THE FERTILISER ASSOCIATION OF IRELAND

D J Gately

FERTILISER USE SURVEY

W.E. Murphy and W.F. O'Keeffe

NITRATE LEVELS IN RIVER WATERS IN THE SOUTH-EAST OF IRELAND

Michael Neill

FERTILISER USE AND GROWTH IN FARM OUTPUT 1970-1980

L.T. Stafford

WINTER MEETING — NOVEMBER 20th, 1987

Publication No. 28

PRESIDENTS OF THE FERTILISER ASSOCIATION OF IRELAND

Name	Year	Name	Year
Dr T Walsh	1968	Mr G Cussen	1978
Mr W J C Milne	1969	Mr W E Murphy	1979
Mr G Foley	1970	Mr P McEnroe	1980
Dr J N Greene	1971	Mr T Fingleton	1981
Mr E J Sheehy	1972	Mr J Leonard	1982
Mr J C Brogan	1973	Mr P Duffy	1983
Mr T James	1974	Dr M Ryan	1984
Prof D M McAleese	1975	Mr P Keane	1985
Mr S McCann	1976	Dr J F Collins	1986
Mr M Roche	1977	Mr M Stanley	1987
		Mr. W. O'Brien	1988

COUNCIL OF FERTILISER ASSOCIATION OF IRELAND

Mr W O'Brien, Irish Fertilizer Industries Ltd.
Mr M Stanley, Fontstown Manor, Athy
Mr T King, IAWS
Mr L Stafford, Irish Fertilizer Industries Ltd.
Dr T F Gately, An Foras Taluntais
Mr D O'Neill, Albatros Fertilizers Ltd
Mr G Leonard, Grassland Fertilisers Ltd
Mr R Walsh, ACOT (Red'd)
Mr J Dardis, Irish Farmers Journal
Mr J Guinan, Teagasc
Mr J Murphy, McDonogh Fertilisers
Dr H Tunney, Teagasc

THE FERTILISER ASSOCIATION OF IRELAND

FERTILISER USE SURVEY
W.E. Murphy and W.F. O'Keeffe

NITRATE LEVELS IN RIVER WATERS IN THE SOUTH-EAST OF IRELAND
Michael Neill

FERTILISER USE AND GROWTH IN FARM OUTPUT 1970-1980
L.T. Stafford

FERTILISER USE SURVEY 1985

by W E Murphy and W F O'Keeffe
An Foras Taluntais
Johnstown Castle Research Centre,
Wexford

INTRODUCTION

Fertiliser use practice surveys have been carried out at intervals since 1964. They have been derived from data collected in the course of the Farm Management Survey by the staff of the Economic and Rural Welfare Centre of An Foras Taluntais.

Table 1. Use of Fertilisers and lime (1000 T) per year.

Year	N	P	K	G. Limestone *
1954/55	15	24	32	840
1959/60	22	36	48	720
1964/65	29	49	75	1127
1969/70	70	73	116	1729
1974/75	133	50	93	1560
1979/80	248	68	157	959
1980/81	275	63	150	1349
1981/82	275	62	148	1598
1982/83	296	63	153	2213
1983/84	334	66	162	1711
1984/85	328	66	164	878

* Ground limestone figures are for the calendar year i.e. 1955 etc.

Table 1 shows trends in total N, P, K and lime use since 1954. Over that period phosphorus use has increased 3 times K use has increased 5 times and N use has increased over 20 times. In recent years N use has continued to increase P and K use has levelled off and lime use has declined.

Table 2 shows that average rates of application of N, P and K to the different crops in kg per ha. The number of farms in the survey on which each crop was found is also shown. This indicates the frequency of each crop. The total number of farms in the survey was 1328. Grassland was present on every farm but root crops such as swedes or fodder beet were present on less than 100 farms. Therefore the reliability of the figures for these crops is much lower than for hay and silage.

N, P, K on Crops

Table 2. N, P and K use on different crops 1985 kg/ha.

