as yellow grey earths at the lower altitudes where the rainfall is low (20 to 25 inches). The soils are classified as yellow brown earths where the rainfall is high (25 to 100 inches). These loess derived soils respond to lime, molybdenum and phosphate. Soils formed from the volcanic basaltic rock are classified as brown earths. These, in general, occur on the steep slopes or just below the steep slopes where the naked basalt rock is not covered by loess. Even here these soils are interspersed with patches of soils formed from loess. The volcanic brown earths are lime rich and do not give marked fertilizer responses.

Climate: The rainfall varies from an annual average of 20 inches on the coast to 100 inches on the tops. However the modal rainfall for the largest groups of farms lies in the 30 to 40 inch range. Snow lies on the tops of the hills for a few days each year, but in general the climate of the Peninsula is milder than the Canterbury Plains and more humid except near the coast.

Cover: Originally bush covered the Peninsula but this was felled and milled in the early days of settlement. Now cocksfoot, ryegrass and white clover cover the better pastures. Sweet vernal, danthonia, browntop and flat weeds constitute the poorer pastures. Tussock covers some of the drier and higher areas. Secondary regrowth, fern, canuka and gorse has invaded some farms. In their survey of the Akaroa county, Stuart and Tocker (1955) found that 9 per cent of the area was covered with heavy bush or rocky outcrops, 11 per cent was reverted leaving 80 per cent of the area in clear pasture.

System of Farming: Banks Peninsula farmers run sheep and cattle. In the main they have Romney ewes and mate them to Romney rams. Some are kept as replacements or for sale as two-tooths. They sell the remainder as fat lambs or stores depending on the farm and the season. However some fat lambs are sired by Down rams.

Farmers also run cattle. On the harder country the usual practice is to have a breeding herd of cows, selling weaners or keeping stock to older ages. A common practice on easier country is to buy weaners in the autumn and sell fat cattle at 2½ years old. Cattle not only provide an income but also help deal with the reversion problem. Stuart and Tocker (1955) found a correlation between degree of reversion and total cattle run in their survey of 83 farms.

The Peninsula was a stronghold of dairy farming in the early days (11,077 cows in milk in 1925). Dairying now plays only a small part in the output of the Peninsula (4,867 cows in milk in 1963).

Stock Carried: Table 1 below summarises the position on 31 January, 1963. These figures are taken from the Agricultural and Pastoral Statistics 1962-63.

Table 1: Stock Numbers in the Counties of Mt. Herbert, Akaroa and Wairewa 1963

Cows in milk	4,867
Beef Cattle	29,834
Total Sheep	259,797

The author has calculated a least squares regression of total ewe equivalents on years between 1924-25 and 1959-60. This showed a decline of 566 ewe equivalents per year. This regression was significant at the 5 per cent level.

Farm Size: Ignoring farms of less than 100 acres, there were 305 properties on the Peninsula averaging 605 acres in 1962 when the Government Valuation Department last valued the area.

Production per acre: Stuart and Tocker (1955) found an average of 18 lb of fat lamb meat per acre and 11 lb of wool. Ewe equivalents average 1.8 per acre. In the main Peninsula farming is low cost, "status quo" farming.

THE HYPOTHESIS TO BE TESTED

As far back as 1930, topdressing trials have shown that phosphate gave responses on Peninsula loess soils (Hudson and Montgomery (1930)) yet few farmers adopted this practice. Consequently the Department of Agriculture set up a "demonstration farm" in 1954 (Barrer and Stuart (1960)) in co-operation with Mr W.A. Newton on whose farm at Paua Bay the "demonstration" took place. The purpose of the "demonstration" farm was to test the hypothesis "that farm development by the use of topdressing is profitable" and to communicate these results to Peninsula farmers. An analysis of the results by Barrer and Barwell (1964) supported the hypothesis. However this simple analysis, which was primarily for the benefit of farmers, did not make allowances for the time lag between costs incurred in development and benefits received later on. This is one reason for the analysis reported here.

Further results from another case study are now available. Mr D.L. Johns, who was the Department of Agriculture's farm advisory officer on Banks Peninsula, resigned from the Government Service in 1957, and bought a farm adjacent to Mr Newton's property. He emulated the programme adopted by Mr Newton. Mr Johns has been most kind in making his data available to the author for analysis.

The Development Strategy:

In broad outline the strategy for development used by both farmers was as follows. Each acre of the farm developed, received 3 cwt of superphosphate, 2 ounces of molybdenum and clover seed (if necessary) in the first year. This was followed by 2 cwt. of superphosphate and 2 lb of D.D.T. (100 per cent para para isomer) to control grass grubs in the second year. In the third year a further 2 cwt. of superphosphate was applied. After this each acre received 2 cwt. to the acre every 2 to 3 years as a maintenance dressing with D.D.T. being reapplied every third year.

Approximately one third of the farm was started on this programme in each year from the beginning of the development programme.

There were deviations from this plan. Mr Newton used basic slag instead of superphosphate during the first three years of development. However by 1957 the Department of Agriculture had discovered that molybdenum and superphosphate gave as good results as basic slag in plot experiments. Consequently he changed to the cheaper alternative thereafter. Further, Mr Newton found that grass grubs were reducing the yield of his pastures in 1957 and, from then on, used D.D.T.

Along with the topdressing programme, both farmers adopted a policy of increased subdivision aimed at fencing shady from sunny faces. The purpose of this is to force sheep to eat feed on the shady faces which would otherwise be wasted, and to prevent over-grazing on the sunny faces. This fencing programme also entailed an extension of water supplies.

As extra feed grown with fertilizer must be used by stock in order to increase farm output, both farmers adopted a "stock up" policy. Both increased their breeding flock size and increased their cattle numbers. They also adopted a policy of winter fattening extra purchased store lambs.

Some Theoretical Considerations:

A clear distinction must be made between testing the hypothesis "that the development strategy of more topdressing plus more stock is profitable" and the determination of a development strategy which gives an optimum outcome. The latter would involve a complex experiment comparing a range of each input with a design which would measure their interaction. The purpose here is simply to determine whether or not the mixture of inputs comprising the strategy defined above is profitable. No doubt, further information will become available in the future which will be used to modify this development strategy so that its outcome approaches a maximum.

Further our approach to verifying the development strategy needs clarification. The scientific method combines the construction of abstract models with their testing in the real world (Bross 1953). In the social sciences, the information gained from hypothesis testing in the real world is used to construct further abstract models used for predicting the outcome of possible courses of action. Thus in this study, the Department of

