BOUNTIES FOR FERTILIZERS

R. G. MAULDON

University of Western Australia

Bounty payments on fertilizers have rapidly emerged as a major form of assistance to Australian agriculture. They have been justified as a way of reducing costs and increasing productivity, though economic theory and experience from agricultural production studies suggest that they achieve these objectives inefficiently. The bounties are directed towards making acres more productive, which should in turn make farmers more productive. It is suggested that greater economic welfare would result from tackling the problem the other way round.

During 1966-67, only four years after its reintroduction, the value of bounty payments on superphosphate exceeded the value of bounty payments on butterfat, which for over a decade had made the largest direct claim by Australian agriculture on public funds. The period which has elapsed since the reintroduction of the fertilizer bounties is too short to have measured their effects directly. Even an indirect estimate is scarcely feasible; our knowledge of the structure of the agricultural sector is too meagre. My purpose is, therefore, not to measure but rather to focus attention on what has almost overnight become the major form of financial assistance to Australian agriculture.

Types of Assistance

Assistance to agriculture has come under a great deal of academic scrutiny, mainly centering on price maintenance and stabilization. Yet these schemes form only a part of the array of methods by which financial assistance is given to agriculture. The fertilizer bounties are only one of these other methods.

Price support schemes apply to industries, since the Commonwealth Government in settling on its price policies negotiates with industries, not with regions or income groups.[1] Hence price support goes to whole industries, not to problem regions or income groups within them. On the other hand, financial assistance which is not attached to the prices which farmers receive, tends to be tied less specifically to particular industries. Exceptions certainly do exist, such as the dairy extension grant and contributions to the various industry research funds. But generally non-price aid which is associated with specific industries is less likely to accrue to the whole of the industry, and often the association is due to a particular regional location or regional income problem. For instance, capital grants for Brigalow or cattle roads development are associated with the cattle industry as a result of location and the various dairy industry rehabilitation schemes have been associated with dairying because of low regional income. Other forms of assistance, such as the

[1] The term "industry" is used here in the administrative sense rather than in its economic sense of a number of firms closely related through the competitive process.

fertilizer bounties, are available to producers in all agricultural industries, though they may have a larger impact on some industries than on others.

Price subsidies and other forms of assistance therefore tend to be argued for in different ways. Price support schemes have been introduced mainly to stabilize incomes (wheat and dairying) or to develop an industry to replace imports (cotton). In fact, they all operate to raise incomes, though this effect may be dissipated over time as subsidies are capitalized into real estate values. A major outcome of these schemes is to increase the disparity of incomes within industries by keeping some otherwise sub-marginal producers within the industry while at the same time inducing and enabling further investment by more favourably situated producers. They appear to have been successful in encouraging production, but particularly in the case of the older established industries, it is debatable whether the value of the induced production has exceeded the total value of additional costs.

Other forms of assistance have been justified in a variety of ways, which seem to fall into one or more of five major categories. These are: (i) welfare of people in vulnerable situations, (ii) benefits which go beyond the farm, (iii) regional development, (iv) compensation for capital market disadvantage, and (v) increasing productivity through reducing costs of production.

The fertilizer bounties have been justified mainly in terms of increasing agriculture's productivity through reducing costs of production. The Minister for Primary Industry stated both of these objectives in commenting on the reintroduction of a nitrogenous fertilizer bounty in the 1966-67 budget. "The Government has had two main objectives in introducing a subsidy on nitrogenous fertilizers. The first of these is to reduce the costs of those industries which are major users of nitrogen and which, as it happens, are currently encountering low returns abroad; the second is to encourage the usage of these fertilizers, particularly in industries where productivity could be raised by the application of nitrogen. The result in either case will be an improvement in the welfare of our farmers and in the efficiency of our agriculture."[2] Similar thinking, at least in part, lies behind the superphosphate bounty which was introduced "to stimulate increased use of superphosphate as a means of improving still further the productivity of farm lands and pastures".[3]

How effective the bounties will be in reducing costs and expanding agricultural production will depend on the outcomes of two questions. First, to what extent will the bounty payment which is intended for farmers be absorbed by suppliers? Second, what will be the extent of additional production in relation to the direct and indirect cost of the bounty itself, and how does this compare with the net return to a comparable outlay spent on subsidizing alternative resources?