Year	N	P	K	No. of farms surveyed
Wheat	188	44	104	168
F. Barley	128	36	76	431
M. Barley	105	27	53	78
Oats	121	40	86	112
Potatoes	139	103	242	296
S. Beet	168	89	204	106
Swedes	58	55	128	66
F. Beet	128	80	198	84
Rape	55	20	42	30
Kale	108	32	75	22
Hay	60	19	44	830
Silage	107	15	48	874
Pasture	48	9	18	1328

The levels of nitrogen used on cereals have increased since the previous survey in 1982. This is a reflection of the move towards more continuous tillage where soil N levels tend to be depleted. Levels of N used on hay and silage are very close to recommended levels.

It is not possible to estimate the proportion of the area of each crop that receives fertiliser because of limitations in the method of collecting the data. However in the past only hay and pasture had substantial areas left unfertilised usually as a result of low stock numbers on some farms.

The data on N use on pasture is not as reliable as it is for the other crops because of the practice of multiple applications during the year. Also nitrogen applied to aftermath of hay and silage is attributed to the grazing area and may lead to over estimate of N for grazing.

Table 3 shows a breakdown of the use of N, P and K on grassland (pasture hay and silage) by county. The total grassland area was used for this table rather than the pasture areas as the data was considered more reliable. In general the counties with high levels of dry stock farming had low levels of fertiliser use on grassland.

Difference between Counties

Table 3. N P K used on Grassland (Pasture, hay and silage) in each county (kg/ha)

County	N	P	K
Carlow	99	17	47
Dublin	43	14	32
Kildare	91	17	52
Kilkenny	88	22	58
Laois	65	21	64
Longford	13	10	23
Louth	87	13	34
Meath	82	18	42
Offaly	38	10	30
Westmeath	52	13	40
Wexford	77	15	33
Wicklow	57	15	32
Clare	31	13	31
Cork (E)	108	21	56
Cork (W)	82	20	48
Kerry	27	8	19
Limerick	62	15	42
Tipperary N	69	18	47
Tipperary S	91	21	57
Waterford	115	19	51
Galway	39	19	48
Leitrim	9	5	9
Mayo	29	14	32
Roscommon	23	12	32
Sligo	38	15	31
Cavan	55	18	44
Donegal	24	7	15
Monaghan	61	18	27

Farming Systems

Table 4. Effect of farm systems on N use on pastures.

Farming System	N kg/ha
Mainly dairy	85
Dairy and dry stock	21
Dairy and dry stock and tillage	58
Dry stock	12
Dry stock and tillage	91
Hill sheep and cattle (excl. marginal land)	47

Table 4 shows that fertiliser use on dry stock farms is much lower than on any other system.

Sources of N, P and K

Table 5. Per cent of total N used on crops 1985

Compound	Wheat	F Barley	M Barley	Oats	Potatoes	Hay	Silage	Total Grassland
10-10-20	1	7	6	8	—	8	1	2
14-7-14	1	9	15	3	6	—	—	—
18-6-12	3	23	35	6		25	4	7
27.5-0-0	61	46	39	60	11	30	35	42
46-0-0	33	11	—	20		10	26	21
High N	1	—	1	1		20	22	28

Table 5, 6 and 7 show the sources of N, P and K for the main crops. Nitrogen is the only nutrient derived in large quantities from 'straight' fertilisers. CAN and Urea are the main sources. Urea was used mainly on wheat, oats and grassland. Sulphate of Ammonia has increased in use and is used on potatoes and grassland. This is due to the increasing awareness of the possibility of sulphur deficiency on the lighter soils.

Table 6. Per cent of total P used on crops

Compound	Wheat	F Barley	M Barley	Oats	Potatoes	Hay	Silage	Total Grassland
0-7-30	16	7	—	10	—	14	44	22
0-10-20	71	24	—	52	—	17	14	22
10-10-20	6	24	23	26	55	27	6	14
14-7-14	2	17	30	5	—	1	1	7
18-6-12	4	28	46	6	3	26	10	17
High N	—	1	—	—		5	22	18

MEETING REQUIREMENTS

Table 8 shows a comparison of amounts of P and K used and the amount that would be used if the standard advice were taken and used in conjunction with soil analysis results. The results of soil analysis carried out in 1985 showed that for P 20% of samples had index 1, 23% index 2, 31% index 3 and 26% index 4. In the case of K 9% had index 1, 33% index 2, 30% index 3 and 28% index 4. For any crop the highest rate of nutrient is required at index 1 and in the case of cereals and grazing no nutrient is required at index 4 and very low rates are required for root crops, hay and silage. As can be seen from the Table there is a tendency to apply too much P and K to cereals sufficient to root crops and too little to grassland crops.