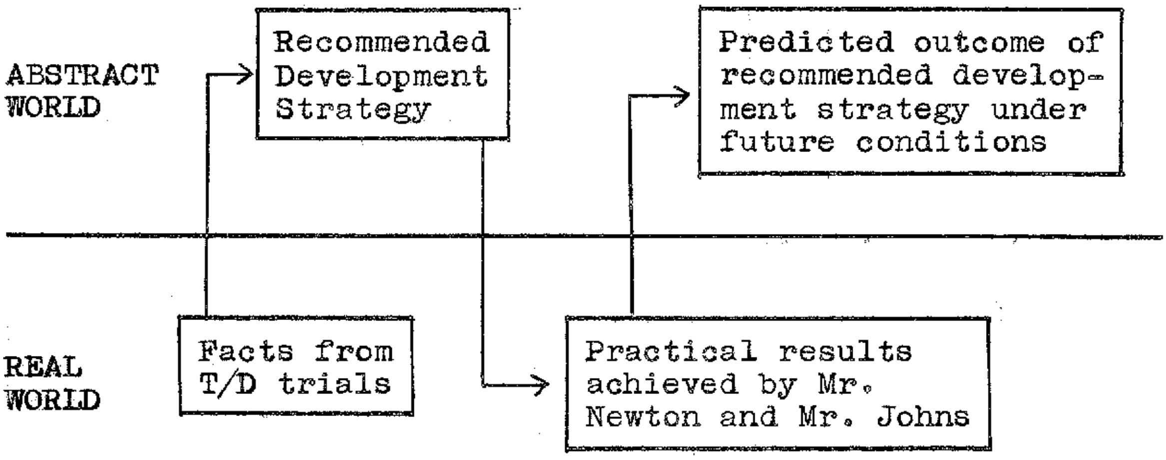
Agriculture's strategy for development on the Peninsula was an abstract model based on practical data from top-dressing trials and other evidence. The practical results on Mr. Newton's and Mr. Johns' farms test this model. From these practical results a further model can be built to predict the outcome of this strategy in the future which is more useful for decision making than historical facts. Thus rather than test the hypothesis, "the development strategy was profitable", I have used the practical information from these two farms to predict the outcome of farm development under future conditions.

The question I have asked is this, "what would be the outcome if Mr Newton and Mr Johns owned farms at present identical to the farms they started with in 1954 and 1957 respectively and developed them using the same strategy with some minor modifications?"

This approach is amplified by Table 2.

Table 2.

Showing the method of approach



TECHNICAL CHANGES AND RESULTS

The first step in answering the question, "what would be the outcome on Mr Newton's and Mr Johns' farms if the development strategy were repeated again?", is to describe the technical changes and results on these two farms.

Mr. W.A. Newton's farm: The technical changes and results have already been reported by Barrer and Stuart (1960) and Barrer and Barwell (1964) but will be summarized again here. In 1954 when the development programme began Mr. Newton farmed 477 acres at Paua Bay and a further 89 acres 5 miles away. This extra block had a higher altitude, a higher rainfall, and was badly infested with gorse. Its main use was to relieve grazing pressure in the summer and Mr Newton sold it in 1958 because with topdressing he was able to lamb earlier. We have ignored this 89 acres in our calculation even though the sale represented a benefit to the programme.

The remaining 477 acres runs from sea level to 1,300 feet and is moderately steep to steep. None of it is ploughable. The soils belong to the Akaroa and Pawson silt loams. The rainfall averages 35 to 40 inches.

In 1954 most of the land was clean except a few patches of canuka and some patches of light bush in the gullies. There were some isolated patches of gorse.

In the three years before development with topdressing, Mr Newton ran 700 ewes. He saved 180 ewe hoggets each year from his lamb crop.

He estimates that he would have normally bought 20 weaner beef cattle each year and sold 20 2½ year-old fat cattle in those days, though the number bought and sold depended on the season. This combined with the sheep numbers gives an estimated ewe equivalent stocking rate in the winter of 2.0 ewe equivalents per acre for the era before topdressing comparable to the average for the Akaroa county of 1.8 found by Stuart and Tocker (1955).

Records of wool sales show that Mr Newton sold an average of 9,955 lb wool for the seasons 1950-51, 51-52 and 52-53. He estimates that he normally sold 375 fat lambs, 180 store lambs and 147 cast-for-age ewes.

At that time, Mr Newton felt that the farm was deteriorating but as the rate of deterioration cannot be established it has been assumed, in the analysis to follow, that the farm would have carried on at this level of output and the technical information given above has been used as the base with which to compare farm changes associated with the development programme.

The main outline of the development programme has already been given. Mr Newton subdivided a 110 acre, a 100 acre and a 60 acre paddock into two, and a large 113 acre paddock into three, using 106 chains of new fencing. This increased his paddocks on the home farm from 8 to 13. He also spent £80 on pipes and troughs for improved water supply.

He built an airstrip with a co-operating neighbour.

Mr Newton's topdressing programme is shown in Table 3 below.

Table 3. Topdressing on Mr Newton's Farm in Tons

(Acres topdressed in brackets)

Kind \ Year	1954/5	1955/6	1956/7	1957/8	1958/9	1959/60	1960/1	1961/2	1962/3
Basic Slag	22 (180)	30 (262)	31 (292)	18 (180)					
Molybdic super phosphate				8 (78)	4 (42)				
DDT Super phosphate				9 (60)	11 (110)	10 (90)	10 (100)	14 (170)	
Molybdic DDT Super phosphate						11 (113)			
Super phosphate							17 (113)		21 (200)
Total Topdressing	22 (180)	30 (262)	31 (292)	35 (318)	15 (152)	21 (203)	27 (213)	14 (170)	21 (200)

A total of 216 tons of topdressing was applied by air to the farm over the nine years and by 1958-59 all the farm had received 7 cwt. of topdressing except a 115 acre paddock which did not start on a topdressing programme until 1959-60.

The results of the improvement programme are reflected in the winter stock numbers shown in Table 4.

Table 4. Winter Stock Numbers on Mr Newton's Farm

Year / Stock	Base Year	1954	1955	1956	1957	1958	1959	1960	1961	1962
Ewes	700	802	817	810	824	860	880	900	1028	980
E.Hgts	180	200	240	240	255	253	250	40	270	320
W.Hgts							70	225	340	385
Cattle	40	49	43	40	65	78	74	27	76	70

In order to raise stock numbers in the 1954/5 year Mr Newton did not sell his cast for age ewes and sold fewer ewe lambs to raise his numbers of ewe hoggets. After this he slowly increased his stock numbers, expecially the cattle but it was not until 1959/60 that he decided he was under-stocked in relation to his new feed supply position induced by topdressing. It was then that he increased his ewe numbers significantly and started buying in store lambs for winter fattening.

Mr. Newton's wool sales are shown in Table 5 below.

Table 5. <u>Wool Sales on Mr. Newton's Farm</u>

Year	Base Year	1954/5	1955/6	1956/7	1957/8	1958/9
Wool Sales lbs.	9,955	12,093	11,865	13,903	12,898	14,579

Year	1959/60	1960/1	1961/2	1962/3	Estimate for Future
Wool Sales lbs.	12,927	16,107	16,826	17,941	13,360

Mr. Newton found that his ewes clipped more wool per head right from the beginning of the programme even though his stocking rate had increased. However the large values for wool sales in the three last years in part reflect the wool clipped from bought in hoggets for winter fattening. The figure of 13,360lb is Mr Newton's estimate for wool sales for future years.

The number of stock bought and sold is shown in Table 6.

Table 6. Number of Stock Bought and Sold by Mr. Newton

	(1) Base	1954/5	1955/6	1956/7	1957/8	1958/9	1959/60	1960/1	1961/2	1962/3	(2) Estimate for Future
Sold:											
Fat Lambs	375	612	233	310	500	516	845	680	1071	1076	940
Stores	180		383	117		249					
Old Ewes	147	161	208	182	171	201	181	185	101	215	190
Fat Hoggets						40	70	100	352	398	200
Fat Cattle	19	13	10	21	47	16	51	6	61	27	38
Bought:											
Ewe Hoggets								177	145	245	
Wether Hoggets							305	359	596		150
2-Tooth					6			160			
4-5 year Ewes									36		
Rams	4	2	3	4	5	2	3	9	13		5
Rising 1 yr Cattle	20	8		38	21	20	22		36	33	40
" 2 " "								39	1	36	
" 3 " "								6	16		

Note 1. The numbers in the column are estimates of the situation for the base year.

