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DEPARTMENT OF HORTICULTURE

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Economics and Management of Vegetable Production

Editor : T. M. Morrison

PROCEEDINGS OF A SHORT COURSE ON ECONOMICS AND MANAGEMENT OF VEGETABLE GROWING

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PREFACE

The Vegetable and Produce Growers Federation for a number of years has been encouraging collection of costs of production of process crops. While this is valuable in maintaining a watching brief on processor pay-outs, it is only one factor in assessing the relative profitability of competing crops. The full science or art, of management must be brought to bear on the problems before any solution can be suggested.

With farmers diversifying into vegetable production and others likely to follow as processing expands into export it is opportune that a course such as this was held at this time. Some of the discussions show the pertinence of papers to problems facing the industry right now. Others show the way to the future.

The course offered a new look in education to vegetable growers. We have maintained that our greatest contribution to the established grower is to bring recent information to his notice - preferably after he has been in the industry for some time. With a recession in fresh vegetable prices, "economic" management is probably the most serious omission from growers' education. Fortunately in this department and others in the College we can present an expertise in this modern subject.

The papers do not attempt to answer all specific questions but are designed to give a base on which the individual grower can build for himself from his own experience. They also may serve to demonstrate to the grower that in horticulture we have a long way to go to fill the gaps in our "management" knowledge. It behoves all growers to help us and consequently themselves to acquire this knowledge.

Finally I must thank all lecturers at this course for they provided a stimulating four days and all growers who attended, for without a receptive audience no course can succeed.

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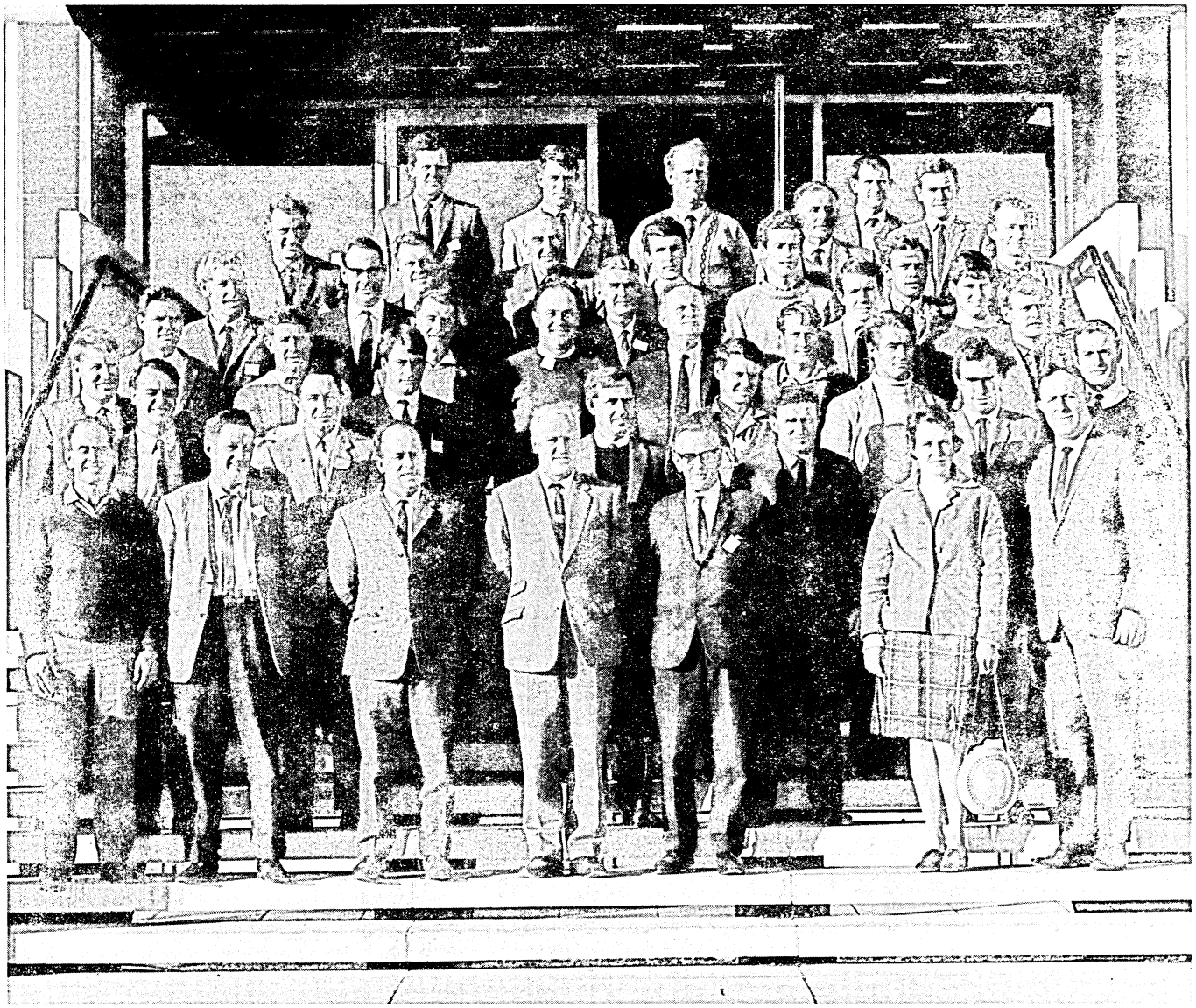