Sharing the Bounty

In spite of the administrative safeguards which are made to ensure that the full benefits of price bounties are passed on to farmers, the pressure of the market is always working to shift part of the benefit to suppliers of the subsidized resource. This pressure operates in the fol-

[2] The Minister for Primary Industry, *Press Statement*, 16th August, 1966.

[3] The Federal Treasurer, *Budget Speech*, 13th August, 1963.

lowing way. A price reduction caused by a bounty payment will increase the demand for the resource, and the increases in production of the resource which are made necessary by this expansion in demand may give rise to situations which call for subsequent price modifications by its suppliers. The strength of this pressure will hence depend on two factors: firstly, on the responsiveness of farmers to purchase more of the resource as its price is lowered, and secondly, on the price adjustments which are necessary to induce suppliers to provide greater quantities of the resource to farmers.

In terms of the principles of intermediate economic analysis we can say that the more elastic is the demand for a subsidized resource, the larger will be the expansion of its use and the greater will be the proportion of the bounty which is absorbed by its suppliers. Also, the more elastic is the supply of a subsidized resource, the smaller will be the proportion of the bounty which will be absorbed by its suppliers.[4] This price increase will generally be larger, for a given cost structure, in supplying industries with a greater degree of monopoly power.

I must stress that this analysis is a description of inducements within the market, not of market behaviour. The political climate and commercial prudence do not permit a price adjustment which shifts bounty payments from farmers to suppliers in a rapid or once-for-all fashion. But I strongly suspect that industry does respond to these inducements, absorbing these shifts within general price movements which occur for a variety of reasons, and which may be distributed through time. I do not mean to imply any undue commercial avarice. Market adjustments of these types tend to be quite impersonal, even in monopolistic situations where individual decisions determine prices within a whole industry. Industry usually faces an increase in cost structure if it has to expand its output in a hurry, since it has to go to more expensive sources of supply for its own resources. It could be claimed that expansion of production in the longer run leads to economies of scale and consequent inducements to reduce prices. However, if this were the case I expect that the bounty would only serve to slow down the rate at which suppliers would otherwise reduce their prices in order to appropriate these gains.

Already we might note a clash of aims. The use of a resource price bounty to expand resource use and to lower costs will not be uniformly successful in achieving both purposes if the suppliers of the resource act in their own best interest. The more effective a price reduction is in expanding resource use, the less effective will a bounty be in reducing price.

We have little knowledge about the price responsiveness of farmers to specific changes in resource prices. There has certainly been a marked increase in superphosphate usage over recent years when its price has declined. The extent of this increase was not anticipated by Treasury officials when the bounty was introduced, since at the time of the 1963 Budget the Federal Treasurer anticipated that the cost of the bounty would be $14 m. in 1963-64 and $18 m. in a full year. In fact the bounty cost $19 m. in 1963-64 and $23 m. in 1964-65.

The estimation of demand characteristics for fertilizer in Australia is not a straightforward matter. Since the early 1950's there have been

[4] See Boulding, K. E. *Economic Analysis*, Vol. 1. New York, Harper and Row, 1966, pp. 207-209.

strong trends at work in all the relevant time series. A direct regression using aggregate time series indicates a marked response to price changes, but year to year price changes appear to have had a much smaller effect on year to year changes in fertilizer use. Factors such as additional land clearing, the increasing momentum of the pasture revolution, the rapid expansion of wheat acreage as a result of buoyant prices, and an easier rural credit situation must have played major roles in accounting for the rapid expansion in fertilizer use.

However, a 50 per cent rise in the use of superphosphate has been associated with a 33 per cent decline in superphosphate price during this time, and on face value it appears as though a large portion of the bounty payment could be absorbed within the fertilizer industry itself.