Note 2. The numbers in this column are Mr. Newton's estimates of the expected number of stock bought and sold in the future.

Table 6 shows an increase in sales of fat lambs throughout the years together with increased purchases of wether hoggets and then sale as fat hoggets from 1958/9 onwards. For three years (1960/1 to 1962/3 inclusive), he bought ewe hogget replacements rather than breeding his own, but as indicated in his prediction for the future, Mr. Newton intends to return to his original policy of breeding his own replacements.

Finally Table 7 summarises in cash values the remaining inputs into the farm under the headings of wages and other farm expenses. These have been extracted from Mr. Newton's accounts and inflated to 1963 prices using a price index calculated from data made available by the Economic Service of the Meat and Wool Boards.[2]

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[2] Thus in Table 7 the inflated wages figure is £612 in 1954/5. The actual wage cost was only £540 in 1954/5 but wages have risen since then by a ratio of 1.185. This ratio is an average figure for New Zealand calculated from the Economic Services data. Consequently the actual wage cost of £540 has been multiplied by 1.185 to bring it up to £612. This is the cost in terms of 1963 prices of buying the actual quantity of labour used in 1954/5.

1963 prices have been used because we are attempting to predict the outcome of future development in terms of present prices.

Table 7. Cash Value of Non-Stock Inputs on Mr. Newton's Farm

Year	Est. Base	1954/5	1955/6	1956/7	1957/8	1958/9	1959/60	1960/1	1961/2	1962/3	Estimate for Future
	£	£	£	£	£	£	£	£	£	£	£
Wages	236	612	599	604	586	567	157	173	496	942	942
Fertilizer	-	536	590	588	578	467	483	574	366	270	500
Other Farm Expenses	1283	1765	1690	1368	1627	1091	1245	964	1380	1196	1220
Total Farm Expenses	1519	2913	2879	2560	2791	2125	1885	1711	2242	2408	2662

Some of the categories in Table 7 need explanation.

1. **Wages:** In the estimate for the base year, the £236 for wages is Mr Newton's estimate of the amount he would have normally spent on wages if no development work had been done. The remaining figures in the wages row are the actual figures taken from Mr Newton's accounts and subsequently inflated. However the figure for the future is the figure spent in the 1962/3 year when Mr Newton employed a man on the farm so he could live in semi-retirement at Akaroa.

2. **Fertilizer:** These are the inflated figures spent on fertilizer and its application by air except that in the years 1954/5, 1955/6, 1956/7 and 1958/9 £5 per ton of basic slag used has been subtracted. As this data will be used for making predictions of future non-stock inputs later on in this paper, it was decided to reduce the cost of fertilizer when basic slag was used because we now know that this is an expensive way of applying phosphate and molybdenum.

   In the "future" column, Mr Newton expects to spend £500 each year on fertilizer. He will top-dress half the farm each year with 2 cwt. of superphosphate coupled with an application of D.D.T. prills every third year.

3. Other Farm Expenses: Except for the "base" and "future" columns, these data were taken from Mr Newton's accounts and inflated. They include all expenses except interest, tax payments and capital repayments. For the base year, the average of the first four years of the development era were used with development expenses for fencing material and water supply subtracted. This is probably a generous figure because Mr Newton was running more stock over this period than he had been in the pre-development era.

Mr. D.L. Johns' Farm: Mr. Johns bought his 430 acre farm in the Autumn of 1956. It is moderately steep country lying by the sea and bounded by steep 300 foot cliffs. The farm is triangular in shape jutting out to sea as a peninsula. At the most South-Eastern point stands Pompey's Pillar, a well-known rock formation and land mark. The farm's altitude runs from sea level to 800 feet. The soils belong to the Kiwi-Takahe silt loam. The natural cover was probably bush but has been covered by tussock for the last 400 years. The rainfall averages 27 inches. It is early country but high winds dry it out in the summer. This is a difficult problem if there is inadequate rain in October.

The farm had never been run as an independent unit until Mr. Johns bought it in 1956. It has no house and

Mr. Johns lives in Akaroa and commutes the eight miles to work each day.

Mr. Johns did not embark on his development programme until two years after he purchased the farm. However during this period he spent approximately £500 on fencing materials and built fences to subdivide the four original paddocks for normal management. This expenditure would have been necessary even if no development with topdressing had been carried out. The data from these first two years, corrected for the fencing expenditure, provide the base year farm surplus for comparison with development.

When Mr. Johns started his development programme in 1959/60 he had the information from Mr. Newton's farm upon which to base his decisions. He knew that the soils responded to molybdenum and phosphate and therefore used molybdic super rather than basic slag. He appreciated the need for protection from grass grub with the use of D.D.T. and the importance of paralleling the topdressing and fencing programme with an increased stocking rate. Thus Mr. Johns developed his farm more rapidly than Mr. Newton.

Table 8 below shows the quantity and area of topdressing in each year.

Table 8. Topdressing on Mr. Johns' Farm

Fertilizer \ Year	1959/60		1960/1		1961/2		1962/3		1963/4	
	Tons	Ac.	Tons	Ac.	Tons	Ac.	Tons	Ac.	Tons	Ac.
Superphosphate	21	140								
Molybdenum DDT superphosphate	14	140	10	100	13	170				
DDT super-phosphate superphosphate			15	150	10	100	27	200	34	340
Total Fertilizer	35	280	25	250	33	270	27	200	34	340
D.D.T. Prills									1.4	175

A total of 154 tons of topdressing has been applied by air to the farm over the five years. By 1962 all the farm had had some fertilizer.

Mr. Johns continued with his fencing programme dividing the farm into 12 paddocks.

The stock number changes are shown in Table 9.

Table 9. Winter Stock Numbers on Mr. Johns' Farm

Stock \ Year	Base Years		Development Years				
	1958	1959	1960	1961	1962	1963	1964
Ewes	600	718	700	730	913	945	945
Ewe Hoggets	120	-	-	220	50	92	135
Wether Hoggets						180	150
Cattle	19	20	-	-	-	18	33

Unfortunately there was a drought in the first year in which Mr. Johns started on development and he had to sell all his cattle. He stocked up with extra ewe hoggets for the winter of 1960 lifting his ewe numbers to 913 in 1961. He started building his cattle up again in 1962.

Table 10 shows the change in wool weight over the years.

Table 10. <u>Wool Weights on Mr. Johns' Farm (lb.)</u>

Year	Pre-Development Years		Development Years					Future
	1957/8	1958/9	1959/60	1960/1	1961/2	1962/3	1963/4	
Wool Sales (lb)	7,500	8,000	9,900	12,334	11,910	13,214	13,920	14,000

The wool sales are the actual sales of all wool including crutchings made by Mr. Johns, except in the 1957/8 year when the wool sales represented 17 months' growth. The figure of 7,500 is 12/17ths of the actual wool sales figure for that year and therefore an estimate. The value for future wool production is Mr. Johns' estimate of the average the farm will produce in the future.

Table 11 shows the number of stock bought and sold in each year during the years of development and an estimate for the future.

