THE FERTILIZER ASSOCIATION OF IRELAND

# IMPLICATIONS OF CAP REFORM PROPOSALS FOR INPUTS USE IN IRISH AGRICULTURE

*K. Reidy*

# A REVIEW OF SULPHUR USE IN IRISH AGRICULTURE

*M.D. Murphy*

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# IMPLICATIONS OF CAP REFORM PROPOSALS FOR INPUTS USE IN IRISH AGRICULTURE

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## Introduction

The topic for discussion here is very broad in scope and highly relevant at the present time. The final detailed outcome of the current CAP reform proposals will not be known until sometime next year. In these circumstances, my approach here is to attempt to raise the salient issues which arise out of the present set of proposals and to indicate the likely direction of future changes in the use of the principal inputs in Irish agriculture.

Quantitative forecasting is a hazardous occupation even under fairly stable policy and economic environments. Currently, there is great uncertainty about the shape and content of the reformed CAP not to mention conflicting estimates of its economic impacts. In such circumstances, a well-focused discussion of emerging issues in qualitative terms and their implications should be useful at this juncture.

This paper is made up of three parts. Firstly, the CAP reform proposals themselves will be discussed. Secondly, a brief review of recent developments in the agricultural economy is undertaken which are relevant in attempting to understand the agricultural sector in the post-reform era. Finally, issues with regard to inputs use in agriculture are raised and discussed.

## CAP Reform Proposals

As we know, the legal text of CAP reform proposals have only recently been published. The crucial negotiations phase at Council level is also in the initial stages. The history of attempted reforms of the CAP including restrictive annual support price proposals in the past, suggests that the final outcome could differ in many important ways, especially in matters of detail, from the initial proposals put forward by the Commission (Fennell, 1987).

The present CAP reform proposals are the latest in a long series of reform documents produced by the EC Commission. These began not long after the CAP became operational with the Mansholt Plan of 1968. This famous but failed initiative was followed up with different proposals in 1973, 1975, 1979, 1981, 1985 and 1991. In effect "reform" in the broadest sense has been on-going albeit in an ad hoc and unsystematic manner throughout the 1980s. To date, the key policy changes occurred in 1984 (milk quota system, common support price reductions) and 1988/89 (stabiliser mechanisms for cereals, oilseeds, protein crops, beef and sheep).

In general, these measures were designed to reduce price guarantees in response to over-production. They did not represent changes in the underlying support structures of the CAP. Now, however, fundamental reform of the CAP is firmly on the negotiating agenda. There are grounds for suggesting that the present set of proposals stand more chance of being adopted in a meaningful fashion than many previous proposals (Harris, 1991).

A number of real issues are addressed in the proposals including:

(a) Compensation for lower support prices,

(b) CAP will be more acceptable in international trade discussions,

(c) Agricultural production and, hence, surpluses will be reduced,

(d) Move to less intensification in livestock production and agri-environmental measures will have some environmental benefits,

(e) Equity considerations in the distribution of the benefits of CAP supports.

A brief summary of the basic reform proposals is given in Appendix 1. Generally speaking, the proposals stipulate that the reform measures would be introduced on a phased basis from the 1993/94 marketing year and fully operational by 1996/97.

The overall economic climate pertaining to farming would be governed by lower product prices, greater competition on domestic and Community food markets, greater incentives for environmentally friendly farming, increased reliance on direct income support payments and a financial recognition of the dual role of the farmer as food producer and manager of the countryside. Furthermore, production of agricultural produce for non-food use would be stimulated and improved arrangements for earlier farmer retirements and farm restructuring would be facilitated.

In very general terms, adjustment of the CAP along the lines indicated above but without producer compensation, would lead to greater losses in economic welfare in Ireland compared to any other Member State. There would, however, be overall gains to the EC as whole (Sturgess, 1991). The problems Ireland face arise from a number of fundamental features of the Irish economy: (1) There is a high economic dependency on the agricultural sectors covered by the reform proposals compared to other Member States; (2) The dominant position of grassland-based agriculture means that the full benefits of lower feed prices will not be captured; (3) Consumer gains due to projected lower food prices will be modest because of our low population.

Compensation will reduce the extent of farmers' losses arising out of the reform process. However, the burden of losses will still be borne by the larger and more efficient producers, thereby impacting adversely on the volume of agricultural output and inputs use generally. This scenario does not, however, reflect adequately producers' adjustments to the new support arrangements over the longer term, which if recent history tells us anything, can evolve in ways not foreseen at the outset. A reflective look at recent developments in the agricultural sector may give us some useful insights here.



**The Agricultural Economy**

Agricultural incomes are once again under pressure largely as a result of adverse market developments and changes in institutional supports leading to falling producer prices (Figure 1). The marked downward trend in aggregate real incomes has continued into 1991 and no great change in the picture is expected for 1992. This would be the last full year under the existing CAP arrangements and the experience of recent years has led to widespread acceptance of the need to reverse the trend of excess supply and falling incomes from agriculture.

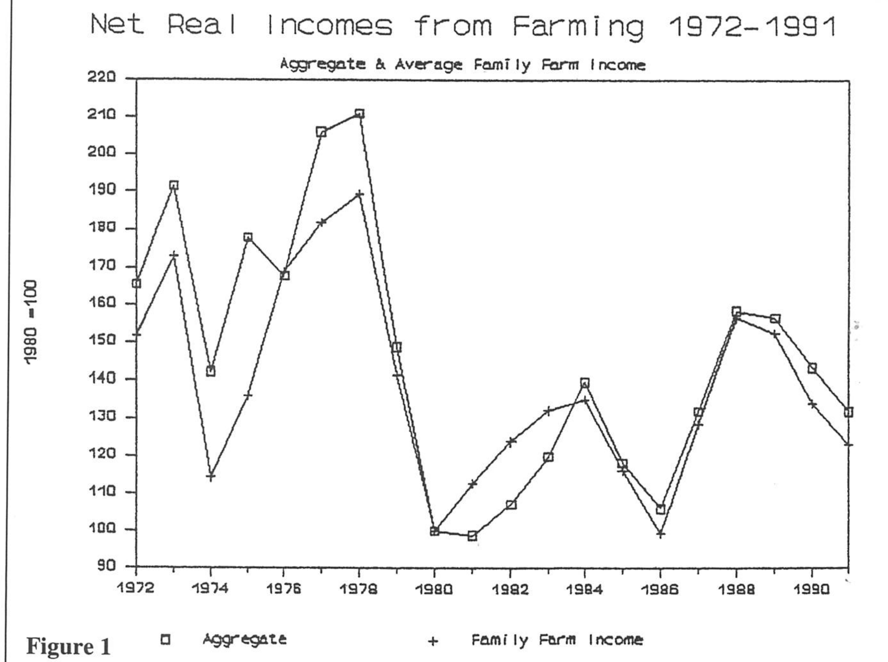


Figure 1

The generally adverse price environment of recent years can be seen from a review of the terms of trade facing the agricultural sector as a whole which has deteriorated substantially since 1989 (Figure 2). Despite this, the volumes of agricultural output and inputs have continued to grow. We can see that the governing input/output price environment although extremely important from the point of view of income determination, does not necessarily lead to volume reductions when it deteriorates (e.g. in 1981-1985 and 1990-1991). In fact, the experience of the 1980s indicates increased agricultural output as the response to falling agricultural prices in real terms (Figure 3).

Furthermore, the imposition of radical policy changes affecting output volumes, as in the case of the milk quota system, have had a greater impact on agricultural output than product prices per se. Initial estimates of the general impact of the reform proposals suggest that an effective ceiling on the volume of agricultural