Table 7. Per cent of total K used on crops

Compound	Wheat	F Barley	M Barley	Oats	Potatoes	Hay	Silage	Total Grassland
0-0-50	—	—	—	—	—	—	2	2
0-7-30	29	13	—	19	—	25	58	37
0-10-20	60	22	—	47	—	15	9	17
10-10-20	5	22	—	23	47	23	3	10
14-7-14	—	16	30	4	—	1	1	—
18-6-12	2	26	47	6	2	23	6	12
High N	—	—	—	—		8	20	18

Table 8. Comparison of actual and advised rates of P and K

	Needed P	Actual P	Needed K	Actual K
Cereals	25	37	50	79
Potatoes	107	103	199	242
Hay	37	17	124	44
Silage 1 cut	37	19	124	48
2 cuts	50	?	167	?
Grazing	21	9	37	18

NITRATE LEVELS IN RIVER WATERS IN THE SOUTH-EAST OF IRELAND

Michael Neill
An Foras Forbartha,
Regional Water Laboratory, Kilkenny

INTRODUCTION

The Regional Water Laboratory at Kilkenny has been monitoring water quality, including nitrate levels, at approximately 500 locations in 100 rivers in the south-east since 1979. While nitrate levels are generally well below the E.E.C. (1) maximum admissable concentration (11.3 mg/1 N) for drinking water the recommended or guide level (5.65 mg/1 N) is exceeded in some areas at times mainly during winter.

A high dietary intake of nitrate is known to lead to the condition methaemoglobinaemia (blue baby syndrome) in bottle-fed infants and is suspected to lead to the formation of carcinogenic nitrosamines and nitrosamides. High nitrate levels can lead to excessive growths of phytoplankton in estuaries while phosphorous is generally considered to be the limiting nutrient for plant and algal growth in freshwaters.

The use of nitrogenous fertilisers in Ireland has increased from 29,500 tonnes/annum in 1964/65 to 323,000 tonnes/annum in 1985/86. Nitrate levels in freshwaters are of major concern in many of the developed countries and levels in Irish rivers therefore need to be carefully monitored.

ANALYTICAL METHODS AND SAMPLING LOCATIONS

The analytical method used to determine nitrate is the automated cadmium reduction method from the U.S. Standard Methods (2). This method determines total oxidised nitrogen (nitrate — nitrite) however as nitrite levels are generally very low (0.1 mg/1 N) it can be assumed for practical purposes that the total oxidised nitrogen concentration is equal to the nitrate concentration. Nitrate levels are expressed as mg/1 N. In order to ensure the correctness of analytical results, An Foras Forbartha carries out regular intercalibration tests between the four water laboratories which it operates including the Kilkenny laboratory.

There are four main catchments in the south east region, these include the Slaney, Barrow, Nore and Suir. Because of the considerable amount of data available it was decided that, for this study, one sampling station from the lower freshwater reaches of each catchment would be examined as this would give an indication of the overall trends in each catchment. The rivers Shannon (at Portumna) and Blackwater at Ballyduff were also examined although most of these catchments lie outside the region. Because a special investigation was carried out on the river

Burren (near Carlow Town) in 1985-86 this river is also included. (3) The sampling locations examined for this report are listed in Table 1. and are shown in the map (Figure 1). Monthly sampling is normally carried out at these stations.

Table 1. Sampling locations examined for this report.

River	Location	Number of samples/annum	Comment
Shannon	Portumna	6	Upper Shannon catchment
Blackwater	Ballyduff Bridge	12	
Suir	d/s Carrick-on-Suir	12	
Nore	u/s Kilkenny City	12	To exclude any effects from the new sewage treatment plant at Kilkenny.
Barrow	Graiguenamanagh Br.	12	
Slaney	Edermine Br.	12	
Burren	2 Km. u/s Carlow	6	A special investigation of nitrate levels was carried out at this location in 1985/86.