Table 11. Numbers of Stock Bought and Sold by Mr. Johns

	Base Years		Development Years					(3) Future Years
	1957/8	1958/9	1959/60	1960/1	1961/2	1962/3	1963/4	
Sold:								
Fat Lambs	412	442	304	615	899	1035	1108	1000
Stores		290	389					
Old Ewes	(1) 100	146	146	233	250	135	138	150
Fat Hoggets				19		89	141	150
Fat Wethers						11		
Fat Cattle	(2) 10	(2) 10					16	17
Store Cattle			40					
Bought:								
Ewe Hoggets	120			220		142	193	200
Wether Hoggets						182	154	150
2-Tooths		123	121	217	232	176		
Rams				6	5	5	6	4
Rising 1 yr Cattle	(2) 10	(2) 10			18	16		19

Notes: (1) Mr. Johns bought a young flock and had no old ewes to sell in 1957/8. In a normal year he would have had 100 old ewes to sell and hence this number.

(2) The normal number of cattle bought and sold would have been 10, in the base years, according to Mr. Johns' estimate.

(3) The figures in this column are Mr. Johns' estimates of the expected number of stock bought and sold in the future.

Fat lamb output rose from approximately 400 in the base years to 1000-1100 after development. Mr. Johns bought two-tooths to replace and build up his flock in the early years because ewe hoggets did not thrive on his farm. After development he was able to rear hoggets. However he now finds hoggets respond well to the anthelminthic thiobendizole and selenium. He has also found a response to copper and has used copperized super-phosphate on 126 acres.

Finally Table 12 summarises the non-stock inputs in terms of cash values from Mr. Johns' account and inflated to 1963 prices.

Table 12. Non-Stock Inputs

	Base Years		Development Years					Future
	1957/8	1958/9	1959/60	1960/1	1961/2	1962/3	1963/4	
Farm Exps.	810	764	3,019	1,802	1,705	2,148	1,737	1,737

Farm expenses for non-stock inputs include all farm expenses including wages (but not wages for Mr. Johns) and fertilizer, but excluding interest and capital repayments.

The basis for the figures in Table 12 were taken from Mr. Johns' accounts except that the farm expenses for

1963/4 were adjusted downwards as Mr. Johns increased his inventory of fertilizer and fencing material in that year.

Farm expenses in 1959/60 include a figure of £1,350 with which Mr. Johns bought a Land Rover. The purchase of this farm machine was an integral part of his development strategy as it allowed him to develop his farm without increasing his physical efforts. Farm expenses in 1962/3 also include £350 for the replacement of the Land Rover with a new and improved model. The allowance for future annual farm expenses should be more than adequate to maintain the value and output of the farm.

METHOD OF ECONOMIC ANALYSIS

The problem for analysis is to predict the outcome of the strategy for farm development recommended by the Department of Agriculture. There are several considerations which must be taken into account.

National or Farmers' Point of View?

While the main aim of this bulletin is to determine the outcome of development from the national point of view to help in making decision at the national level, a course of action cannot be recommended or encouraged with any chance of success unless it is profitable to farmers. Therefore the outcome has been determined both from the national point of view, where taxation has been ignored, and the farmers' point of view where taxation is taken into account.

<u>Marginal or Average Analysis</u>.

The capital put into farming by the nation or the farmer is a sunk cost. The returns from this capital are immaterial when making decisions about investing extra capital in the future. Therefore we are solely concerned with the extra costs and extra benefits from investing extra capital in Peninsula farms. An average analysis would measure the mixture of past development plus the outcome of development using the Department of Agriculture strategy.

To make a marginal analysis the outcome of "development" has been compared with outcome of "no development". The data from the base years has been projected forward to estimate the outcome of no development. This is not an entirely satisfactory approach because part of the measured effects of "development" will reflect seasonal factors. It was not possible to even make an attempt to correct for these seasonal factors by the use of technical data from adjacent undeveloped Peninsula farms because no such data is available.

Allowing for Time:

Dr. J.T. Ward, Senior Lecturer in Agricultural Economics, has discussed the concepts of future worth, present worth and the internal rate of return for estimating the outcome of farm development projects. These are described in the Agricultural Economics Bulletin No. 9 in this series (Ward 1964).

All these methods allow for the time lag between incurring costs and the receipt of benefits by using compound interest principles.

The present worth of a stream of extra costs and extra benefits expresses the marginal value of the outcome of development as a lump sum payment today by using discounting procedures.

The internal rate of return determines an interest rate at which the present value of the outcome is zero.

Method of Assessing the Outcome after Development is Completed:

Data is available from the case study over the development period, and estimates are available for the future. In estimating the value of the future stream of extra income we have converted this to a capital sum. Thus an extra £1000 per year at a 6% rate of interest is worth £16,667 as a capital sum. This, of course, assumes that the extra £1000 income is carried on for an infinite period of time. From the national point of view this seems a reasonable assumption. From the point of view of some individual farmers it may be better to consider only the stream of income for the expected life of the farmer.

Handling Uncertainty:

There is considerable uncertainty about future prices for farm products. Consequently it is wise to examine the outcome of development under a range of price regimes. In Decision Theory, these are known as "states of nature". I have selected three "states of nature" termed optimistic, standard and pessimistic prices.

One criterion used by some businessmen is to avoid following any strategy which has disastrous results when the worst comes to the worst - or in other words when a pessimistic state of nature occurs in the future.

Table 13 gives the set of prices under these three states of nature for stock sold.

Table 13. Assumed values for Stock Sold

Class of Stock \ State of Nature	"Pessimistic"	"Standard"	"Optimistic"
	£	£	£
Fat Lambs	1.75	2.0	2.25
Stores	1.00	1.25	1.50
Old Ewes	1.25	1.75	2.25
Fat Hoggets	2.25	2.75	3.25
Fat Wethers	2.75	3.25	3.75
Fat Cattle	30.0	35.0	40.0
Store Cattle	20.0	20.0	20.0

Table 14 below shows the prices of stock purchased. "Optimistic", "standard" and "pessimistic" prices of stock when bought or sold have been used for the analysis from the individual farmer's point of view. However when assessing the outcome from the national point of view, standard prices of stock purchased have been used in conjunction with optimistic, standard and pessimistic prices for stock sales. If the sale value of stock rises because of an increase in overseas prices, sellers of stock to Peninsula farmers will also gain in increased prices and this gain must be included when measuring the gain from the national point of view. If the prices of replacement stock were also increased when output prices rise, then the full effect of the benefits to the nation would not be measured.

Table 14. Assumed Values for Stock Bought

Class of Stock \ State of Nature	Pessimistic	Standard	Optimistic
	£	£	£
Ewe hoggets	1.75	2.0	2.25
Wether hoggets	1.25	1.5	1.75
Two Tooths	3.5	4.0	4.5
4-5 year old ewes	2.0	2.5	3.0
Rams	12.0	15.0	18.0
Rising 1 yr Cattle	12.0	15.0	18.0
Rising 2 yr Cattle	20.0	25.0	30.0
Rising 3 yr Cattle	25.0	30	35.0

The assumed prices for wool are shown in Table 15.

Table 15. Assumed Prices for Wool

State of Nature	Pessimistic Price		Standard Price		Optimistic Price	
	£	Pence	£	Pence	£	Pence
Wool price per lb.	0.15	36	0.175	42	0.20	48

These prices are net of selling costs which amount to about 4d per lb.

All these assumptions have been checked with Nr. Newton and Mr. Johns who use values between the "standard" and "optimistic" values for budgeting on their own farms.

Taxation:

Taxation has been taken into account in assessing the outcome of development from the individual farmer's point of view. The assumption has been made that Messrs. Newton and Johns if they were to develop their farms again, would live on the tax paid cash income (or take-home-pay) that they would have earnt if no development had taken place. Because of farm investment, an overdraft is accumulated upon which interest is paid each year. This, of course, becomes a farm cost and enters the calculation for the profit assessment for tax purposes in the succeeding years.