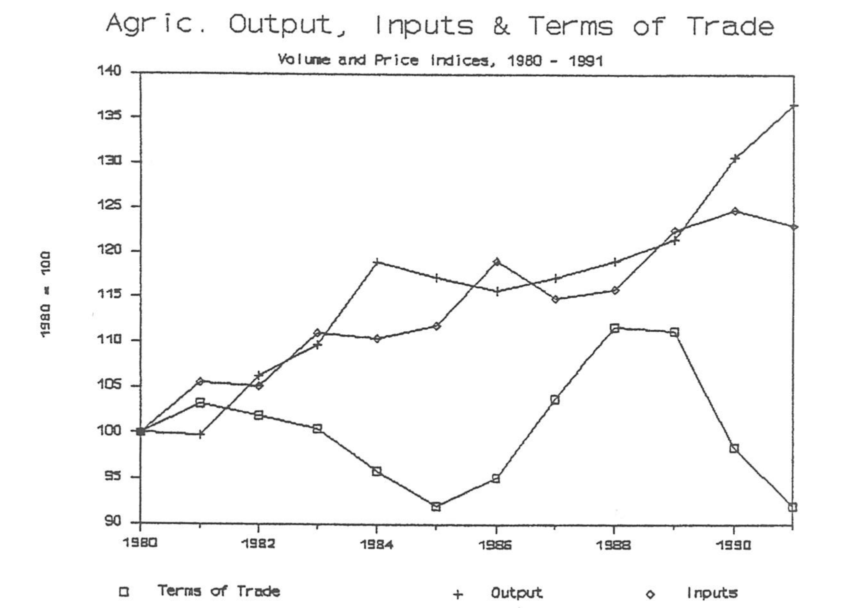


Figure 2

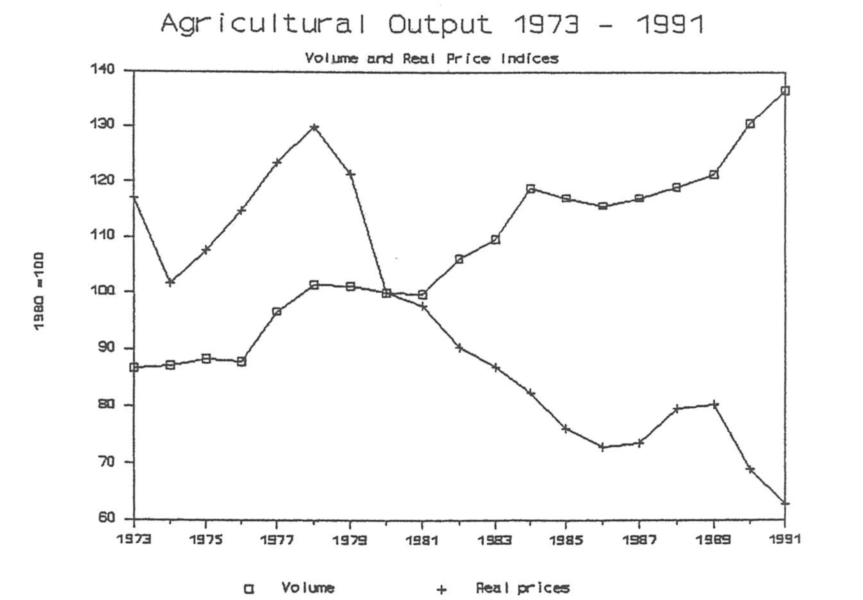


Figure 3



output will be imposed at slightly lower than the current levels. Constraints imposed on livestock production through reduced milk quota, maximum stocking rate limits for eligibility for compensation to dairy and cattle producers and set-aside of arable crops are the principal reasons for this. Expansion in other sectors such as pigs and poultry and sheep (without ewe premium on excess numbers) is not precluded but it is questionable that these sectors would be able to sustain the rise in agricultural output of recent years.

Real prices of the critical non-factor input components, animal feeds and fertilizers have in fact fallen since 1980 at a faster rate than for inputs as a whole (Figure 4). There has been considerable expansion in use of animal feeds while the increased consumption of fertilizers has generally kept pace with trend for inputs as a whole (Figure 5).

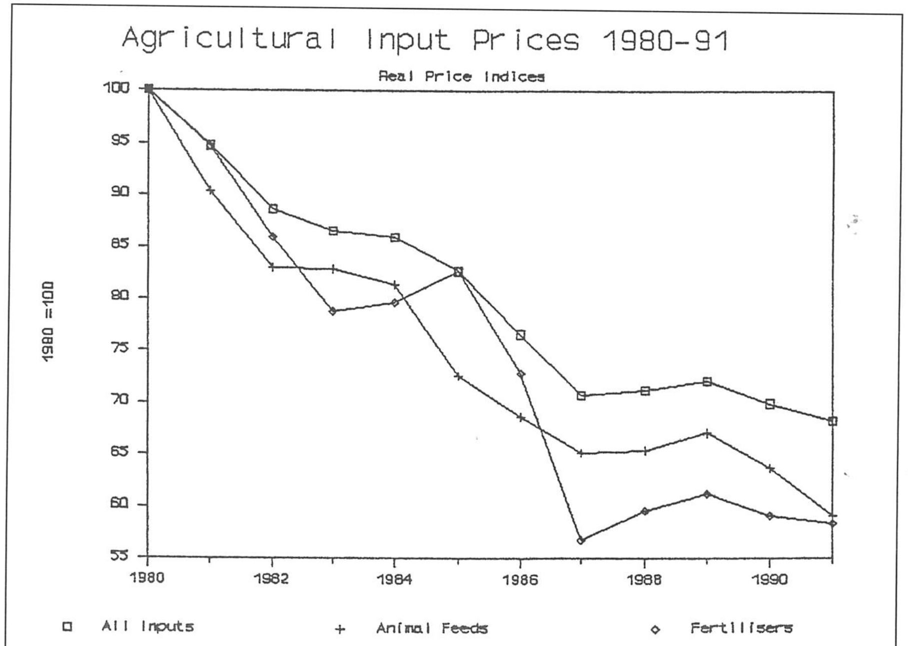


Figure 4

These developments have been reflected in the continued rise in agricultural productivity as measured by volume changes in Gross Agricultural Product (Table 1). On-going changes in the pattern of Irish agriculture are also responsible, these include the continued move into silage production, expansion in poultry and pig (in recent years) output and the accelerating shift from spring into winter cereals.

The shape of things to come is perhaps evident from the increased importance of direct transfers to agriculture in the form of subsidies which rose from about six per cent of the value of Gross Agricultural Product in the early 1980s to between 15 and 20 per cent by the early 1990s. Without these subsidies (ewe premiums,

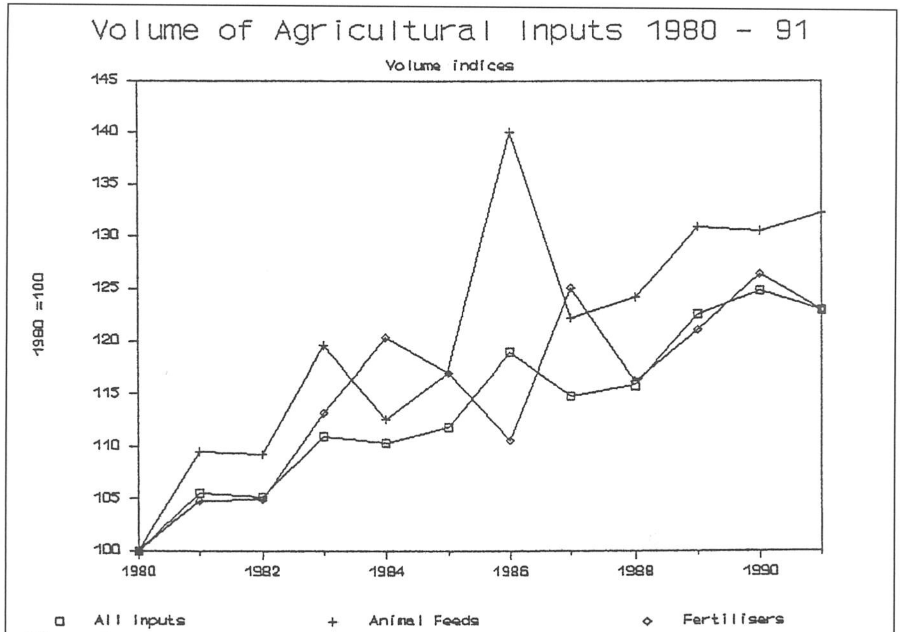


**Figure 5**

suckler cow payments and headage payments in less favoured areas) the fall in incomes sustained in recent years would have been even more severe. Direct income support will be a strong feature of the revised regimes for milk, beef and, in particular, cereals.

*Table 1:* Trends in economic indicators in the agricultural sector, 1980 - 1991

| Year | Gross Agric. Product[1] | Terms of Trade | Net Incomes Aggregate (Real) | Interest Payments | Subsidies % of GAP |
|---|---|---|---|---|---|
| 1980 | 100 | 100 | 100 | 100 | 5.5 |
| 1981 | 95.0 | 103.2 | 98.9 | 93.0 | 6.5 |
| 1982 | 106.8 | 102.0 | 107.3 | 94.5 | 6.5 |
| 1983 | 108.3 | 100.4 | 120.0 | 78.6 | 6.9 |
| 1984 | 125.2 | 95.9 | 139.7 | 68.0 | 9.3 |
| 1985 | 120.6 | 92.0 | 118.2 | 60.7 | 12.3 |
| 1986 | 111.3 | 95.2 | 106.1 | 56.0 | 11.5 |
| 1987 | 117.7 | 103.8 | 132.0 | 48.8 | 10.3 |
| 1988 | 120.5 | 111.7 | 158.5 | 42.7 | 11.3 |
| 1989 | 118.9 | 111.3 | 156.5 | 52.1 | 10.7 |
| 1990 | 134.2 | 98.5 | 143.9 | 61.3 | 20.5 |
| 1991[2] | 140.0 | 92.0 | 131.7 | 57.9 | 15 –18 |

Source: CSO, Irish Statistical Bulletin, various issues
Note 1 = GAP volume is the difference between the volumes of Gross Outputs and non-factor inputs at market prices
2 = Own estimates

During the period under review, agricultural output prices have fallen by over three per cent per annum in real terms since 1980. This substantial development has



led to major adjustments in the farming sector including a reduction in the numbers employed in agriculture of 25 per cent and general intensification of farming practices in order to maintain financial viability. It should also be remembered that restrictive price policies have operated without-price compensation for farmers over the period.