It would be informative to know whether this source of potential bounty absorption would be greater for fertilizers than it would be for other resources, such as labour or fixed capital. I raise this question not with a view to suggesting that it would be wiser to subsidize these alternatives, but rather with a view to examining our strategy of encouraging various types of resource use. Though we have no estimates of the resource demand structure for Australian agriculture of the sorts that Heady and Tweeten have made for the United States,[5] I suspect that fertilizer would have one of the highest elasticities of demand of all resources. Fertilizer is an ideal type of resource to respond to in the light of price changes, as our use of fertilizer response examples in the teaching of elementary agricultural economics suggests. It is a homogeneous resource and it does not suffer from the lumpiness of many of the alternatives. Also, vocational training and technical extension have developed farmers' skills in the administration of acres and animals, both of which are closely associated with fertilizers, to relatively high levels, while farmers receive negligible training in the administration of labour and its close substitutes.

But this pattern of behaviour does not imply that for income maximization fertilizer *should* have the highest elasticity of demand. Some recent analysis suggests quite the opposite conclusion.[6] In general our "broad acres" farming is characterized by low production elasticies for land and by large land/labour ratios. Most profitable farming would therefore lead to greater relative price responsiveness to the use of labour and items associated with labour than to the use of fertilizer and other land based items.

The other side of the bounty-sharing coin is the ease and cost of increasing the supply of resources to farmers. In spite of some severe distribution problems, the fertilizer industry has shown a remarkable ability to handle a rapid expansion of production over the last few years, with a continuing increase in plant capacity. One certainly cannot envisage a response in the supply of, say, farm labour of this order. From this point of view the pressure for bounty absorption must have been minimal. However, with the recent rapid increases in raw material costs, caused in part by our expanded needs for rock phosphate, the price

[5] Heady, E. O., and Tweeten, L. G. *Resource Demand and Structure of the Agricultural Industry*. Ames, Iowa State University Press, 1963.

[6] For the clearest statement of this thesis see Davidson, B. R., and Martin, B. R. The Relationship Between Yields on Farms and in Experiments. *Aust. J. Agric. Econ.* 9: 129-140, 1965.

pressure now appears to be on. The real crunch will come if (as seems likely) raw material prices fall again.

It is interesting to conjecture about the degree of monopoly power within the fertilizer industry. All the superphosphate companies in Australia have been inbred to some extent, mainly to facilitate the flow of technical information and to rationalize markets. It is an industry with virtually no product or price differentiation between companies within States, though there have frequently been discrepancies in prices between States. This has enabled the industry in each State to change its prices frequently without fear of price discrepancies between companies. This is in marked contrast to, say, the farm equipment industry where there is considerable product differentiation and a stickiness of prices from year to year. The fertilizer industry is monopolistic to the extent that it is fully able to set its own price at the level which best suits it, but I see no evidence that it has used monopoly power to limit overall production to increase that level of prices which best suits it. This, perhaps, provides the greatest potential for the industry to appropriate a major share of the bounty.

Benefits and Costs

In most cases when the price of a farm resource is reduced, it will pay to expand its use. Part of this expansion will represent a substitution for other resources. Most often, however, there will be an expansion in the use of all resources. A price bounty on fertilizer is therefore unlikely to result in a reduction of total costs which is as large as the bounty times the level of fertilizer use prior to the introduction of the bounty. In fact it may result in an expansion of the total cost bill. Offsetting this, to a greater or less degree, will be an expansion of production.

So even if none of the bounty is absorbed by suppliers, the question remains—what is the benefit of the bounty in comparison to its costs? "Costs" is pluralized since we must not only consider the direct cost of the bounty, but also the indirect cost which occurs as a result of the additional resources drawn into the industry. We should bear in mind that prices for non-subsidized resources might rise as a result of their expanded use. This would be of most importance where factor supply markets are inelastic.

If farmers were using fertilizers at well below the rates which yield maximum profits, and if by focusing on fertilizer usage the bounties induced farmers to use fertilizers at more efficient levels, then the bounties could generate an income which was greater than their combined costs to the public and the farmers. But I know of no general evidence which suggests that farmers have been underspending their working capital on fertilizers, or that the bounty payment induces farmers to use fertilizers more efficiently. In the absence of this evidence our understanding of agricultural production processes suggests that the social costs of the bounties might exceed the social benefits, and that farmers' net incomes might not even be increased by as much as the total bounty payments. These conclusions, again, follow from the principles of intermediate economic analysis.