RAINFALL DATA

The mean annual rainfall in each of the Slaney, Barrow, Nore and Suir catchments, which were calculated from the isohyetal maps in the Water Quality Management Plans for these catchments, are given in table 2. These data were collected in the period 1941-1970.

Table 2. Mean Rainfall data

Catchment	Mean Annual Rainfall mm/annum
Slaney	1091
Barrow	922
Nore	966
Suir	1108

ANNUAL VARIATIONS IN NITRATE LEVELS

A survey of the nitrate levels in the River Burren at Ballycrogue Bridge which involved weekly sampling was carried out for Carlow County Council between May 1985 and September 1986. A hydrometric gauge was erected just downstream of the sampling location before the project commenced and this was calibrated by the Hydrometric Section of An Foras Forbartha which also provided flow data for the times of sampling. The results of analyses and flow data are given in Table 3. The variations of nitrate concentration throughout the sampling period are graphed in Figure 2. This graph was prepared using a curve plotter computer programme.

The annual variation of nitrate concentration for other rivers in the region follow the same pattern as that of the river Burren although levels vary from catchment to catchment.

The highest nitrate levels occurred in January and February and the lowest nitrate levels occurred in July and August. This observation is consistent with experiences in other countries (4, 5, 6 and 7). The occurrence of higher nitrate levels in river waters during winter months is influenced by several factors which include strong leaching of nitrate by water moving through soil in the winter period and the absence of nitrogen uptake by plants in the dormant season. It has also been argued that plant die-back during winter provides a supply of nitrogen to the soil. Lower river nitrate levels in summer are thought to reflect the diminished soil water movement and the uptake of nitrate by growing crops.

VARIATIONS IN NITRATE LEVELS FROM 1979 TO 1986

The annual median and maximum nitrate concentrations for each of the sampling locations are graphed in Figures 3 and 4 respectively.

The nitrate concentrations in river waters are generally well below the E.E.C. Mandatory level for water for human consumption (11.3 mg/1 N). There was little overall increase in median nitrate concentrations for the period 1979-85. Maximum (winter) levels were also fairly constant for the period 1979-83 although there was a noticeable increase in some rivers from 1983-85.

In 1986 however there was a significant increase in both median and maximum nitrate concentrations in all of the catchments. In the Slaney, Barrow and Nore the nitrate concentrations exceeded or reached the E.E.C. Guide levels (5.65 mg/1 N) for the first time even if only for a short period during winter. The reason for the increases in nitrate concentrations in 1986 is not clear and may have been due to the very wet summer of that year. However a wet summer also occurred in 1985 when nitrate levels did not show such a significant increase.

There has been a tenfold increase in nitrogen application since 1965 (see Figure 5) however, the rate of application has been fairly constant over the last few years.

Monitoring of nitrate levels is continuing and the situation will be examined again as soon as the 1987 data are available.

VARIATIONS IN NITRATE LEVELS BETWEEN CATCHMENTS

It is clear from Figures 3 and 4 that the highest nitrate levels occur in the east of the region (Slaney Catchment) and that there is a steady decrease in nitrate levels from east to west. It is suspected that this trend is due to agricultural practices in the region with a higher percentage of tillage in the east (counties Wexford and Carlow). Data on land use and fertiliser application has recently been received from An Foras Taluntais in order to explain the east-west trend in nitrate levels, however, it will take some time to process these data.

In the United Kingdom the highest nitrate levels are found in lowland rivers with catchments dominated by arable farming in southern and eastern England. Lowest nitrate levels are associated with rivers in high relief areas where the agricultural economy is based predominantly on cattle and sheep rearing (8).

NITRATE LOADS IN THE RIVER BURREN

The mean nitrogen run-off in the river Burren for the period 1985-86 is given in Table 4. The mean nitrogen load in grammes N/sec was calculated from the data in table 3. There was insufficient flow data to enable similar calculations for the main catchments however, it is evident from Figures 3 and 4 that the nitrogen run-off/hectare is higher in the river Burren than in the main catchments examined.