It is further assumed that no attempt is made to pay back the accumulated overdraft when cash benefits accrue in later years.

Change in stock inventory also has to be allowed for in calculating the profit assessment for tax purposes. Standard values of £2 a head for sheep and £15 per head for cattle have been used.

Exemptions for calculating taxable income depend on family size and life insurance premiums. A figure of £960 was used in the case of Mr. Johns and £726 for Mr. Newton.

A short cut technique for calculating income tax was used to speed the calculations. This is shown in Appendix II.

Extra Costs Associated with Gorse Eradication:

Messrs. Newton's and Johns' farms were initially clear of weeds and scrub. This is not true of all Peninsula farms as indicated earlier. To test the additional hypothesis "that the development strategy would be profitable if 60 acres of gorse clearing were included in the programme" gorse clearing costs given by Holderness (1964) were used. These gorse clearing costs are shown below in Table 16.

Table 16. Gorse Clearing Costs for 60 acres

Year	1	2	3	4	5
Costs	£400	£467	£352	£471	£186

The gorse clearing programme assumed that these farmers would start cleaning 30 acres of gorse a year.

Results to Follow:

The following hypothesis will be tested by the results presented in the next section: "That development would be profitable on Mr. Newton's and Mr. Johns' farms under these conditions."

1. From the National point of view ignoring taxation, with and without a gorse control programme, under the three states of nature, "optimistic", "standard" and "pessimistic", using present value and the internal rate of return as methods of measurement.

2. From the individual point of view including taxation, with and without a gorse control programme, under three states of nature, "optimistic", "standard" and "pessimistic", using present value as the method of measurement.

The Models which give the details of the method of calculation are shown in Appendix I.

RESULTS

The National Point of View:

Using the model defined in Appendix I (Model 1) the change in farm surplus from the national viewpoint resulting from development was calculated in each year for Mr. Newton's and Mr. Johns' farms. These changes in farm surplus are shown in Table 17 and Table 18.

Table 17. <u>Predicted Change in Farm Surplus (The National Point of View) from Development with and without a hypothetical gorse clearing programme on Mr. Newton's farm at Optimistic, Standard and Pessimistic Prices.</u>

Note: The figures in brackets indicate the outcome with a gorse clearing programme.

	Years of Development										After Development
	1	2	3	4	5	6	7	8	9	10	
	£	£	£	£	£	£	£	£	£	£	£
	OPTIMISTIC PRICES										
Farm Surplus with development	1892 (1492)	1615 (1148)	1415 (1063)	1712 (1241)	2765 (2579)	3217 (3217)	4443 (4443)	1199 (1199)	4830 (4830)	4573 (4573)	3822 (3822)
Farm Surplus without development	2297	2297	2297	2297	2297	2297	2297	2297	2297	2297	2297
Change in Farm Surplus from development	-405 (-805)	-682 (-1149)	-882 (-1234)	-585 (-1056)	+468 (+282)	+920 (+920)	+2146 (+2146)	-1098 (-1098)	+2533 (+2533)	+2276 (+2276)	+1525 (+1525)
	STANDARD PRICES										
Farm Surplus with development	1460 (1060)	1014 (547)	811 (459)	1062 (591)	1996 (1810)	2461 (2461)	3529 (3529)	455 (455)	3610 (3610)	3414 (3414)	2868 (2868)
Farm Surplus without development	1795	1795	1795	1795	1795	1795	1795	1795	1795	1795	1795
Change in Farm Surplus from development	-335 (-735)	-781 (-1248)	-984 (-1336)	-733 (-1204)	+201 (+15)	+666 (+666)	+1734 (+1734)	-1340 (-1340)	+1815 (+1815)	+1619 (+1619)	+1073 (+1073)
	PESSIMISTIC PRICES										
Farm Surplus with development	1029 (629)	413 (-54)	207 (-145)	411 (-60)	1229 (1043)	1705 (1705)	2614 (2614)	-291 (-291)	2390 (2390)	2255 (2255)	1914 (1914)
Farm Surplus without development	1294	1294	1294	1294	1294	1294	1294	1294	1294	1294	1294
Change in Farm Surplus from development	-265 (-665)	-881 (-1348)	-1087 (-1439)	-883 (-1354)	-65 (-251)	+411 (+411)	+1320 (+1320)	-1585 (-1585)	+1096 (+1096)	+961 (+961)	+620 (+620)

Table 18. Predicted Change in Farm Surplus (The National Point of View) from Development with and without a hypothetical gorse clearing programme on Mr. Johns' farm at Optimistic, Standard and Pessimistic Prices.

Note: The figures in brackets indicate the outcome with a gorse clearing programme.

	Years of Development 1	2	3	4	5	After Development
	£	£	£	£	£	£
	OPTIMISTIC PRICES					
Farm Surplus with Development	872 (472)	1285 (818)	1989 (1637)	2021 (1550)	4391 (4205)	3947 (3947)
Farm Surplus with-out development	2178	2178	2178	2178	2178	2178
Change in Farm Surplus from Development	-1306 (-1706)	-893 (-1360)	-189 (-541)	-157 (-628)	+2213 (+2027)	+1769 (+1769)
	STANDARD PRICES					
Farm Surplus with Development	378 (-22)	696 (229)	1341 (989)	1341 (843)	3547 (3361)	3112 (3112)
Farm Surplus with-out development	1805	1805	1805	1805	1805	1805
Change in Farm Surplus from Development	-1427 (-1827)	-1109 (-1576)	-464 (-816)	-491 (-962)	+1742 (+1556)	+1307 (+1307)
	PESSIMISTIC PRICES					
Farm Surplus with Development	-115 (-515)	108 (-359)	693 (341)	607 (136)	2702 (2516)	2277 (2277)
Farm Surplus with-out development	1387	1387	1387	1387	1387	1387
Change in Farm Surplus from Development	-1502 (-1902)	-1279 (-1746)	-694 (-1046)	-780 (-1251)	+1315 (+1129)	+890 (+890)

Present Value from the National Viewpoint:

The stream of changes in farm surplus from development has been discounted by $1/(1 + .06)^n$ and summed to produce a lump sum payment - a present value for the development phase. The estimate of after development change in annual farm surplus has been discounted and added to this value. The results for both farms are shown below in Table 19.

Table 19. Present Value of the Development Strategy

State of Nature \ Farm	On Mr. Newton's				On Mr. Johns'			
	Per Farm		Per Acre		Per Farm		Per Acre	
	Without Gorse Prog.	With Gorse Prog.	Without Gorse Prog.	With Gorse Prog.	Without Gorse Prog.	With Gorse Prog.	Without Gorse Prog.	With Gorse Prog.
	£	£	£	£	£	£	£	£
Optimistic prices	16,508	14,907	35	31	21,372	19,774	50	46
Standard prices	10,478	8,878	22	19	14,466	12,865	34	30
Pessimistic prices	4,435	2,836	9	6	8,309	6,709	19	16

A word of explanation may be needed to outline the meaning of these figures. The present value of the development strategy without a gorse clearing programme on Mr. Johns' farm at standard prices is £16,508. This was calculated from the series of farm surpluses given in Table 17. In the first year of development Mr. Johns' lost £1,427, in the second year he lost £1,109, in the third year he lost £464 and in the fourth year he lost £491. Now suppose Mr. Johns wanted to know how much money he would have to have at the beginning of the first year to cover this series of costs. Obviously he would need less than £1,427 + £1,109 + £464 + £491 = £3,491 because he would only be spending £1,427 in the first year and his unspent cash would be earning a 6% rate of interest until he needed it.