There is no doubt that the CAP reform proposals will augment the shift in the under-lying focus of agricultural policy towards viability of farm households particularly when the rural development dimension is incorporated into the policy mix (Department of Agriculture & Food, 1990). From the point of view of agricultural production, the central issue to be resolved is whether the intensification route to viability can be maintained in the post CAP-reform era. At first sight, the prognosis does not appear optimistic on this front. However, further reflection on this issue suggests that the impact of the reform proposals will impact on the use of inputs in different ways.

### CAP Reform Implications

The reform of the CAP may indeed be the item that is of most interest on the policy agenda at the present time. However, this should not deflect consideration away from other important policy issues which will also impinge on agricultural activity in an increasing fashion in the coming years. Some of these issues are shown in Table 2.

*Table 2:* Emerging issues impinging on the agricultural sector

| Trade & Economic Integration | Food Issues | Environmental/Ethical |
|---|---|---|
| *Agric. Trade Liberalisation (GATT)*<br>*Access to EC food markets*<br>*EC enlargement*<br>*Single Market* | *Product acceptability*<br>*Food safety*<br>*Food quality*<br>*Changing dietary trends* | *Agricultural pollution*<br>*Farmer as countryside guardian*<br>*Acid rain / Global warming*<br>*Animal welfare*<br>*Environmental taxation* |

Should the current attempts at reform of the CAP come to nothing, the issues identified in Table 2 will still have to be addressed. In many ways, the implications of these factors for Irish agriculture are similar to those engendered by the CAP reform proposals. In other words, agriculture is heading towards a more competitive environment with lower product prices despite increased constraints on production methods because of environmental, food quality or consumer acceptability demands. In these circumstances, the pattern of inputs use would be likely to change as would the competitive structure of the farming sector as a whole.

Having said this, it would be unhelpful, at this stage, to exaggerate a tendency and extrapolate a new trend. Perhaps a more fruitful approach would be to consider likely developments in a general way for the main non-factor inputs in turn but without recourse to specific forecasts.

Animal Feed

Animal feeds are the largest single component of input costs in Irish agriculture accounting on average for 40 per cent of total expenditure (Tables 3 and 4). Cereal prices will fall dramatically over the reform phasing-in period (e.g. proposed intervention buying-in prices for 1996/97 will be 42 per cent below the average for 1991/92). Allied to this, the payment of approximately £100 per acre to existing cereals producers would be expected to lead to an initial reduction of 10 per cent in the current cereals production base of two million tonnes. This would be dependent on the set-aside requirement not greatly exceeding the proposed 15 per cent of the arable crops area of larger producers.

Commentators agree on some decreases in demand for animal feeds due to enforced reductions in dairy cow numbers and stocking rate adjustments on intensive livestock farms. TEAGASC has estimated that there will be a volume reduction of approximately two per cent while expenditure by farmers on animal feeds could be reduced by more than £100 million. These volume reductions may be partially offset by increased demand for pig and poultry meat as well as the feed demand impetus from the likely downward drift in the entire structure of feed ingredient prices, including cereals substitutes.

*Table 3:* Expenditure on non-factor inputs in agriculture, 1980 to 1990

| | GAO | Feed | Fert. | Energy | Maint. & Repairs | Services | Other | All Inputs |
|---|---|---|---|---|---|---|---|---|
| | | | | £ Million | | | | |
| 1980 | 1710.8 | 315.6 | 164.7 | 88.8 | 52.7 | 36.8 | 101.4 | 760.0 |
| 1981 | 1986.4 | 380.8 | 194.4 | 115.7 | 61.4 | 70.9 | 95.9 | 919.1 |
| 1982 | 2280.1 | 408.2 | 214.1 | 130.3 | 70.9 | 42.3 | 145.6 | 1011.4 |
| 1983 | 2555.2 | 488.8 | 235.0 | 144.8 | 77.0 | 49.1 | 145.3 | 1140.0 |
| 1984 | 2842.7 | 493.2 | 264.2 | 148.0 | 82.9 | 56.4 | 174.3 | 1219.0 |
| 1985 | 2738.7 | 479.3 | 289.5 | 155.9 | 87.4 | 65.2 | 184.9 | 1262.2 |
| 1986 | 2720.5 | 556.5 | 258.8 | 137.9 | 88.9 | 69.0 | 178.2 | 1289.3 |
| 1987 | 2871.6 | 474.6 | 223.3 | 132.9 | 90.8 | 70.6 | 186.9 | 1179.1 |
| 1988 | 3157.1 | 489.0 | 221.4 | 130.4 | 93.3 | 76.5 | 218.1 | 1228.7 |
| 1989 | 3365.2 | 541.1 | 249.1 | 143.2 | 97.6 | 83.0 | 232.8 | 1346.8 |
| 1990 | 3215.9 | 524.1 | 261.8 | 155.9 | 105.6 | 88.9 | 229.0 | 1365.3 |

Source: CSO, Irish Statistical Bulletin, various issues

*Table 4:* Expenditure on non-factor inputs in agriculture, 1980 to 1990

| | Inputs % of GAO | Feed | Fert. | Energy | Maint. & Repairs | Services | Other | Total |
|---|---|---|---|---|---|---|---|---|
| | | | | | Per cent of Inputs | | | |
| 1980 | 44.4 | 41.5 | 21.7 | 11.7 | 6.9 | 4.8 | 13.3 | 100.0 |
| 1981 | 46.3 | 41.4 | 21.2 | 12.6 | 6.7 | 7.7 | 10.4 | 100.0 |
| 1982 | 44.4 | 40.4 | 21.2 | 12.9 | 7.0 | 4.2 | 14.4 | 100.0 |
| 1983 | 44.6 | 42.9 | 20.6 | 12.7 | 6.8 | 4.3 | 12.7 | 100.0 |
| 1984 | 42.9 | 40.5 | 21.7 | 12.1 | 6.8 | 4.6 | 14.3 | 100.0 |
| 1985 | 46.1 | 38.0 | 22.9 | 12.4 | 6.9 | 5.2 | 14.6 | 100.0 |
| 1986 | 47.4 | 43.2 | 20.1 | 10.7 | 6.9 | 5.4 | 13.8 | 100.0 |
| 1987 | 41.1 | 40.3 | 18.9 | 11.3 | 7.7 | 6.0 | 15.9 | 100.0 |
| 1988 | 38.9 | 39.8 | 18.0 | 10.6 | 7.6 | 6.2 | 17.8 | 100.0 |
| 1989 | 40.0 | 40.2 | 18.5 | 10.6 | 7.2 | 6.2 | 17.3 | 100.0 |
| 1990 | 42.5 | 38.4 | 19.2 | 11.4 | 7.7 | 6.5 | 16.8 | 100.0 |

Source: CSO, Irish Statistical Bulletin, various issues



Since 1980/81 real prices for compound feeds have fallen by an average of three per cent while compound feed production has increased at a similar rate (Figure 6). This has occurred despite the introduction of the milk quota system and subsequent reductions in the national quota (in excess of 10 per cent). Table 5 shows comparative data on livestock numbers and compound feed production at the beginning and end of the 1980s. Increased output of poultry and pigs (more recently) has led to increased demand for feed. At the same time, the demand for dairy feeds has increased despite reduced numbers in the national herd. The improving milk/feed price ratio has been the key factor in this development (Table 6).

Simple projections of average milk and feed prices in the post-reform era show that the resultant price ratio would by no means be inferior to that obtaining in the latter 1980s. On this basis, a reduction in dairy feed production beyond that induced by the quota reduction seems unlikely.

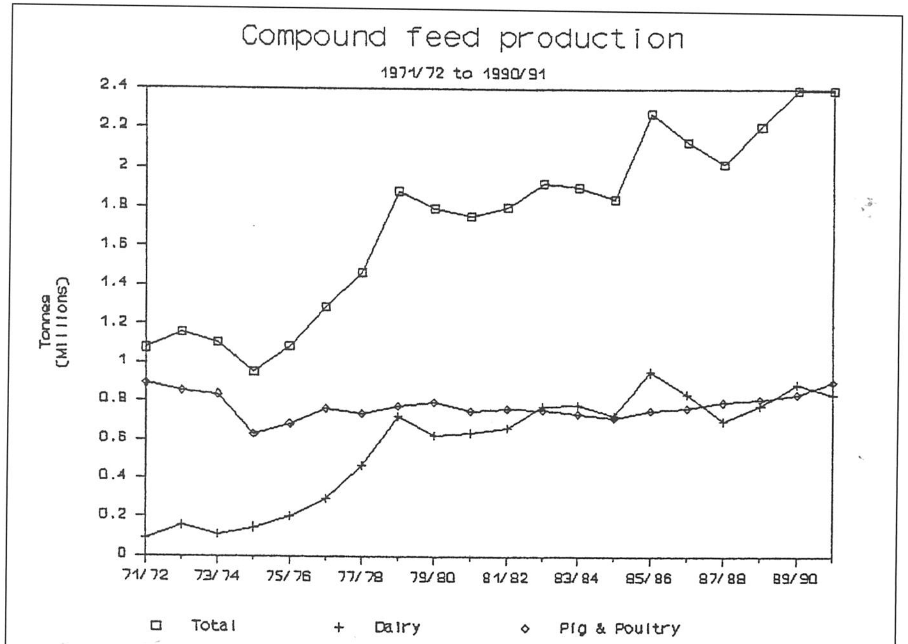


**Figure 6**

*Table 5:* Livestock numbers and compound feed production, 1980/81-82/83 and 1988/89-90/91[1]

| | 1980/81 -1982/83 | 1988/89 - 1990/91 | Change (Per cent) |
|---|---|---|---|
| Total compound feed production ('000 tonnes) | 1,824.0 | 2,331.2 | + 27.8 |
| Dairy cow numbers ('000) | 1,591.0 | 1,463.3 | − 8.0 |
| Dairy feed production ('000 tonnes) | 692.7 | 833.3 | + 20.3 |
| Other cattle LUs[2] ('000) | 3,890.4 | 4,104.6 | + 5.5 |
| Other cattle feed production ('000 tonnes) | 346.7 | 519.2 | + 49.8 |
| Pig output ('000) | 2,249.7 | 2,431.0 | + 8.1 |
| Pig feed production ('000 tonnes) | 488.4 | 469.4 | − 3.9 |
| Poultry output ('000) | 31356.3 | 44670.0 | + 42.5 |
| Poultry feed production ('000 tonnes) | 266.7 | 384.2 | + 44.1 |
| Sheep LUs[2] ('000) | 668.6 | 1488.8 | +122.7 |
| Sheep feed production ('000 tonnes) | 11.0 | 96.5 | +777.3 |