THE ECONOMICS OF FERTILISER USE AND PLANT PROTECTION IN VEGETABLE GROWING*

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The cost-price squeeze is a fact of life. One thing we can all be sure of in a rather uncertain world is that costs are rising, and will continue to do so in future years. Persistent inflation, and higher standards of living will ensure that the cost of farming inputs, to farmer and grower alike, will inevitably creep upwards. While it is the responsibility of Government to ensure that inflation is checked, it is both unwise and unreal to suggest that unit cost increases can, or should be, avoided.

Both secondary and tertiary industry in New Zealand can, to a large extent, recoup increased costs through higher pricing policies. No such convenience is available to most groups of farmers, and will not be in the foreseeable future. Primary producers, especially fruit and vegetable growers, have historically shown reluctance to combine their selling strengths and exert a monopolistic effect on the market. Consequently, the vegetable market continues to be a free market where the time-honoured laws of supply and demand still reign, virtually unchecked, and the price the grower receives for a product is often a matter of fortune. Further, world-wide trends indicate that the prices of food products are becoming cheaper relative to manufactured products, i.e. the "terms of trade" are moving against the grower.

The solution to the cost-price squeeze is not simple, and as you well know, no magic formula exists. As the profit margin per unit of product narrows, some possible tactical openings for the grower are:

a) to increase the size of his holding, or to establish a larger area of crop
b) to concentrate his efforts only in the higher-profit crops
c) to slow down his cost increases, by very careful attention to expenditure.

All of these possibilities have inherent difficulties. Others will discuss (a) and (b) in various forms. My paper will concentrate on some aspects of (c), i.e. the use of farm capital in the application of variable inputs, especially fertiliser and sprays. Two points should however be kept in mind:

a) the principles developed below are applicable to all variable farm inputs and not restricted to fertiliser and spray use
b) that we are considering only one facet of increases efficiency, i.e. keeping rising costs within reasonable limits.

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* The advice of Dr J.G.H. White of Lincoln College is gratefully acknowledged.

TABLE 1

Crop		Cost per acre $	Percentages of Direct Costs per acre %	Percentages of Gross Revenue per acre %
Potatoes	Fertiliser	11.7	3.7	2.6
(at $30 ton)	Sprays	7.5	2.4	1.7
Pumpkins	Fertilisers	11.7	8.4	2.9
(at $40 ton)	Sprays	-	-	-
Carrots	Fertilisers	11.7	4.1	3.1
(at $12.50 t.)	Sprays	27.0	9.6	7.2
Onions	Fertilisers	11.7	5.4	2.6
(at $30 ton)	Sprays	8.0	3.7	1.8
Cabbage	Fertilisers	11.7	7.1	4.1
(at $24 ton)	Sprays	3.1	1.9	1.1
Processing Peas (b)				
Hawkes Bay	Fertilisers	3.79	(a)	4.0
	Sprays	5.90		6.3
Canterbury	Fertilisers	2.48		3.0
	Sprays	3.42		4.2

Source: Taylor N.W. Horticulture Business Management
Department of Farm Management (roneo)
Lincoln College, 1964.