Now using the discount factor of $1/(1 + .06)^n$ where n is the number of years we can calculate the amount of cash he would have to have at the beginning of the first year in order to cover the cost of £1,427, £1,109, £464 and £491 in the first, second, third and fourth years respectively. The calculations necessary are shown below.

Table 20. Method of Calculating Present Value of Costs

Year	Cost	Discount factor $1/(1 + .06)^n$	Discount factor x Cost
1	£1,427	$1/1.06 = 0.9434$	£1,346
2	£1,109	$1/1.06^2 = 0.8900$	£987
3	£464	$1/1.06^3 = 0.8396$	£390
4	£491	$1/1.06^4 = 0.7921$	£389
Total of discounted costs or present value of costs =			£3,112

Thus he would need £3,112 at the beginning of the first year to meet his costs over the first four years. Thus we can say that the present value of this stream of costs is £3,112.

Now let us turn to the returns which Mr. Johns expects to receive from the development strategy. In the fifth year he makes a cash gain of £1,742. After that in the following years he expects £1,307 each year.

We will deal with the £1,307 per year first. At a rate of interest of 6% this is equivalent to a capital sum of 1307/.06 = £21,783. That is, if Mr. Johns had £21,783 invested at 6% this would give him £1,307 per year in perpetuity.

We now have a gain of £1,742 in the fifth year coupled with the equivalent extra capital sum of £21,783.

The next question we ask is this. How much money would we have to invest at 6% at the beginning of the first year in order for it to grow into £1,742 plus £21,783 or £23,525 in the fifth year. Again, this can be simply calculated by using the appropriate discount factors. The method is shown in Table 21.

Table 21. Method of Calculating Present Value of Returns

Year	Return	Discount Factor	Discount Factor x Returns
5	£23,525	$1/(1 + .06)^5 = 0.7472$	£17,578
Discounted returns or present value of returns			£17,578

Now combining the discounted stream of costs represented as a present value with the stream of benefits, we have the present value of the development strategy at "standard prices" as

Present value of extra benefits less present value of extra costs = Present value of Strategy

£17,578 - £3,112 = £14,466

Thus the development strategy has a present value of £14,466 and this value is shown in the appropriate cell of Table 19.

This means that Mr. Johns can expect to get back all his development costs plus the equivalent of a cash payment of £14,466 paid to him at the beginning.

While this explanation has been given in terms of the individual farmer to aid clear communication, readers must remember that taxation has not been taken into consideration, i.e. £14,466 is the present value of the strategy from the national point of view.

Present value is a most convenient method of allowing for time - particularly for comparing two or more strategies in which the pattern of costs and benefits differ. For example the method allows us to compare the development on Mr. Newton's farm which took ten years with the development on Mr. Johns' farm which took five.

The Internal Rate of Return for the National Viewpoint:

The internal rate of return is a measure of the rate of interest earned by the sacrifices in income in the years of development. The approximate values for the internal rate of return for the development strategy on both farms from the national point of view is shown in Table 22.

Table 22. The Approximate Internal Rate of Return of the Development Strategy (To the nearest % unit)

State of Nature \ Farm	On Mr. Newton's		On Mr. Johns'	
	Without Gorse Programme	With Gorse Programme	Without Gorse Programme	With Gorse Programme
Optimistic Prices	30%	21%	36%	26%
Standard prices	22%	15%	25%	18%
Pessimistic prices	13%	9%	17%	13%

A further word of explanation may be needed. The internal rate of return measures the interest rate at which the discounted costs (or the present value of the costs) equals the discounted returns (or the present value of the returns). In other words if the ruling rate of interest was 25% and there was no taxation, then at standard prices Mr. Johns would just get his investment back, no less, no more.

This figure of 25% for internal rate of return is calculated by trial and error. The interest rate of 25% actually gives a present value of £-6 which is near enough to zero for practical purposes. This is shown in Table 23.

Table 23. Present Value at 25% Rate of Interest

Year	Cost	Discount factor $1/(1 + .25)^n$	Discount factor x Cost
1	£1,427	$1/1.25 = 0.8000$	£1,142
2	1,109	$1/1.25^2 = 0.6400$	710
3	464	$1/1.25^3 = 0.5120$	237
4	491	$1/1.25^4 = 0.4096$	201
	Present value of costs		£2,290
	Benefit		
5	1,742	$1/1.25^5 = 0.3277$	571
	$\frac{1307}{0.25} = 5228$	$1/1.25^5 = 0.3277$	1,713
	Present value of benefits		2,284
Present value of strategy			-6

There are some practical and theoretical drawbacks to this criterion which will not be discussed here. A treatment of the concept of present value and internal rate of return is given in the text book, "Principles of Engineering Economy", Grant and Ireson (1960).

Present Values from the Farmers Point of View:

There are considerable economic and psychological difficulties in deciding on a criteria for measuring the profitability of development from the individual farmer's point of view. This is because objectives, both financial and non-financial, vary from farmer to farmer. These difficulties will not be discussed here as they have been touched on by Ward (1964).

The method of analysis used in this report is similar to the method recommended by Ward. In estimating the outcome of the development strategy, it is assumed that the farmer makes no sacrifices in his standard of living. During development it is assumed that his tax free cash income remains the same as if he had not developed. His annual deficits accummulate as an overdraft on which he pays interest at 6 per cent. Of course extra interest costs become a charge against his assessment of profit for tax purposes. It is assumed he makes no attempt to pay back his overdraft. Gains in take-home-pay are discounted back to present values as before. The results of these estimates are shown in Tables 24 and 25.

Table 24. <u>Predicted Gain in Take-home-pay, Taxation and Overdraft Level from Development with and without a hypothetical gorse clearing programme on Mr. Newton's farm at Optimistic, Standard and Pessimistic Prices.</u>

	Years of Development 1	2	3	4	5	6	7	8	9	10	After Development
	£	£	£	£	£	£	£	£	£	£	£
OPTIMISTIC PRICES											
Without a Gorse Programme											
Gain in Take-home-pay	0	0	0	0	48	371	1382	0	940	870	622
Extra Tax Payments	-49	-242	-322	-130	+224	+374	+501	-3	+926	+820	+515
Overdraft	356	831	1436	2091	2091	2091	2091	3775	3775	3775	3775
With a Gorse Programme											
Gain in Take-home-pay	0	0	0	0	0	326	1350	0	904	851	579
Extra Tax Payments	-188	-365	-406	-295	+109	+335	+457	-35	+792	+875	+471
Overdraft	617	1452	2362	3379	3480	3480	3480	5216	5216	5216	5216
STANDARD PRICES											
Without a Gorse Programme											
Gain in Take-home-pay	0	0	0	0	0	287	1280	0	908	812	520
Extra Tax Payments	-18	-209	-273	-122	+113	+233	+308	+66	+668	+568	+318
Overdraft	316	907	1672	2383	2438	2438	2438	3990	3990	3990	3990
With a Gorse Programme											
Gain in Take-home-pay	0	0	0	0	0	+227	+1223	0	+858	+759	+460
Extra Tax payments	-137	-285	-302	-241	+15	+194	+266	+32	615	+518	+275
Overdraft	598	1597	2727	3854	4085	4085	4085	5702	5702	5702	5702
PESSIMISTIC PRICES											
Without a Gorse Programme											
Gain in Take-home-pay	0	0	0	0	0	211	1129	0	831	681	365
Extra Tax Payments	+4	-148	-174	-99	+26	+137	+151	+110	+444	+338	+156
Overdraft	269	1004	1982	2771	2957	2957	2957	4366	4366	4366	4366
With a Gorse Programme											
Gain in Take-home-pay	0	0	0	0	0	135	1054	0	762	610	286
Extra Tax Payments	-84	-174	-174	-158	-41	+100	+113	+75	+396	+292	+118
Overdraft	581	1776	3152	4423	4827	4827	4827	6314	6314	6314	6314

Table 25. Predicted Gain in Take-home-pay, Taxation and Overdraft Level from Development with and without a hypothetical gorse clearing programme on Mr. Johns' farm at Optimistic, Standard and Pessimistic Prices.