Notes 1 = July-June year for compound feed production (Source: Dept. of Agriculture), June livestock enumerations (Source: CSO).
2 = LUs= Livestock Units.

*Table 6:* Milk / feed prices, 1984 - 1991 and post-CAP reform

| | Milk price £/gal | Dairy feed[1] £/tonne | Kg feed/gal | Price Ratio (£) Kg feed: kg milk |
|---|---|---|---|---|
| 1984 | 71.7 | 201.5 | 3.6 | 1.32 |
| 1985 | 74.9 | 182.6 | 4.1 | 1.14 |
| 1986 | 76.7 | 175.6 | 4.4 | 1.07 |
| 1987 | 79.9 | 168.6 | 4.7 | 0.99 |
| 1988 | 89.4 | 166.9 | 5.4 | 0.87 |
| 1989 | 101.7 | 176.9 | 5.8 | 0.81 |
| 1990 | 87.6 | 173.6 | 5.1 | 0.93 |
| 1991[2] | 80.0 | 165.0 | 4.8 | 0.97 |
| Post-reform | 72.0 | 132.0 | 5.4 | 0.86 |

Source: CSO, Irish Statistical Bulletin, various issues
Notes 1 = Dairy cubes/nuts, 16% protein
2 = Own estimates

While demand for pig and poultry feed per se is to some extent enhanced by the fall in feed prices and on-going increased preference for white over red meats, the recent surge in sheep feed production would be expected to come to an end. Prospects for increased demand for other cattle are more difficult to assess. Some commentators suggest a more seasonal pattern of production based on grass (Fitzgerald, 1991). The outcome is very dependent on the agreed details of the new regime. For instance, lifting the proposed stocking rate limit for compensation payments in less favoured areas (LFAs) and a transfer of the third instalment of the male cattle subsidy onto suckler cows would considerably reduce the tendency towards increased seasonality in cattle production implicit in the reform proposals. In any event the demand for cattle compounds has increased quite significantly,



though generally unnoticed, throughout the 1980s despite all the problems besetting the sector.

The general conclusion from the above discussion is that the animal feed sector would not be expected to sustain considerable dislocation because of the reform proposals. Analysis, currently unpublished, would tend to support the view that the principal burden of adjustment in the input supply sector will not be borne by animal feeds (Boyle, 1991).

Fertilizers

A number of factors coincide which suggest that the prospects for increased consumption of chemical fertilizers are not encouraging. This general outlook would tend to hold even without CAP reform. Some of the important factors include:

Greater emphasis on storage and efficient land application of animal manures for economic reasons,

Increasing average soil phosphorus status of Irish soils (Tunney, 1990),

Tighter environmental restrictions on nitrogen and phosphorus applications to avoid pollution,

Increased awareness of proper timing of fertilizer applications especially nitrogen.

In these circumstances, reference to strict input/output price ratios alone will not give a true picture of the achievable benefits of future fertilizer use. Although nitrogen consumption declined by 2.4 per cent in 1990/91 compared to the previous year, this had been preceded by strong underlying growth in demand throughout the 1980s. Despite fluctuations, total consumption of nitrogen has increased by 35 per cent since 1980/81 (Figure 7). Two thirds of this increase came from nitrogen in compounds as against one third from straights.

Nitrogen use in tillage production has stabilised at about 50,000 tonnes in the last couple of years (Figure 8). The increase in winter cereals area has compensated for the continued reduction in overall cereals area. However, the projected set-aside requirement is expected to reduce the national base cereals area by about 10 per cent. Clearly this will have immediate implications for the relevant input supply sectors. Total demand for fertilizers and other chemical inputs would fall on this account but probably not by the 10 per cent indicated as the bulk of the set-aside would be expected to come from spring feed barley area. A further supression of fertilizer demand might be expected because of the lower fertilizer/ cereals price ratio. Table 7 for instance indicates that the economic optimum fertilizer use for winter wheat would fall by about six per cent with only a marginal reduction in yield.

These trends may, to a certain extent, be tempered by the tendency of high nitrogen users to resist downwards movements in the production curve which might be indicated by relative prices. Maintaining the existing optimum level of nitrogen use at post-reform cereals prices would entail substantial reductions in fertilizer prices in excess of 30 per cent.

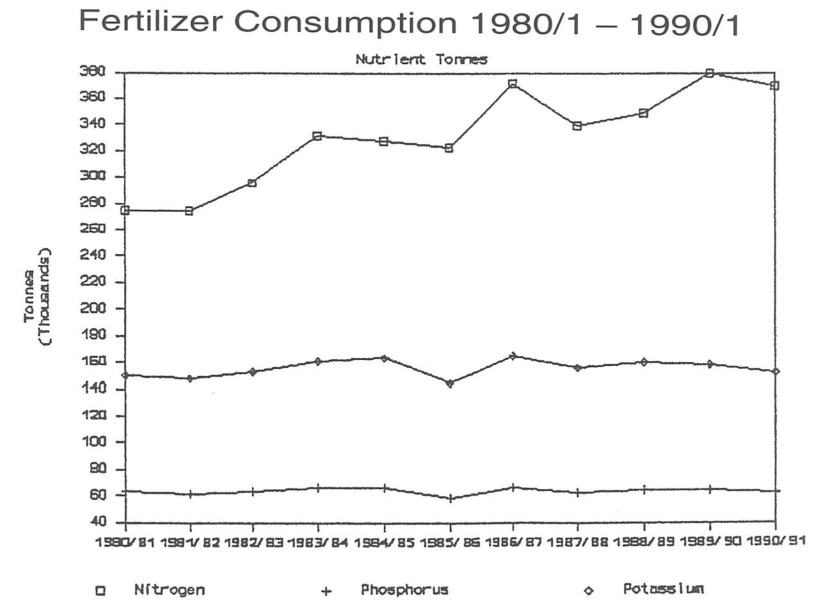


Figure 7

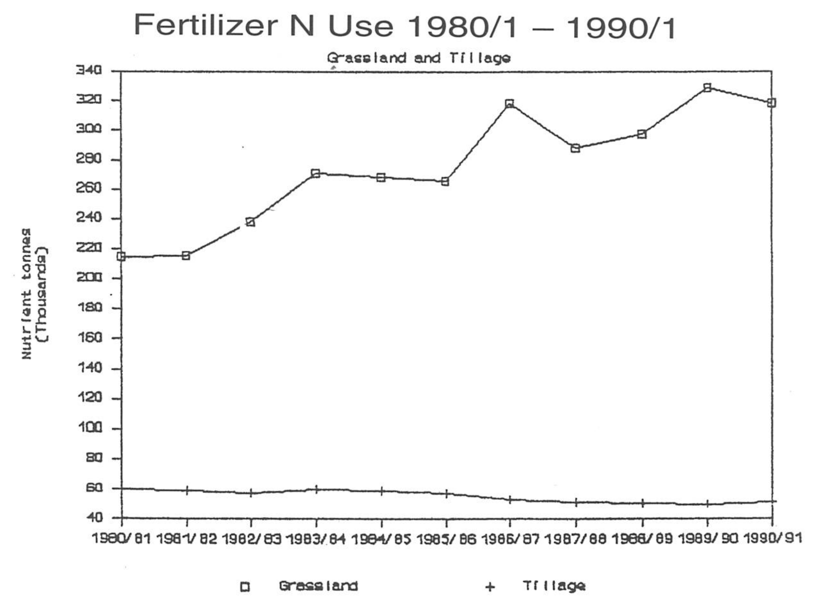


Figure 8



*Table 7:* Indicative economic optima of N use in cattle, milk and winter wheat production

| | Cattle[1] | Milk | Winter Wheat |
|---|---|---|---|
| | | Kg N/ha[2] | |
| 1980 | 179 | 225 | 178 |
| 1981 | 182 | 226 | 175 |
| 1982 | 182 | 226 | 175 |
| 1983 | 187 | 229 | 178 |
| 1984 | 188 | 228 | 175 |
| 1985 | 181 | 226 | 173 |
| 1986 | 187 | 232 | 176 |
| 1987 | 199 | 240 | 180 |
| 1988 | 199 | 240 | 181 |
| 1989 | 196 | 242 | 179 |
| 1990 | 193 | 238 | 178 |
| 1991 | 188 | 234 | 177 |
| Post reform | 184 | 231 | 167 |

Notes: 1 = Cattle, Bullocks, 500-550 kg
2 = Nitrogen in CAN (27.5% N)

The increased consumption of nitrogen throughout the 1980s has come from grassland led by the increased area devoted to silage production (Figure 9). The impact of CAP reform will ultimately depend on the actual details finally agreed. As the proposals stand, at the present time, 20 per cent or more of livestock numbers in the country would be excluded from price compensation (in dairying and cattle production) because of the stocking rate stipulations. The majority of these would be located in the LFAs. Exceeding the upper limits herd sizes for compensation payment purposes would disqualify the farmer from receiving compensation.