Notes: (a) directly comparable data not available
(b) from Hamilton B.N. & Johnson R.W.M. "Processing Peas: A Survey of Growers' Return 1967-68", Agricultural Economics Research Unit, Research Report 53 Lincoln College 1968.

Fertilisers and Sprays in the Grower's Budget

In terms of total expenditure, neither fertiliser nor sprays assume a very important role. Table 1 indicates to some extent the importance of both fertiliser and sprays in the grower's budget. It would appear that fertilisers can be expected to make up an average of about 5.7 per cent of growers' direct costs and sprays about 4.4 per cent. Taken together they occupy only about one-tenth of direct expenses incurred by growers. It would seem clear then that growers should concentrate attempts to increase efficiency, i.e. cost reduction per unit of output, on the items which are substantial components of expenditure, e.g. harvesting expenditure. Effort devoted to a 10 per cent cost reduction in fertiliser and spray costs could perhaps more profitably be allocated to achieving a 3-4 per cent reduction in harvesting costs. Nevertheless, as previously outlined, the principles to be kept in mind when allocating scarce working capital to various uses, apply to all inputs. These will now be outlined using fertiliser or sprays as an example.

To my knowledge, no experimental data exist which is complete enough to demonstrate the principles developed below. I have therefore used a hypothetical example as an illustration. This example refers to the application of fertiliser to a potato crop.

Background

Let us assume, as an illustrative example, that a grower is in doubt concerning fertiliser rates for his potato crop, but "knows" the response he could expect from applications of fertiliser over a range of 0-6 cwt of "complete" fertiliser per acre. We must assume also that no other factors such as water shortages are inhibiting potato production. We shall begin by considering a potato budget at zero fertiliser level for a Canterbury farmer, as shown in Table 2.

TABLE 2 Potato Budget at Zero Fertiliser Level*

	(per acre)	$
Gross Revenue	12 tons at $30	360.00
Direct Costs		
Cultivation	5 hours at 60 cents	3.00
Seed	15 cwt at $70 per ton	52.50
Sprays		7.50
Harvesting	168 bags at 25 cents	42.00
Cartage	168 bags at 12 cents	20.16
Grading	12 tons at $6	72.00
Levy	12 tons at $3	36.00
Sacks	168 at 12 cents	20.16
	TOTAL DIRECT COSTS	253.32

Gross Margin per acre ($) = 360.00 - 253.32 = 106.08

* adapted from N.W. Taylor, op.cit.

As the use of any input changes, the budget will reflect changes in costs and income.

Increased Revenue from Fertiliser Use

We do not know precisely the nature of the fertiliser response function for potatoes in Canterbury, but will assume that if follows that shown in *Figure 1. While the true relationship would be a curve, we can approximate the curve, as shown in Table 3 over page.

* see page 58

TABLE 3

Fertiliser application (cwt/acre)	Yield of Potatoes Total (tons/ac)	Yield of Potatoes Value ($)	Additional Yield due to last .5 cwt fertiliser Yield(tons/ac)	Additional Yield due to last .5 cwt fertiliser Value ($)
0	12	360.0	-	-
0.5	12.8	384.0	0.8	24.00
1.0	13.35	400.5	0.55	16.50
1.5	13.8	414.0	0.45	13.50
2.0	14.2	426.0	0.40	12.00
2.5	14.45	433.5	0.25	7.50
3.0	14.65	439.5	0.20	6.00
3.5	14.8	444.0	0.15	4.50
4.0	14.9	447.0	0.10	3.00
4.5	14.95	448.5	0.05	1.50
5.0	15.0	450.0	0.05	1.50
5.5	15.0	450.0	0.0	0.00
6.0	15.0	450.0	0.0	0.00

It will be noticed that, as the level of fertiliser use increases each additional half-cwt of fertiliser produces a smaller response than the previous one. This is, of course, the historically observed law of diminishing returns in operation i.e. as the amount of an input is increased (others being held constant) the additional or marginal increment to the total product decreases at an increasing rate.