Table 4: Nitrogen Run-off in the River Burren, 1985-86

Sampling Location	Ballycrogue Bridge
Catchment Area	155 Km^3
Number of samples	58
Mean Nitrogen load	11.88 g/sec as N
	375 tonnes/annum as N
Mean Nitrogen Run-off	24.2 Kg/ha/annum as N

ADDENDUM

The nitrate levels in these rivers declined considerably in 1987

Figure 1: Sampling Locations

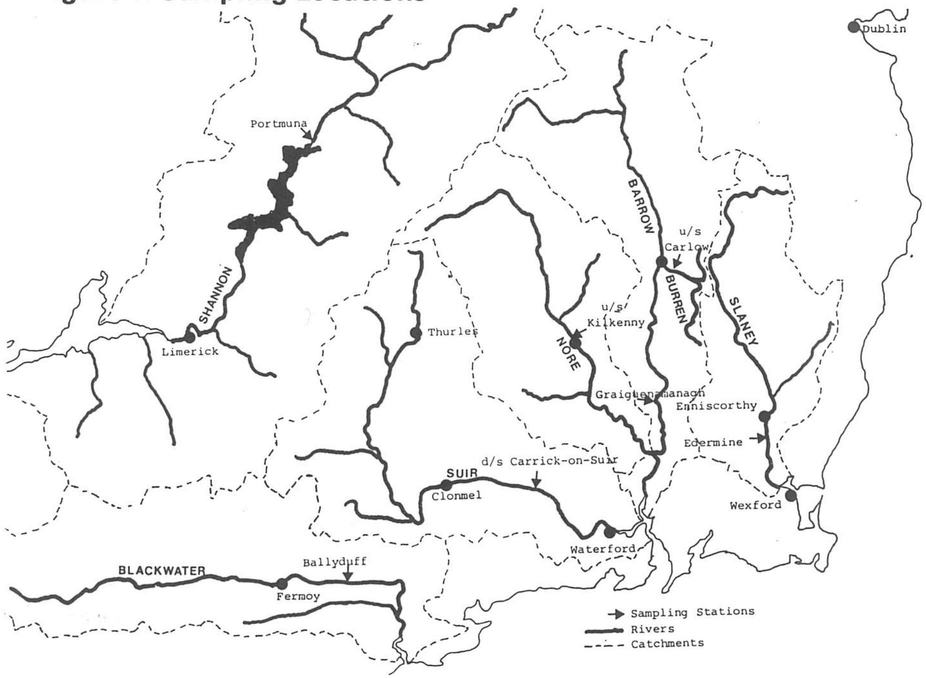


Figure 2.