The incentive to de-stock in order to qualify for price compensation will be relatively greater for cattle producers than dairy producers. This prospect coupled with the reduced milk quota would, of themselves, be expected to lead to an overall shift towards extensification in grassland production. In such circumstances, high input use for intensive grazing and third cut silage would have to be re-assessed. Reference to Table 7 suggests that product prices in the post-reform era would lead to further deterioration in the economic optimum use of nitrogen. This is only part of the story as this type of analysis does not capture the fact that fertilizers are a derived demand product, in that the fundamental determinant is the demand for land-based agricultural produce.

This cursory analysis would appear to indicate that fertilizers would bear the brunt of the input reductions arising out of proposed CAP reform. Having said this, it is possible to consider some mitigating factors which may lessen this rather gloomy prospect even in the context of the present proposals. A move away from less attractive intervention product or commodity production towards consumer products in the context of lower consumer prices would be expected to counter the extensification in beef production especially. The extent of this adjustment which could be market led or stimulated by counter cyclical producer supports is

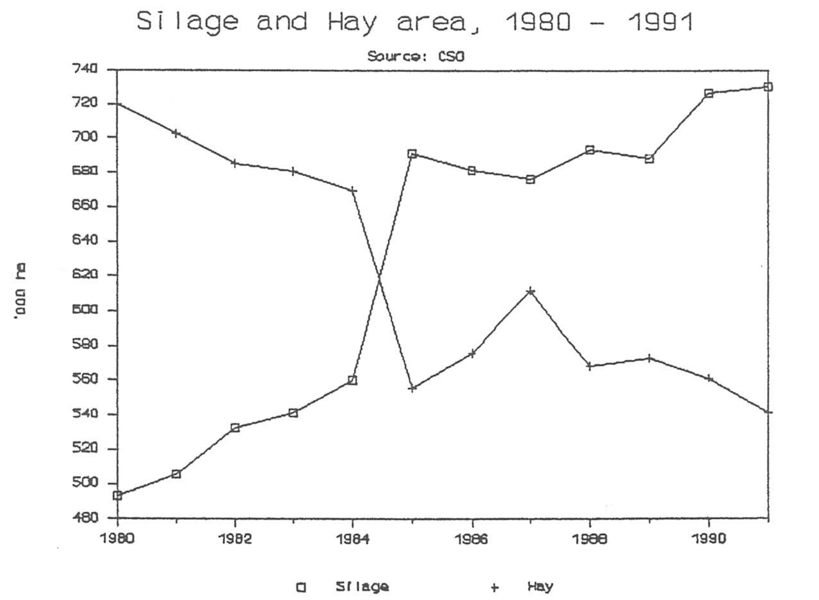


Figure 9

hard to predict at the outset. Furthermore it is most unlikely that silage production would be displaced in view of farmers' established practices and their existing on-farm facilities for silage conservation.

Accompanying Measures

A further aspect of the CAP reform proposals which could have important implications for farmers and agri-business alike is the inclusion of the so-called accompanying measures (see Appendix 1). Of particular importance, in the present discussion, are the proposals for an agri-environmental action programme and an extension of existing aids for afforestation of agricultural land. It is proposed to introduce a scheme of aids to encourage farmers to farm less intensively or farm in an environmentally manner. These aids would require national co-financing and would be zone specific, factors which would militate against their nationwide introduction . Nevertheless, they may give rise to local reductions in input demand. In the longer term, the diversion of existing agricultural land into forestry on foot of improved grants (subject to national co-financing) may curb the extensification drift engendered by other aspects of the reform proposals.

In conclusion

The CAP reform process is one of a number of highly important factors which will bring increasing pressure to bear on the agricultural and related sectors. These factors all seem to be operating to put a ceiling on the overall volume of agricultural output. As a result, the prospects for expansion in the major input sectors seem remote. Farm investment opportunities in the short term would also appear very limited. A process of change is underway which will impact on all those involved in the rural economy. The best that can be said at the moment, is that the determination of the new CAP should proceed quickly so that the present uncertainties can give way to the realities of the future.



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## APPENDIX 1

Summary of CAP Reform Proposals 1991

*Beef*

* Intervention price cut by 15 per cent.
* Special premium for male cattle (currently £34.96 per head over 9 months):
  - £52 per head at each of three ages, viz 6-9, 18-21 and 30-33 months,
  - Maximum premium per herd £4680 (£52 X 90 animals).
* Suckler Cow premium ( currently £52.43 per cow):
  - £66 to £88 per cow pa depending on national supplement,
  - Limited to 90 animals per herd of beef or dual purpose breeds.
* Stocking rate requirements for the payment of male cattle and suckler cow premia:
  - Not more than 1.4 livestock units per forage hectare in less favoured areas,
  - Not more than 2 livestock units per forage hectare in other areas,
  - Livestock units calculated from dairy and beef cows, male cattle and ewes.

*Cereals*

* 42 per cent cut in intervention price for all cereals.
* Price compensation for existing producers:
  - Approximately £273 per hectare
* Set-aside requirement for eligibility for price compensation:
  - No set aside if annual production is less than 92 tonnes,
  - 15 per cent of cereals area set-aside if annual production is greater than 92 tonnes,
  - Set-aside payment for all areas set aside by producers of 92 - 230 tonnes at approximately £273 per hectare,
  - No set-aside payment on area set aside above 5.75 hectares.

*Dairying*

**Prices**

* Support prices cut by 10 per cent.
* Price compensation at £65.91/cow up to a maximum of 40 cows.
* Price compensation subject to the same extensification criteria as for beef.

**Milk Quotas**

* Four per cent quota cut with one per cent allocated to special categories.
* Quota cuts for producers of less than 44,000 gallons to be avoided if voluntary cessation scheme takes out enough milk.
* Special voluntary cessation scheme at 66p/gal for three years.
* Compensation for compulsory quota cuts at 19.5p/gal for 10 years.

**Other Measures**

* Special scheme for disposal for slaughter of young male calves (<10 days old) from dairy herds at £88 per head.

*Sheep*

* Ewe premium limited to the number of ewes eligible for premium in 1990.
* Limits on number of ewes per flock eligible for premium:
  - 750 in less favoured areas,
  - 350 in other areas.



*Accompanying Measures*

* Agri-Environmental Programme

  - Production methods with low risks of pollution and damage to the environment.
    A system of variable and regional specific aids would be introduced to constrain farming practices where environmental damage is being caused.

    Crop production: Lower use of potentially polluting chemical inputs, Community co-financing maximum aid (75%) of £220/ha.

    Livestock Production: Lower cattle and sheep numbers where damage is being caused by over-stocking, Community co-financing maximum aid (75%) of £185/Livestock unit.

  - Environmentally friendly management of farmed land would be supported through a system of area based aid payments. Activities which would be supported in this way include,

    (I) Desisting from practices harmful to the environment,
    (2) Restoration of former natural features,
    (3) Extensive farming on low-value agricultural land.

    Community co-financing maximum aid (75%) of £220/ha.

  - Environmental upkeep of abandoned agricultural land would be supported by a flat-rate area aid payment.

    Community co-financing maximum aid (75%) of £220/ha.

  - Long term set-aside (20 years) of agricultural land for environmental purposes would be aided by maximum co-financing (75%) of £615/ha.

* Afforestation of Agricultural Land

  - Increased afforestation grants
    Conifers: Maximum grant £1758/ha
    Broad-leaved Trees: Maximum grant £3515/ha
  - Aid for management of new plantations on farms
    Conifers: £835/ha spread over five years
    Broad-leaved Trees: £1,670/ha spread over five years
  - Increased annual forestry premium to approximately £273/ha (i.e. the set-aside payment rate) payable over a maximum of 20 years.

* Early Retirement of Farmers

  - Annual pension of £3,515 to £8,788 pa for full-time farmers over 55 years

# A REVIEW OF SULPHUR USE IN IRISH AGRICULTURE

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## Introduction

Sulphur is an essential major element in plant and animal nutrition and approximately similar amounts (0.15 to 0.50 percent) of sulphur and phosphorus occur in plant tissue. The importance of sulphur in agriculture has long been recognised and during the 18th and 19th centuries gypsum (calcium sulphate) was widely used as a fertilizer. The development and widespread use of sulphur containing fertilizers such as superphosphate and ammonium and potassium sulphates, together with ever increasing concentrations of the element in the atmosphere from industrial sources, frequently resulted in excessive accretions of sulphur to the soil. Thus it seemed to many soil scientists that the supply of sulphur to crops was more than adequate and as a result interest waned and sulphur became known as the neglected element.