Rather than spell out these principles in terms of continuous production functions and the calculus of maximization, let me illustrate them

with some material drawn from two farm production studies.[7] One is a study of dairying in 1955 in the Perth-Bunbury wholemilk region of Western Australia, and the other is a study of sheep farming in 1955-56 in the Canterbury Plains of New Zealand. I have selected these two studies simply because they are conveniently published, fertilizers are considered as one of the inputs, and they contain all of the necessary information for the calculations which follow. The following figures indicate the changes which would take place on the average farm in the sample if a total payment amounting to $100 were allocated to the farm by way of a bounty,[8] and if the farmer were to use unrationed working capital in a profit-maximizing way.

	W.A. Wholemilk Dairying	N.Z. Sheep Farming
Increase in production ($)	146	171
Increase in farm expenditure ($)	58	75
Increase in net farm income ($)	88	96
Total social cost ($)	158	175

In both cases we see that the total social cost would exceed the value of additional production and that the farm's net income would increase by a smaller amount than the value of the bounty payment.

This would be so for any resource which was subsidized. However, it would not be uniformly so for all resources. In general, the greater the elasticity of production of a resource, the greater will be the increase in production from a given bounty payment, the greater will be the net income going to farmers, and the smaller will be the gap between total social cost and the value of additional production.

This generalization can also be illustrated from the two production studies used above. In the W.A. dairy study the production elasticity for labour was greater than it was for fertilizer, while in the New Zealand sheep farming study the production elasticity for fertilizer was greater. The figures in the next table indicate the corresponding changes which would take place if the $100 bounty payment were allocated to labour. Production elasticities for fertilizer and labour are also given. Differences are small, but they illustrate the point.

A general picture emerges from these types of studies.[9] In "small acres" intensive farming, a greater relative production response usually

[7] Schapper, H. P., and Mauldon, R. G. A Productive Function for Farms in the Whole-Milk Region of Western Australia. *Econ. Record* 33: 52-59, 1957; and Mason, G. Resource Productivities from a Sample of Light Plains Farms, Canterbury, N.Z. *Aust. J. Agric. Econ.* 4: 121-129, 1960.

[8] I.e., the bounty payment per unit of fertilizer times the total quantity of fertilizer used at the bounty price equals $100. Fertilizer in the New Zealand study does not include lime, which is treated as a separate resource.

[9] A useful summary of production function estimates from around the world is given by Heady, E. O., and Dillon, J. L. *Agricultural Production Functions.* Ames, Iowa State University Press, 1961, Chap. 17. The inferences drawn from this summary follow those of Davidson and Martin, *op. cit.*

	W.A. Wholemilk Dairying	N.Z. Sheep Farming
Increase in production ($)	154	169
Increase in farm expenditure ($)	62	74
Increase in net farm income ($)	92	95
Total social cost ($)	162	174
Production elasticity for fertilizer	0·13	0·22
Production elasticity for labour	0·23	0·15

comes from fertilizers and other land based expenditures than from labour or items associated with labour. This situation is reversed for "broad acres" extensive farming. Since Australian farming is dominantly extensive, I suspect that the fertilizer bounties may not be increasing farmer income or expanding rural production as effectively as might equivalent expenditure on other items if it could be effectively administered by the farmer.

We should also compare the outcome of assistance given by way of a resource price bounty with the outcome of an equivalent amount of assistance given by way of product price support. Again, our two production studies illustrate a general point. The following figures show what the outcomes would be on the average farm in the sample if a total payment of $100 were allocated to the farm by way of price support on production,[10] and if the farmer were to use unrationed working capital in a profit-maximizing way.

	W.A. Wholemilk Dairying	N.Z. Sheep Farming
Increase in production (pre-subsidy $)	66	76
Increase in revenue ($)	167	177
Increase in farm expenditure ($)	68	78
Increase in net farm income ($)	99	99
Total social cost ($)	168	178

In both cases, the price supports would induce a smaller increase in production than would the resource bounties, but the additional production would occur in a more efficient manner, resulting in a larger net income boost to the farmer and a smaller gap between total social costs and the value of additional production. In general, the price support will be the more efficient of the two forms of assistance. The resource bounty pushes in a particular resource in an economically inefficient way. The price support draws in all resources in a way which the resource market directs. The price support is resource-neutral, even though it is not product-neutral. The resource bounty is neither product-neutral nor resource-neutral.