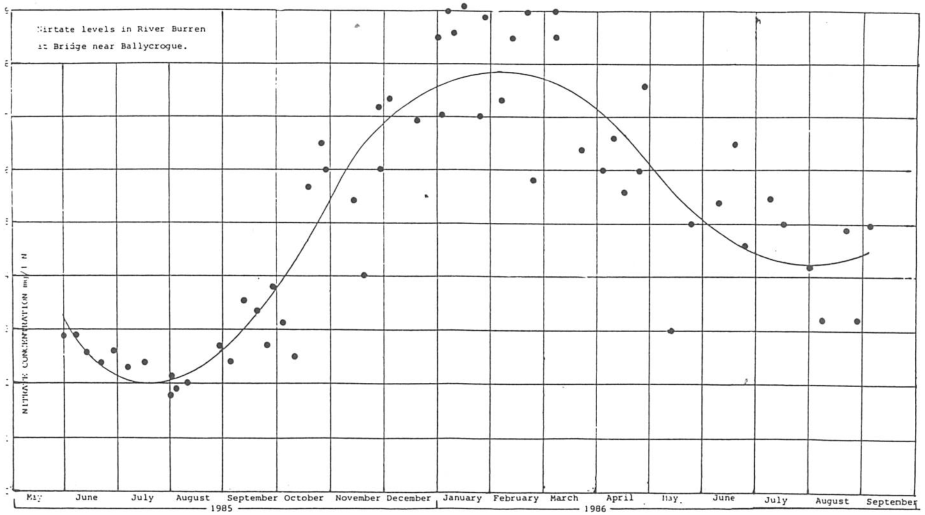


Table 2: Results of analysis and flow data for River Burren

Sampling Date	Sampling Time	Gauge m	Flow m³/sec	Nitrate + Nitrite Concentration mg/l N	Nitrate + Nitrite Load g/sec N
28/5/85	15.30	0.40	1.12	2.5	2.8
30/5/85		0.375	0.98	2.9	2.8
5/6/85	12.15	0.35	0.82	2.9	2.3
11/6/85	13.10	0.34	0.77	2.6	2.0
20/6/85	16.15	0.31	0.60	2.4	1.44
27/6/85	10.20	0.31	0.60	2.6	1.56
5/7/85	10.00	0.29	0.505	2.3	1.16
15/7/85	16.00	0.305	0.58	2.4	1.4
30/7/85	15.56	0.36	0.88	1.8	1.6
31/7/85	12.30	0.335	0.73	2.1	1.5
1/8/85	15.10	0.315	0.62	1.9	1.2
8/8/85	15.00	0.39	1.08	2.0	2.16
19/8/85	10.30	0.62	3.00	--	--
27/8/85	12.15	0.56	2.40	2.7	6.5
2/9/85	15.20	0.56	2.40	2.4	5.8
11/9/85		0.445	1.42	3.5	4.9
18/9/85	10.50	0.405	1.16	3.3	3.8
23/9/85	15.15	0.41	1.20	2.7	3.2
26/9/85	--	0.41	1.20	3.8	4.56
3/10/85	14.45	0.405	1.16	3.1	3.6
8/10/85	09.45	0.47	1.60	2.5	4.0
17/10/85	13.40	0.39	1.08	5.7	6.2
24/10/85	17.00	0.36	0.88	6.5	5.7
29/10/85	17.30	0.36	0.88	6.0	5.3
11/11/85	14.20	0.44	1.38	5.4	7.45
18/11/85	16.20	0.46	1.54	4.0	6.15
27/11/85	14.15	0.41	1.20	7.2	8.65
28/11/85	15.00	0.40	1.12	6.0	6.7
2/12/85	14.00	0.85	6.05	7.3	44.16
18/12/85	--	--	--	6.9	--
30/12/85	--	--	--	8.5	--
2/1/86	15.50	1.32	16.0	7.0	112.0
6/1/86	14.34	0.78	5.05	9.0	45.45
8/1/86	--	--	--	8.6	--
14/1/86	14.45	0.77	4.90	9.1	44.6
23/1/86	21.50	0.79	5.20	7.0	36.4
29/1/86	17.00	0.62	3.00	8.9	26.7
5/2/86	15.50	0.56	2.40	7.3	17.5
13/2/86	15.45	0.47	1.60	8.5	13.6
20/2/86	15.35	0.43	1.12	9.0	10.1
25/2/86	16.00	0.41	0.94	5.8	5.4
5/3/86	13.55	0.42	1.00	8.5	8.5
7/3/86	14.15	0.40	0.86	9.0	7.75
20/3/86	10.00	0.54	2.20	6.4	14.1
2/4/86	14.45	0.53	2.10	6.0	12.6
10/4/86	15.30	0.44	1.26	6.6	8.3
16/4/86	14.45	0.46	1.48	5.6	8.3
24/4/86	16.20	0.57	2.53	6.0	15.2
29/4/86	14.10	0.48	1.68	7.6	12.8
12/5/86	14.30	0.64	3.25	3.0	9.75
26/5/86	15.30	0.51	1.93	5.0	9.65
10/6/86	10.15	0.43	1.12	5.4	6.05
19/6/86	10.00	0.39	0.77	6.5	5.0
25/6/86	10.00	0.39	0.77	4.6	3.5
7/7/86	12.40	0.43	1.12	5.5	6.2
15/7/86	16.00	0.39	0.77	5.0	3.85
31/7/86	14.20	0.39	0.77	4.2	3.2
7/8/86	12.50	0.84	5.90	3.2	18.9
18/8/86	14.20	0.405	0.90	4.9	4.4
27/8/86	10.15	1.66	26.50	3.2	84.8
4/9/86	09.50	0.504	1.90	5.0	9.5

Note: Calibration flow measurements taken at this station range from 0.8 m³/sec on 18/7/85 to 9.9 m³/sec on 8/1/86. Values quoted outside this range are based on extrapolation and therefore should be treated with caution.