Around 1960 there was a revival of interest in sulphur in the United States and P, K. Hanley, who was studying at Iowa State University in 1966, was impressed by the work of Bremner and others on the subject. When he returned to Ireland in 1968 a programme to assess the sulphur status of Irish soils was initiated. Aspects of the programme, which is still ongoing, are summarised in this publication.

## Meteorological Data

Sulphur in the Irish atmosphere is markedly lower than in the industrial countries of Europe (Hanley and Tierney, 1969) . Emissions of sulphur dioxide in various European countries are shown in Figure 1 and the disparity between Ireland and most other countries is very evident. Deposition of the element from the atmosphere is correspondingly lower and it has been estimated that the mean annual deposition of sulphur in Ireland is 12 kg/ha compared to 50 kg/ha in central England (Fisher, 1982). Because of leaching losses during winter less than 50 per cent of the deposited sulphur is available to the plant during the growing season and in most parts of the country this is not nearly sufficient to meet crop requirements.

## Inputs from Fertilizers

In 1969, 63,000 tons of nitrogen and 37.000 tons of sulphur were used in Irish fertilizers, i.e. a nitrogen to sulphur (N/S) ratio of 2:1 (Fig. 2). With the intensification of Irish agriculture the consumption of nitrogen increased annually to reach 380,000 tons in 1989. The consumption of sulphur on the other hand fell rapidly until 1975 when less than 8,000 tons were used. This dramatic reduction was due to the development of nitrogen, phosphorus (P) and potassium (K) compound

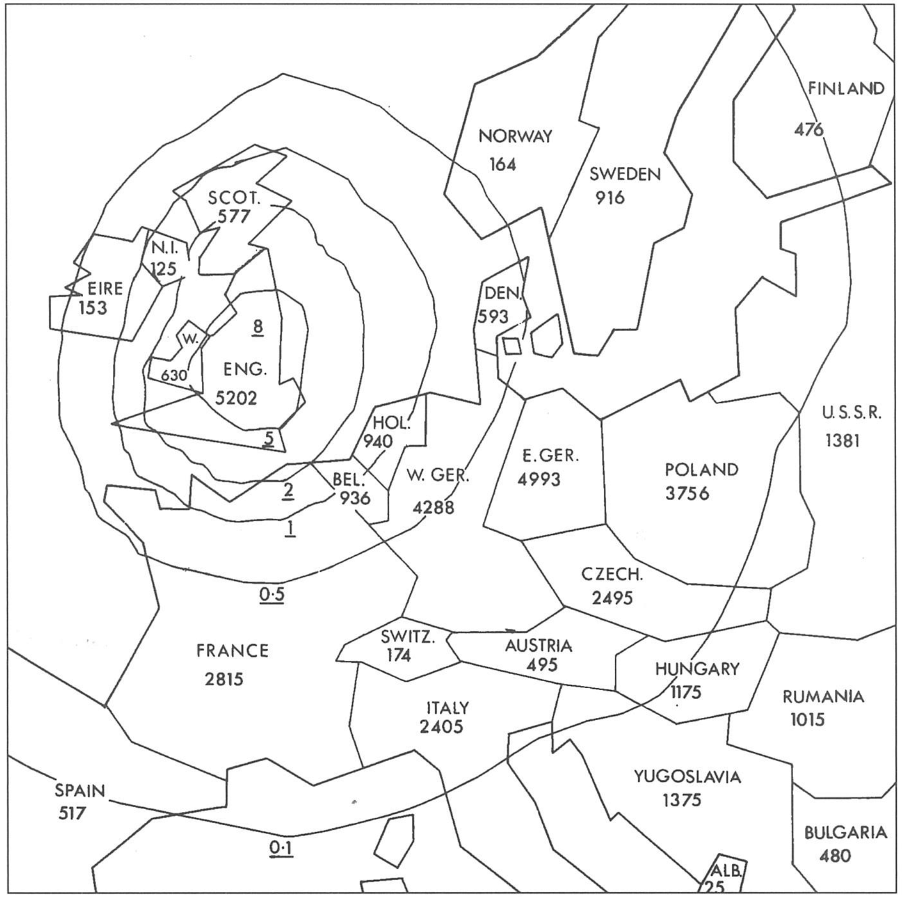


**Figure 1** Estimated annual emissions of $SO_2$ for European Countries (t x 000) (Eliassen and Saltbones, 1975).

fertilizers containing little or no sulphur and a decline in the use of sulphur containing fertilizers such as superphosphate and ammonium sulphate. Since 1975 sulphur usage increased annually to a level of 20,000 tons in 1989 as the findings from the research programme were disseminated to the farming community.

## Crop Responses

In view of the low inputs of sulphur from both Irish atmospheric and fertilizer sources a research programme involving laboratory, greenhouse and field experiments was initiated. Since grassland is by far Ireland's most important crop, accounting for 75 per cent of the total utilisable land area of 5.70 million hectares, the bulk of the research programme was devoted to this crop (Murphy, 1987).



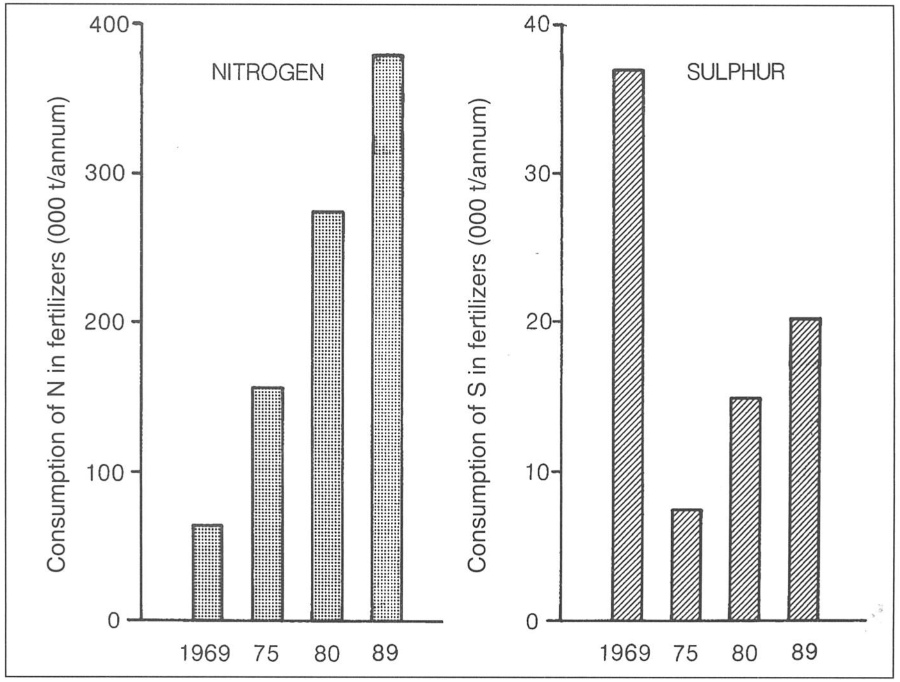


**Figure 2** Nitrogen and sulphur fertilizer consumption in Ireland 1969-1989.

(a) Greenhouse experiments. The programme commenced with a series of pot experiments with grasses and clovers grown on soils taken from the principal soil, types throughout the country. Under these intensive conditions sulphur deficiency developed fairly rapidly with visual symptoms and weight reductions occurring on most soils after two cuts of herbage had been removed. When sulphur, either in the elemental or sulphate form was added the deficiency symptoms disappeared and large yield increases resulted.

(b) Grassland Field Trials. One of the most responsive soils in the pot experiments was a very sandy soil from Screen, Co. Wexford and in 1970 a field experiment was located there. There was no response to sulphur for the first two years but in 1973 a significant response of 15 per cent was obtained. This was the first recorded response to sulphur under field conditions in Ireland (Hanley et al., 1974).

A further 140 grassland field trials were carried out in 15 countries between 1974 and 1989 (Murphy, 1986) . Application of sulphur increased yields of herbage in 70 out of the 140 trials (Table 1). Four cuts of herbage were generally taken between April and September at each site and responses were smallest at the first cut and increased as the season progressed. One of the biggest responses was obtained at Borrisokane, Co. Tipperary in 1991 where sulphur increases the annual yield of herbage by 65 per cent and by a record 190 per cent at the fourth cut (Table 2).