Increased Costs of Fertiliser Use

The increased use of fertiliser will involve costs. These will be:

a) the cost of the fertiliser

b) the cost of application

c) costs of handling and harvesting the increased production

Some of these costs will vary in proportion to the amount of fertiliser used, others will be independent, and will have to be considered in relation to increases in output. These costs are detailed in Table 4, and shown in Figure 2. (see page 58)

It is normally expected that cost curves will be U-shaped. The curve in Figure 2 is downward sloping only. However, if fertiliser levels were significantly increased it would be expected that they might increase beyond a certain point. This curve is a "marginal" or additional cost curve of fertiliser applications.

TABLE 4 Additional Costs of .5 cwt of Fertiliser Application
Costs associated with Additional Production (per acre)

Fertiliser Application (cwt/acre)	(a) Fertiliser	Spreading	Harvesting	Cartage	Grading	Levy	Sacks	Total Cost
0	0	0	0	0	0	0	0	0
0.5	1.25	0.30	0.30	1.32	4.80	2.40	1.32	14.14
1.0	1.25	0.30	2.00	0.96	3.30	1.65	0.96	10.42
1.5	1.25	0.30	1.58	0.76	2.70	1.35	0.76	8.70
2.0	1.25	0.30	1.40	0.67	2.40	1.20	0.67	7.89
2.5	1.25	0.30	0.88	0.42	1.50	0.75	0.42	5.52
3.0	1.25	0.30	0.70	0.34	1.20	0.60	0.34	4.73
3.5	1.25	0.30	0.53	0.25	0.90	0.45	0.25	3.93
4.0	1.25	0.30	0.35	0.17	0.60	0.30	0.17	3.14
4.5	1.25	0.30	0.18	0.08	0.30	0.15	0.08	2.34
5.0	1.25	0.30	0.18	0.08	0.30	0.15	0.08	2.34
5.5	1.25	0.30	0	0	0	0	0	1.55
6.0	1.25	0.30	0	0	0	0	0	1.55

(a) allowing $50 per ton for a "complete" fertiliser.

Profit Maximisation

The use of any input can, of course, only be justified if it contributes to profits. The profits from fertiliser application will be represented as the difference between the revenue generated and the costs incurred. At zero fertiliser application, the gross margin of potatoes is $107 per acre (Table 2). The questions now to be answered are:

a) Will the use of fertiliser add to the Gross Margin?

b) If so, what level of fertiliser should be used?

The first question is answered by subtracting the costs of additional fertiliser application (Table 4) from the value of increased yield due to fertiliser application (Table 3). This is shown in Table 5, and demonstrated in Figure 3. (see page 59)

TABLE 5 Profits, Costs & Returns of Additional Fertiliser application

Fertiliser Application (cwt/acre)	Additional Revenue ($)	Additional Costs ($)	Additional Profit ($)	Cumulative Additional Profit ($)
0.5	24.00	14.14	9.86	9.86
1.0	16.50	10.42	6.08	15.94
1.5	13.50	8.70	4.80	20.74
2.0	12.00	7.89	4.11	24.85
2.5	7.50	5.52	1.98	26.83
3.0	6.00	4.73	1.27	28.10
3.5	4.50	3.93	0.57	28.67 - Maximum
4.0	3.00	3.14	-0.14	28.53
4.5	1.50	2.34	-0.84	27.69
5.0	1.50	2.34	-0.84	26.85
5.5	0.00	1.55	-1.55	25.30
6.0	0.00	1.55	-1.55	23.75

Figure 3 draws together the relationships to be considered for profit maximisation. The additional revenue curve is downward sloping and eventually reaches zero as the law of diminishing returns takes full effect. The additional cost curve is also downward sloping as far as it has been drawn. While the additional revenue curve is above the additional cost curve, each further increment in fertiliser use increases profit by an amount equal to the distance between them i.e. the shaded area. This additional profit curve is shown separately in Figure 3; it becomes zero when additional revenue equals additional revenue, losses are incurred on each additional application of fertiliser. Since additional profits are additive as fertiliser use increases, the cumulative profit curve shows the total profit from fertiliser applications. It will reach a maximum at the point where additional cost equals additional revenue and where additional profit is zero. Beyond this point total profit decreases as losses are incurred on increments in fertiliser use.