[10] I.e., the price support per unit of production times the total quantity of output produced at the subsidized price equals $100.

It could be argued that inferences drawn from these types of study are scarcely valid since they highlight characteristics of equilibrium while the bounties have been introduced to encourage development. It is true that in a developmental situation the discounted value of future production could be greater than the discounted flow of the bounty cost, at least when the evaluation is made at market rather than opportunity discount rates, since the bounty effectively acts as a source of capital for development. However, there may be more efficient ways of introducing capital than via a resource subsidy.

Let me again illustrate this with an example. I draw my material from a development study in the Esperance sandplain of Western Australia.[11] This example relates to the development of a 2,000 acre property using either an intensive method of land development with high establishment costs and a rapid build up of stocking capacity per acre, or an extensive method of land development, with lower establishment costs and a slower build up of stocking capacity per acre. The objective is to maximize the flow of surplus income in excess of living costs plus working capital, all carried through to the eleventh year and discounted back to the present. The following figures summarize the results at different levels of beginning capital and alternative methods of financial assistance.

0. Beginning capital level ($)	40,000	60,000	80,000
1. Discounted return using super with no bounty ($)	16,625	37,491	58,340
2. Discounted return using super with a $6 bounty per ton ($)	17,985	39,897	61,840
3. Discounted value of the super bounty used in 2 ($)	2,038	3,756	5,274
4. Discounted return if 3 were allocated on a per lb. of wool produced basis ($)	18,482	40,805	63,129
5. Discounted return if 3 were given as a beginning capital grant ($)	18,752	41,404	63,845

It must be stressed that this does not represent the total story, since there are fixed capital gains under all three assistance regimes which are not considered here. Yet both stocking capacity and livestock run at the end of the plan are greatest when assistance comes as a capital grant, and least when assistance comes as a fertilizer bounty. The picture which emerges from this example is one which has frequently been recognized in the rapidly developing agriculture of the south of Western Australia. There has tended to be an over-generation of capacity for livestock, i.e. an under-generation of the livestock themselves. The fertilizer bounty has acted to widen this discrepancy rather than to narrow it, and has possibly added to the marked increase in livestock prices which has accompanied this rapid development.

Finally, a word of caution. The examples I have used should be considered as indicative rather than definitive. The studies were not designed for the purposes to which I have put them, and I have assumed that farmers would react in an optimizing manner, which is

[11] The structure of the example follows that of the case study described in Moncrieff, I. J., and Mauldon, R. G. The Effect of Land Clearing Regulations on the Rate of Farm Development—A Case Study. *Aust. J. Agric. Econ.* 7: 172-179, 1963. No restriction was placed on the rate of land clearing.

scarcely possible in the real world. Also, they are micro-examples which do not highlight the cost increases which might occur as a result of rising prices on a factor market. I suspect that the differences between the various forms of assistance would be greater than these examples suggest, while increases in net incomes might not be quite so large.

Distribution of Effects

So far I have made only indirect reference to where the impact of the fertilizer bounties will be felt. Naturally they will ease cost of production pressures most in those industries and regions where expenditure on fertilizer forms the largest proportion of total costs. Also, since the elasticity of demand for a resource increases with the proportion of total cost of production accounted for by that resource, it is in those industries and regions that we would expect the relative increase in fertilizer use to be greatest. What part fertilizer will play in the total cost structure will depend partly on edaphic conditions and partly on what is produced and how production is organized.

Soils in southern Australia are generally deficient in phosphate, particularly in the south of Western Australia. This is borne out by the following figures drawn from the pre-bounty 1959-60 to 1961-62 Australian Wheatgrowing Industry Survey conducted by the B.A.E.

	N.S.W.	Vic.	Q'ld.	S.A.	W.A.
Fertilizer expenditure in relation to total costs (%)	2·2	4·4	0·2	5·3	10·3
Return on capital (%)	10·2	9·4	6·9	6·4	11·2

In this industry, cost of production relief through the superphosphate bounty will not give undue encouragement to the less successful sectors of the industry, if return on capital is taken as the indicator of financial success. On the other hand, the successful Western Australian industry is being given a relatively greater stimulus than other regions.