*Table 1:* Mean yields of dry matter and response to sulphur at 71 responsive sites.

| Cutting date | Yield t/ha No S | Yield t/ha S added | Response % |
|---|---|---|---|
| April | 2.70 | 2.84 | 5.2** |
| June | 3.57 | 4.01 | 12.3** |
| July | 2.57 | 3.09 | 20.2** |
| September | 2.06 | 2.59 | 25.2** |
| Total | 10.90 | 12.53 | 15.0** |

Level of significance** = P <0.01

*Table 2:* Dry matter yields and response to sulphur at Borrisokane, 1991.

| Cutting Date | Dry matter yield t/ha No S | Dry matter yield t/ha 25 kg/ha S | Response % |
|---|---|---|---|
| 1 April | 4.85 | 6.84 | 41** |
| 2 June | 1.45 | 2.90 | 100** |
| 3 July | 1.42 | 2.31 | 63** |
| 4 September | 0.53 | 1.54 | 190** |
| Total | 8.25 | 13.59 | 65** |

Level of significance** = P <0.01

Extrapolation of results from the 140 field trials suggests that one million hectares of Irish grassland are deficient. By applying sulphur to these areas yields could be increased by 15 per cent resulting in an extra 1.5 million tons of herbage dry matter, with a minimum value of £75 million, being produced annually.

(c) Grazing trial. Findings from the 140 trials showed that sulphur deficiency frequently occurred under a system where herbage is cut and removed. It was felt necessary to determine if deficiency would occur under a grazing system, where smaller removals and recycling of the element would occur, and for this purpose a grazing experiment with friesian cross steers was carried out on a sandy sulphur deficient site at Screen, Co. Wexford between 1981 and 1985. One treatment received no added sulphur and the other received 50 kg/ha of sulphur during the season and a high and a low stocking rate was allocated to each treatment (Murphy et al., 1983).

The effect of sulphur and stocking rate on daily liveweight gain (DLWG) is shown in Fig. 3. The figure shows that for any given DLWG the sulphur-treated area had a 20 per cent greater stock carrying capacity. Pre grazing measurements showed that the herbage on offer was increased by 25 per cent by added sulphur. Thus it seems that responses under grazing are similar to those obtained where herbage is cut and removed and also the increased herbage production is reflected in improved animal performance.



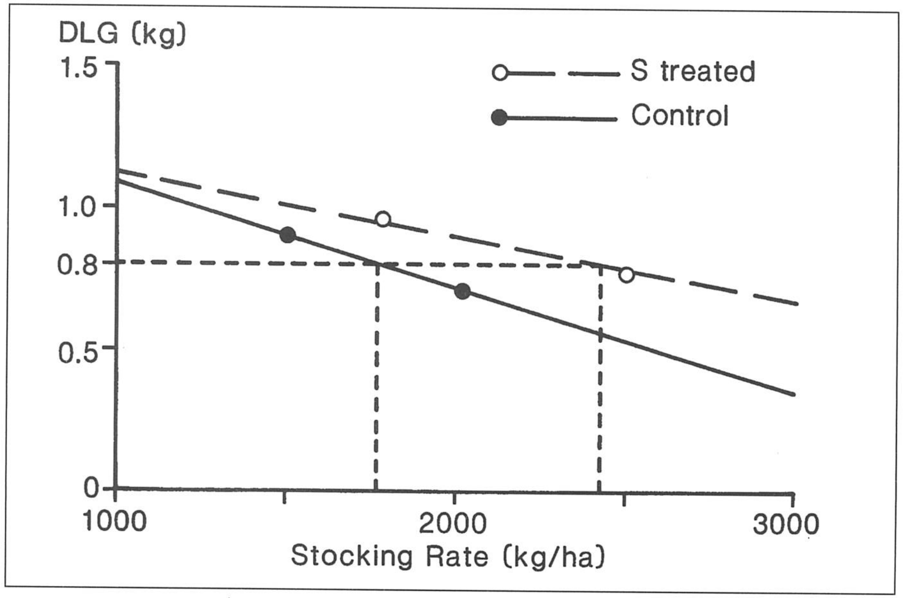


**Figure 3** The effect of sulphur fertilization on animal performance.

(d) Sulphur in Cereals. Cereals have a lower requirement than forage crops for sulphur and up to 1989 only one of the ten trials carried out was responsive to sulphur. However, in 1990 sulphur application increased winter barley yields by 30 per cent at Oak Park, Co. Carlow and spring barley yields by 8 per cent at Stradbally, Co. Laois. The fact that cereals had been grown continuously for 5 years at the Oak Park site may have exhausted the supply of mineralised sulphur from organic matter and led to this large response to added sulphur.

(e) Crop quality. In addition to dramatically increasing crop yields, sulphur has also been shown to improve crop quality. It markedly affects the chlorophyll content of many crops and the yellowing of the leaves and their spindly, stunted appearance is due to inadequate synthesis of this plant constituent. Applications of sulphur also improved other parameters of quality within the plant. Protein nitrogen was increased and the less beneficial non-protein and nitrate nitrogen fractions were reduced (Table 3) (Murphy, 1990).

*Table 3:* Effect of sulphur on the distribution of nitrogen fractions in herbage.

| Nitrogen fraction | Percent of total N in dry matter No S | Percent of total N in dry matter 25 kg/ha S |
|---|---|---|
| Protein-N | 55.5 | 73.4* |
| Non-protein-N | 41.2 | 26.5* |
| Nitrate-N | 2.6 | 1.0* |

Level of significance** = P <0.01

## Fertilizer Sulphur

(a) Forms of sulphur

Various forms of fertilizer were evaluated and it was found that products which contain the element in the sulphate form such as gypsum, potassium and ammonium sulphates and superphosphate were equally effective sources of plant sulphur. When sulphur was applied in the elemental form or as iron sulphide (pyrites) it was less available particularly in the year of application. Both these forms must first be oxidised to the sulphate form before being taken up by the plant and the speed of these reactions depend among other things on the particle size of the product, soil moisture and temperature and the presence of oxidising bacteria.

Animal manures contain approximately 1.0 per cent sulphur on a dry weight basis or 10 kg per 2,000 gallons. Approximately 50% of the sulphur is in the dung fraction, and as it is mainly in organic form, its availability to plants will depend on how quickly it is converted to sulphate by soil conditions. Because of its solubility, large losses of urinary sulphur can occur through leaching. Results from a field experiment in Co. Kilkenny show that both pig and cattle slurries while not as effective as sulphate fertilizers, can help prevent sulphur deficiency occurring. Similar findings have been reported in England where a response was obtained by the application of 24 kg/ha of sulphur as pig slurry but when addition mineral sulphate was applied a larger response resulted (Syers et al., 1987) .

(b) Quantity and time of application. The quantity of sulphur needed for maximum growth depends upon the time of application and form of sulphur used. Trials have shown that an autumn or early spring application of sulphate sulphur suffered leaching losses due to a combination of high rainfall (500 mm) and greatly reduced plant uptake during winter months. Consequently, a further application of 25 kg/ha was necessary in late summer to ensure an adequate supply to the crop.

Based on these trials our present recommendations for sulphur on grassland are 25 kg/ha per cut of silage or 25 kg/ha during the season in a grazing system. The advent of new N + S type fertilizer provides the alternative of applying increments of this amount through the season whenever nitrogen is being applied. The recommendation for root crops and cereals are 25 and 15 kg/ha respectively.

## Interaction with Other Elements

(a) Nitrogen. The pattern of herbage response to nitrogen fertilizer was altered by sulphur application. Data from a sulphur deficient site at Dunmore, Co. Kilkenny showed that when incremental levels of nitrogen were applied to herbage, with no added sulphur, there was no further response to nitrogen above the 250 kg/ha level and the maximum yield was 7 tons/ha (Fig. 4). When sulphur was applied however there was an increased response at each level of nitrogen application to 500 kg/ha when a yield of 10 tons/ha was obtained. When sulphur is deficient large applications of nitrogen will not increase crop yields and may lead to harmful levels of nitrates accumulating.



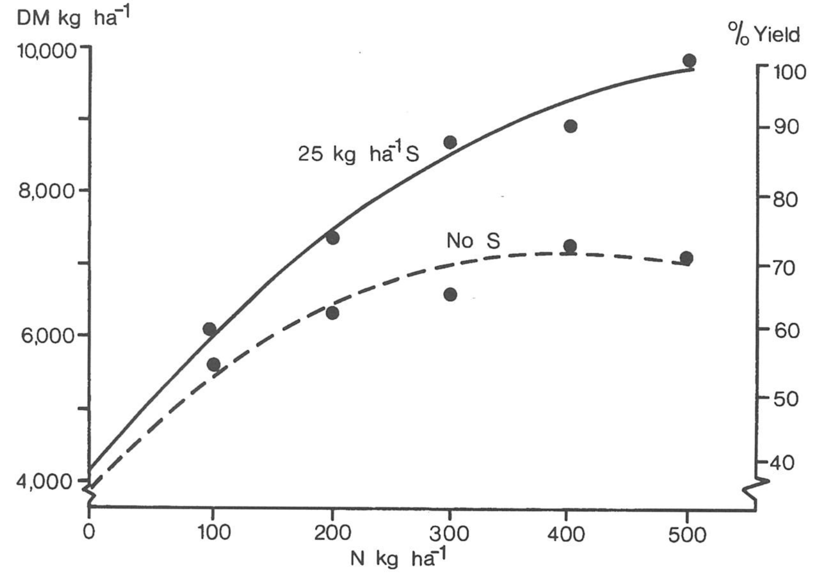


**Figure 4** Response to nitrogen improved by sulphur fertilization.

(b) Selenium. Because of the similarity in their orbital structures an interaction occurs between the two elements and excess sulphur can cause depression of selenium levels in the plant and animal. Results from the grazing trial at Screen, Co. Wexford between 1981 and 1985 are summarised in Table 4. They show that when sulphur was applied, levels of selenium in the herbage fell from 0.20 mg/kg to 0.04 mg/kg and blood GPx levels measured in autumn in the cattle on the no sulphur areas were 90.9 i.u./g Hb compared to 19.2 i.u./g Hb in the cattle from the sulphur treated areas. As selenium levels are already low in Irish herbage and may not meet minimum dietary requirements, care must be taken to ensure that farmers in trying to correct sulphur deficiency, do not overlook the need to maintain an adequate supply of selenium (Rogers et al., 1989).