From Figure 3 and Table 5, it is clear that profit from fertiliser used in this example will be a maximum at some point between 3.5 and 4.0 cwt/acre. Below this level, profit can be increased by the application of additional fertiliser; above this point profits can be increased by reducing fertiliser rates.

It would be unreal to suggest that an exercise of this type is a necessary prerequisite for decisions on the level of use of all inputs. A somewhat simpler approach to the problem, and probably one followed by many growers, is to ask the question:

> "At what fertiliser rate, to the best of our judgement, is it likely that the returns from more fertiliser added will just cover the costs incurred?"

This rate is the best in the economic sense.

A last point, but a very important one remains. Figure 1 shows that maximum production is reached first when 5 cwt of fertiliser is added. We have seen above however that the most profitable level of fertiliser use is 3.5 - 4.0 cwt. Clearly then, the point of maximum production is not the same point as maximum profits. Although this exercise is provided only as an example, this is an economic truism which is seldom recognised in practice.

Figure 1 Assumed Fertiliser Response Function for Potatoes

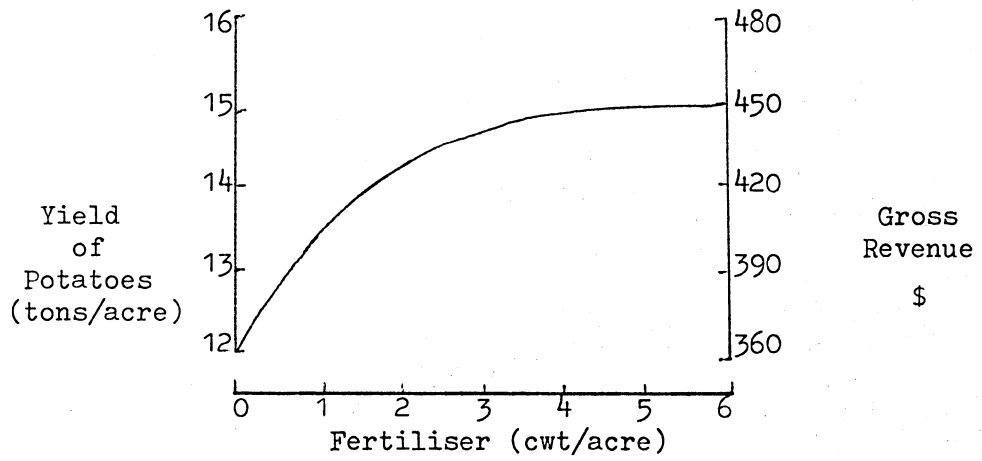


Figure 2 Cost of All Factors in Fertiliser Application

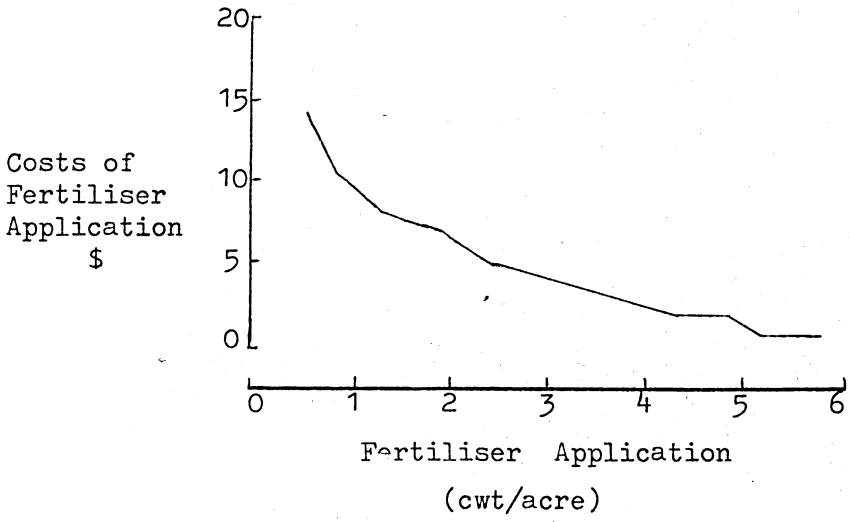
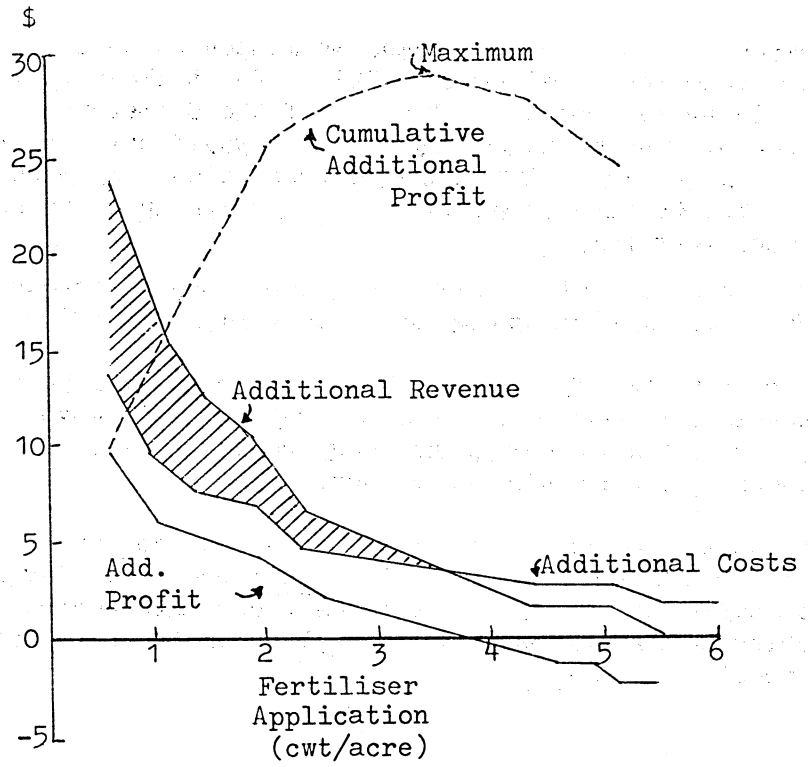


Figure 3 Additional Revenue, Costs & Profits and Cumulative Additional Profit from Fertiliser Applications



DISCUSSION

Q. I don't see how the increased cost of greater fertiliser use can overcome the costs of production since any increase in production must lower the costs of production.

Jensen: Costs of handling and harvesting the extra yield, of say 3 tons of potatoes, add to your costs of production. When you increase production you cannot dodge this extra cost and you must not forget it.