	Years of Development 1	2	3	4	5	After Development
	£	£	£	£	£	£
OPTIMISTIC PRICES						
Without a Gorse Programme						
Gain in Take-home-pay	0	0	0	139	862	989
Extra Tax Payments	-73	-158	-133	+119	+1115	+498
Overdraft	1248	2206	2544	2755	2755	2755
With a Gorse Programme						
Gain in Take-home-pay	0	0	0	0	742	768
Extra Tax Payments	-178	-262	-207	-61	+943	+611
Overdraft	1543	2881	3538	4513	4513	4513
STANDARD PRICES						
Without a Gorse Programme						
Gain in Take-home-pay	0	0	0	0	770	688
Extra Tax Payments	-101	-160	-137	+37	+763	+410
Overdraft	1324	2350	2816	3511	3511	3511
With a Gorse Programme						
Gain in Take-home-pay	0	0	0	0	634	644
Extra Tax Payments	-187	-219	-204	-106	+626	+337
Overdraft	1638	3091	3886	4973	4973	4973
PESSIMISTIC PRICES						
Without a Gorse Programme						
Gain in Take-home-pay	0	0	0	0	693	549
Extra Tax Payments	-102	-120	-117	-16	+465	+232
Overdraft	1385	2479	3056	3806	3806	3806
With a Gorse Programme						
Gain in Take-home-pay	0	0	0	0	503	499
Extra Tax Payments	-132	-157	-147	-107	+391	+204
Overdraft	1755	3301	4249	5101	5101	5101

The present values of the gains in take-home-pay calculated from Tables 24 and 25 are shown in Table 26.

Table 26. Present values of the gains in take-home-pay

	Mr. Newton's Farm				Mr. Johns' Farm			
	Without Gorse Programme		With Gorse Programme		Without Gorse Programme		With Gorse Programme	
	Total	Per Acre	Total	Per Acre	Total	Per Acre	Total	Per Acre
Optimistic	8,047	17	7,533	15	10,965	30	10,120	23
Standard	6,883	14	6,186	13	9,145	21	8,494	20
Pessimistic	5,169	11	4,250	9	7,356	17	6,591	15

The development strategy is still profitable even when a hypothetical gorse clearing programme is introduced under the worst state of nature.

Tax payments also increase, as shown in Tables 24 and 25, and the present value and percentage of total gains (present value of extra tax payments plus extra take-home-pay) is shown in Table 27.

Table 27. Present Value of Tax Payments

	Mr. Newton's Farm				Mr. Johns' Farm			
	Without Gorse Programme		With Gorse Programme		Without Gorse Programme		With Gorse Programme	
	Extra Tax	% of total gain	Extra Tax	% of total gain	Extra Tax	% of total gain	Extra Tax	% of total gain
Optimistic	5,927	42	4,863	39	8,911	45	7,691	43
Standard	3,637	35	2,740	31	5,353	37	4,039	32
Pessimistic	1,837	26	1,156	21	2,922	28	2,360	25

This Table shows that at standard prices the Government obtain 35% of the total financial gain from development on Mr. Newton's farm in terms of extra taxation.

DISCUSSION OF RESULTS

The results using the methods of present values and the internal rate of return appear to support the hypothesis that "the Department of Agriculture's strategy for development (fertilizer plus fences plus stock) is profitable both to the nation and to the individual farmers concerned. However before discussing the implications of these results it is necessary to mention the limitations of the data.

Limitations of Data:

The projection forward of the data obtained in the base years to provide a benchmark against which to measure the change in farm surplus resulting from development does not provide an adequate treatment control. Ideally the change in farm surplus should be measured by a farm experiment in which one area is developed and another area is left undeveloped. However, I believe that the technical and economic estimates used for the base years were relatively optimistic. For instance, Mr. Newton believed that his farm was going back before he embarked on his topdressing programme. He also sold 89 acres during the development phase. These two factors have been neglected in the analysis yet, if some method were available to adjust for them, they would improve the value of the outcome on Mr. Newton's farm. This combined with the high values for present value and internal rate of return make the author confident that the hypothesis is supported so far as the results on these two farms are concerned.

These two case studies can be considered a sample of two farms from a hypothetical population of farms using the Department of Agriculture's development strategy. In the statistical sense inferences could be made, from this sample of two, to this hypothetical population but of course the estimate of the population's mean from such a small sample has a wide confidence limit. Rather, in making inferences from these two farms to the Peninsula in general, we must depend on the subjective opinion of the farm advisory officer in the district who estimates that the results on these case study farms could be obtained on two-thirds of the area of the Peninsula (McSweeney 1964). He is at present working closely with twenty farmers who are emulating Mr. Newton's and Mr. Johns' techniques. Their results will be available in about five years' time. Such a sample should make it possible to estimate the population parameters with reasonable accuracy.

Implication of the Results:

From a National planning point of view these results provide an indication of the quantitative outcome of farm development possible on Banks Peninsula where an integrated strategy is used. The results do not predict the outcome of all farm development on Banks Peninsula. There are some farmers who own properties on the Peninsula who invest capital in fertiliser and fencing but who fail to take advantage of the extra feed they grow by stocking up. However where advisory work is coupled with planned farm development it is the opinion of the author that returns to the nation and to the farmer of the order shown by these results should be possible.

If the owners of the 145,000 acres of the Peninsula (two-thirds of the 220,000 acres) to which Mr. McSweeney believes these results apply, could be persuaded to embark on the identical programme used by Mr. Newton, then the present value of this development would be worth to the nation the equivalent of £3,000,000 as a lump sum payment. This estimate assumes a present value of £22 per acre from development.

The estimates should also prove encouraging to individual Banks Peninsula farmers who may be uncertain of the profitability of development. While farmers should make estimates of the financial outcome for their own farms depending as they will on such factors as level of taxation, indebtedness, the amount of scrub to be cleared, the housing of additional labour, and so on, these results should at least make Banks Peninsula farmers feel dissatisfied with their present position and lead them to search for ways and means within their resources of making similar gains.

Confidence in development should also be improved by the fact that the financial outcome appeared satisfactory even under a pessimistic state of nature coupled with a hypothetical gorse clearing programme (see Table 26). There was a present value of take-home-pay of £9 per acre on Mr. Newton's farm and £15 per acre on Mr. Johns' farm with pessimistic prices and a gorse problem. In terms of decision theory, development in these two cases appears to be a dominant strategy above "no development" even under the worst state of nature.