*Table 4:* The effect of fertilizer sulphur on selenium levels in herbage and cattle. Mean of 3 years data.

| | Blood GPx in autumn i.u./g Hb | Se in Herbage mg/kg | S in Herbage mg/kg |
|---|---|---|---|
| No Sulphur | 90.92 | 0.19 | 1800 |
| Sulphur applied | 19.21** | 0.04** | 3900 |

(c) Copper and Molybdenum. The metabolic relationship of sulphur with copper and molybdenum is far from clear. It seems that high levels of either sulphur or molybdenum can interfere with copper metabolism in the animal but the effect of high levels of both elements is larger than either of them individually. However, Poole and Rogers (198 ) carried out two grazing experiments, one on a soil with a low and the other with a high molybdenum content. No consistent effects of sulphur on animal copper levels were recorded. They concluded that further detailed research is needed to elucidate a complex situation.

**Prediction Sulphur Deficiency**

(a) Plant analysis. Total sulphur values in herbage range from 0.15 to 0.50 per cent. Values below 0.20 per cent are generally deficient but if plant nitrogen is low, for example in mature herbage, then a level of less than 0.20 per cent sulphur may be quite satisfactory. Plant sulphur is also subject to seasonal variation and values tend to be high in spring, low in summer and high again in autumn.

The nitrogen to sulphur (N/S) ratio in healthy plant protein is nearly constant and is sometimes used to determine the sulphur status of plants. A ratio of 15:1 or wider is indicative of sulphur deficiency. However, ratios can frequently result in ambiguity and a larger than 15:1 ratio may be due either to inadequate sulphur or excess nitrogen.

Our experience has been that neither total sulphur or N/S ratios in herbage in the early spring are of little value in predicting deficiencies which may occur later in the season. Mid-summer values may confirm that sulphur is needed and enable corrective action to be taken for late season herbage.

(b) Soil Sulphur. To date it has not been possible to correlate responses from the field experiments with a measurement of available soil sulphur. This is not surprising in view of the fluctuations that occur in these values throughout the year. A significant correlation was obtained, however, between responses in the field

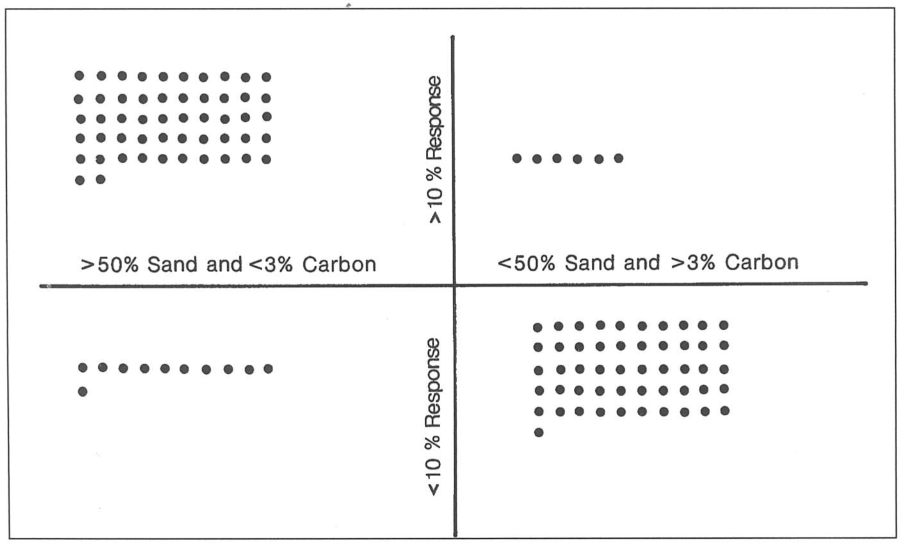


**Figure 4** The relationship between soil texture and organic carbon and response to sulphur.



and soil texture and organic carbon, Fig. 5. Soils with over 50 per cent sand and less than 3 per cent organic carbon were generally responsive to sulphur. The sand content of almost 2000 soil samples taken throughout the country at a depth of 0 to 10 cm is shown in Fig. 6. This map is useful in delineating areas of possible sulphur deficiency. A rapid soil test has been developed for measuring soil texture and organic carbon and this test together with a measurement of available soil sulphur will be used to predict sulphur deficiency (Murphy, 1991).

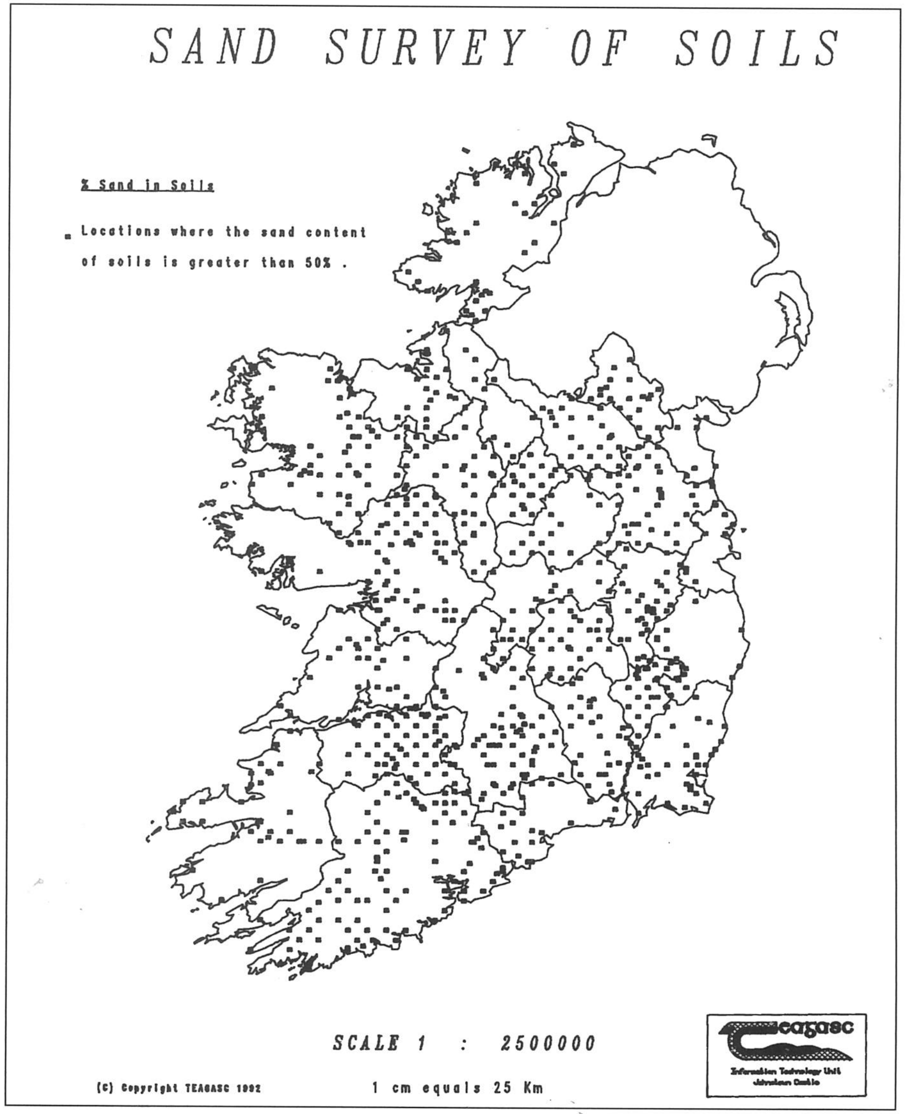


**Figure 4** Survey of sand content in surface horizon of 2000 Irish soils. 52% of them (shown in diagram) contained more than 50% sand.

## Future Research

As the use of fertilizer sulphur increases it is important that a reliable method of determining the sulphur status of soils be developed to ensure that sulphur is applied only where needed. Inputs of the element from atmospheric sources and removals by the crop and leaching losses need to be quantified to estimate the amount of sulphur needed annually for optimum production. The effect of sulphur interactions with the trace elements, selenium, copper and molybdenum and their effects on animal metabolism need detailed study. It has already been shown that texture plays an important role in determining the sulphur status of the soil. This is not the full picture however, as recent work in 1990 has shown. Soils, which on the basis of texture and organic carbon, should be responsive have been shown not to be, while others where no response was expected have proved to be very responsive. The large response obtained on the Borrisokane soil cannot be explained in terms of texture, organic carbon or available soil sulphur.

## Acknowledgement

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