Yet the bounty will not be uniformly successful in giving greatest encouragement to regions with a comparative advantage for production, as the following figures for the manufacturing milk sector from the B.A.E.'s 1961-62 to 1963-64 Australian Dairy Industry Survey show.

	N.S.W.	Vic.	Q'ld.	S.A.	W.A.	Tas.
Fertilizer expenditure in relation to total costs (%)	2·8	4·6	1·0	5·6	8·7	5·9
Return on capital (%)	5·2	7·1	6·7	4·2	3·4	5·2

In this case the superphosphate bounty gives greatest impetus to the relatively unsuccessful South Australian and Western Australian dairy industries. It might be argued that they give most relief where relief is most needed, but as we have already seen, resource price bounties are inefficient techniques for giving income relief.

Apart from purely edaphic conditions, climate and intensity of farming clearly help to determine the relative importance of fertilizer use. The

following figures come from the B.A.E.'s 1960-61 to 1962-63 Australian Sheep Industry Survey. They refer to the major production zones aggregated over all States.

	Pastoral Zone	Wheat-Sheep Zone	High Rainfall Zone
Fertlizer expenditure in relation to total costs (%)	0·1	6·8	11·8
Return on capital (%)	6·8	6·0	3·4

In general, Australian agriculture appears to be most successful when it is based on extensive land use. Yet the fertilizer bounties give greatest impetus to development in regions which apparently have least relative advantage. This may be desirable from the point of view of equity, but it does not encourage growth where our greatest advantages in agriculture lie.

Some Concluding Remarks

Although I have built my argument around the potential inefficiencies of the fertilizer bounties, I do not want to overstress these in my evaluation of the schemes. I am not unmindful that the inefficiencies illustrated by my examples are very small. Most efforts to measure welfare gaps which arise out of free market restrictions have indicated that they are small.[12] What I am most concerned about is that the fertilizer bounties are placing the emphasis in entirely the wrong places, and are therefore an inappropriate strategy to achieve maximum welfare within agriculture. This is the major criticism of the whole philosophy of "equalization" which runs through a great deal of Australian economic life. This philosophy asserts that no area of economic activity should be allowed to develop an undue disadvantage with respect to any other area of economic activity. It is manifested in such Australian institutions as Commonwealth grants to dependent States, capital city retail price equalization, and arbitration. Farmers also use this philosophy to justify their case for price support and cost relief, since they claim a market disadvantage with respect to manufacturers and labour on the one hand and consumers on the other. Equalization may be commendable on egalitarian grounds, but it fails to be an effective philosophy for growth. It draws attention away from most favourable opportunities, while it covers up those aspects of less favoured regions and industries which have genuine comparative advantages.

However, I see no reason why resource bounties should not be judiciously used to encourage some new forms of resource use which we lack information about but which appear to have pay-offs that may be thoroughly worthwhile. Agricultural experimentation is not the most appropriate way to test all forms of resource administration, and farmers might be encouraged to build up a supply of information by a prudent use of resource bounties. This might be the greatest justification for the nitrogenous fertilizers bounty at our current state of knowledge. But any

[12] Leibenstein, H. Allocative Efficiency vs. "X-Efficiency". *Amer. Econ. Rev.* 56: 392-415, 1966.

bounty scheme of this type should have a built-in device to ensure that effective aid diminishes as the scale of resource use builds up.

If funds are to be given to subsidize the use of farming resources, they would be most wisely spent if they were tied in with programmes which are designed to develop farmers' skills for handling resources in ways which we anticipate the organization of commercial farming must follow. Too often ease of administration is taken to be the overriding consideration in deciding upon a type of assistance to agriculture. Assistance which is administered at the farm can be costly, yet it may be at this level that the greatest pay-offs from assistance to agriculture will come.

The most valuable resource in agriculture which we can make more productive is farm people. By concentrating on products on the one hand, and physical resources on the other, agricultural production policy in Australia has been directed largely towards making acres and animals more productive, and too little towards making people more productive. Yet there is ample evidence to suggest that returns to investments in farm people are very high, and this is one form of resource assistance which is likely to remain within the community for which it is intended.