This should also give lending agencies more confidence to advance loans for development on Banks Peninsula where farmers intend to carry out a programme of development under the guidance of a competent farm advisory officer and of course where the farmer has the managerial ability to carry out a systemic plan.

Further, the considerable gain in tax payment to the national exchequer shown in Table 27 provides some idea of the magnitude of the public money that can be spent on encouraging other Banks Peninsula farmers to emulate the example of Mr. Newton and Mr. Johns.

Finally, the results can also be used for national planning of advisory serivces. One of the parameters to be considered in allocating extension forces to areas in order to maximize the outcome to the nation is a parameter which measures the outcome of farm development in terms of present value or internal rate of return. However in making such decisions other factors, particularly those factors which limit the adoption of the recommended development strategy, must be taken into consideration. This will be the topic of a further bulletin in this series.

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APPENDIX I.

1. The Model for Predicting the Outcome from the National Point of View.

The model for predicting the present value to the nation of the development strategy used by Mr. Newton and Mr. Johns to develop their farms is given below. The present value of the development strategy is given by

$$P.V = \sum_{i=1}^{n} \frac{\Delta C_i}{(1 + r)^i} + \frac{\frac{\Delta C_{n+1}}{r}}{(1 + r)^n} \qquad (1)$$

where P.V is the present value of the development strategy.

n is the number of years of development with records available.

r is the rate of interest.

ΔC_i is the estimated change in "farm surplus" from "development" compared with "no development" in the i^{th} year of development.

ΔC_{n+1} is the estimated change in farm surplus per year after development is completed. This is capitalized to a lump sum payment by $\Delta C_{n+1/r}$ and brought back to a present value by multiplying by $1/(1 + r)^n$

The internal rate of return is given by

$$\text{Solving P.V} = \sum_{i=1}^{n} \frac{\Delta C_i}{(1+r)^i} + \frac{\Delta C_{n+1}}{(1+r)^n} = 0 \qquad (2)$$

for r, which is the internal rate of return.

$$\Delta C_i = C_i - C_o,$$

where C_i is the farm surplus in the i^{th} year and

C_o is the farm surplus in the base year.

$$\Delta C_{n+1} = C_{n+1} - C_o,$$

where C_{n+1} is the farm surplus per year after development is completed.

$$C_i = (S_i + W_i) - (b_i + E_i),$$

and $$S_i = \sum_{j=1}^{k} V_j A_{ij},$$

where S_i is the income from stock sales in the i^{th} year.

V_j is the assumed value of the j^{th} class of k class of stock.

A_{ij} is the number of stock sold of the j^{th} class in the i^{th} year of development (see Tables 6 and 11), and $w_i = pq_i$

where p is the assumed price of wool (see Table 15)

q_i is the quantity of wool in the i^{th} year of development (see Tables 5 and 10),

and $$b_i = \sum_{t=1}^{m} V'_t \; A'_{it}$$

where b_i is the cost of stock purchase in the i^{th} year

V'_t is the assumed value of the t^{th} class of m classes of stock (see Table 13)

A'_{it} is the number of stock purchased of the t^{th} class in the i^{th} year (see Tables 6 and 11)

and E_i are the farm expenses in the i^{th} year (see Tables 7 and 12). These include the cost of a gorse clearing programme in the appropriate calculations.

$$C_{n+1} = (S_{n+1} + W_{n+1}) - (b_{n+1} + E_{n+1})$$

where $S_{n+1} = \sum_{j=1}^{k} V_j \; A_{n+1\,j}$ ($A_{n+1\,j}$ is the estimated number of stock sold in the j^{th} class of k classes of stock in future years.)

$w_{n+1} = pq_{n+1}$ (q_{n+1} is the estimated quantity of wool sold in future years)

$$b_{n+1} = \sum_{t=1}^{m} V_t' A_{n+1t}$$ (A'_{n+1t} is the estimated number of stock bought in the t^{th} class in future years.)

E_{n+1} is the estimate of future farm expenses.

$$C_o = (S_o + w_o) - (b_o + E_o)$$

where $$S_o = \sum_{j=1}^{k} V_j A_{oj}$$ (A_{oj} is the estimated or actual number of stock sold in the j^{th} class in the "base year" in the case of Mr. Newton and the average of the two base years of 1957/8 and 1958/9 in the case of Mr. Johns.)

$w_o = pq_o$ (q_o is the estimated pounds of wool sold in the "base year" in the case of Mr. Newton, and for Mr. Johns, the average of the estimate wool production in the 1957/8 season and the actual wool production in the 1958/9 season.)

$$b_o = \sum_{t=1}^{m} V'_j A'_{oj}$$ (A'_{oj} is the estimated or actual number of stock bought in the j^{th} class in the "base year" in the case of Mr. Newton and the average of the two base years of 1957/8 and 1958/9 in the case of Mr. Johns.)

E_o is the estimate of farm expenses for the base years.

In calculating the present value at a discount rate of 6% and the internal rate of return, pessimistic, standard and optimistic set of values were used for V_j and p.

2. Model for predicting the outcome from the individual farmer's point of view.

This model takes taxation into account. The basic model is the same as before.

$$P.V = \sum_{i=1}^{n} \frac{\Delta C_i}{(1 + r)^i} + \frac{\frac{\Delta C_{n+1}}{r}}{(1 + r)^n}$$

but $\Delta C_i = (C_i + \Delta I_i - R_i - T_i) - (C_o - T_o)$

when $\Delta C_i > 0$

where ΔC_i becomes the extra take home pay of the farmer in the i^{th} year.

ΔI_i is the change in stock inventory value in the i^{th} year

R_i is the interest payments in the i^{th} year

T_i is the tax in the i^{th} year

T_o is the tax in the base year

and similarly for ΔC_{n+1}

when $\Delta C_i \leqslant 0$

$\Delta C_i = 0$

and $D_i = D_{i-1} - \left[(C_i + \Delta I_i - R_i - T_i) - (C_o - T_o)\right]$

where D_i is the overdraft in the i^{th} year.

$D_o = 0$

where D_o is the overdraft in the base year.

$R_i = r\ (D_{i-1})$

$T_i = f\ (C_i + \Delta I_i - R_i)$

$T_o = f\ (C_o)$

Details of the last two functions are shown in Appendix II.

APPENDIX II.

Model for calculating tax payments.

Tax payments (T) consist of social security (T_s) and income tax payments (T_i).

$$T = T_s + T_i$$

$$T_s = .075\ (P - Y)$$

where P = profit in pounds

Y = profit exempt from social security tax (£104)

Income tax payments are based on taxable income (M)

$$M = P - X$$

where X is the exemptions allowed for family etc.

$$T_i = f\ (M)$$

where $M < 0$

$$T_i = 0$$

where $0 < M < 500$

$$T_i = 0.13875\ M$$

The parameter .13875 allows for an income tax rebate of 7.5% and the parameter to follow.

where $500 < M < 900$

$$T_i = 1.15625 \times 10^{-4}\ M^2 + .0346875\ M + 23.125$$

where $900 < M < 3050$

$$T_i = 0.578125 \times 10^{-4} M^2 + .13296875 M - 18.5$$

where $3050 < M < 3600$

$$T_i = 0.625 \times 10^{-4} M^2 + .14345 M - 93.9$$

where $M > 3600$

$$T_i = 0.6 M - 927.5$$

This is a quick and convenient method for calculating tax payments on calculating machines or on a computer. It is slightly inaccurate where $500 < M < 3600$ because while the basic tax structure in this range is a quadratic function, in reality it is linear between £100 intervals of taxable income.

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