Q. Can you use a rapid-growing test crop, e.g. radish, to test for the optimum level of fertiliser required before you plant the main crop since we know that soil analyses may not extrapolate accurately from the test-tube to the field?

Rowland: In more delicate vegetables, I mean celery of course, quality is as important as quantity and this is not provided by radish. It is better to work from year to year and adjust fertilisers from experience. Maximum production is not necessarily maximum profits.

Q. In economics bulletins coming out of the College the assumption is often made that by increasing production you get increased profit. Nationally we are on a supply and demand market and therefore our increased

production could depress the market. As an economist are you concerned at this?

Jensen: Very much so. We learnt a valuable lesson on this from the Agricultural Development Conference. This made it clear to farmers that they must increase output but I doubt if the Conference was responsible for the increased output that would have occurred anyhow at that time. Farmers will increase production only when it pays them to do so. But because production of lambs went up, the United Kingdom market price went down.

Now it may well be that a vegetable grower should decrease fertiliser use and therefore production in order to maximise profit.

Q. This works well with fertilisers but with sprays you have to use them at the recommended dosage in order to get the kill - you cannot suddenly stop using them when you have reached the budget allowed or you lose what you have already put on.

Jensen: I set out two years ago to prove that spray companies were recommending dosages in order to maximise their profits. Invariably the most profitable use of sprays is to keep complete control over pests - this humbled me because the spray people seem to know what they are talking about.

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