Figure 3: Nitrate nitrite (median values)

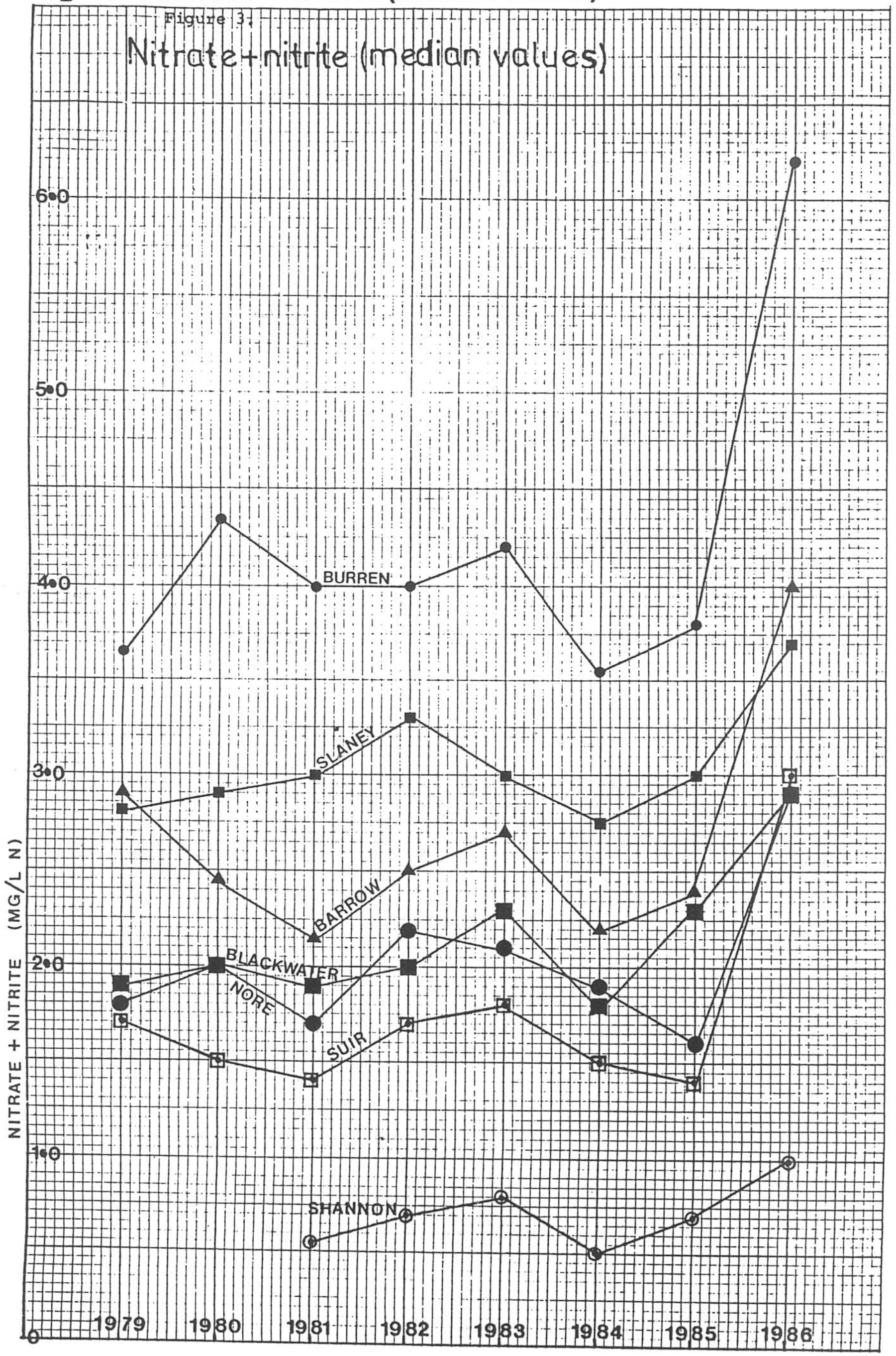


Figure 4: Nitrate nitrite (maximum values)

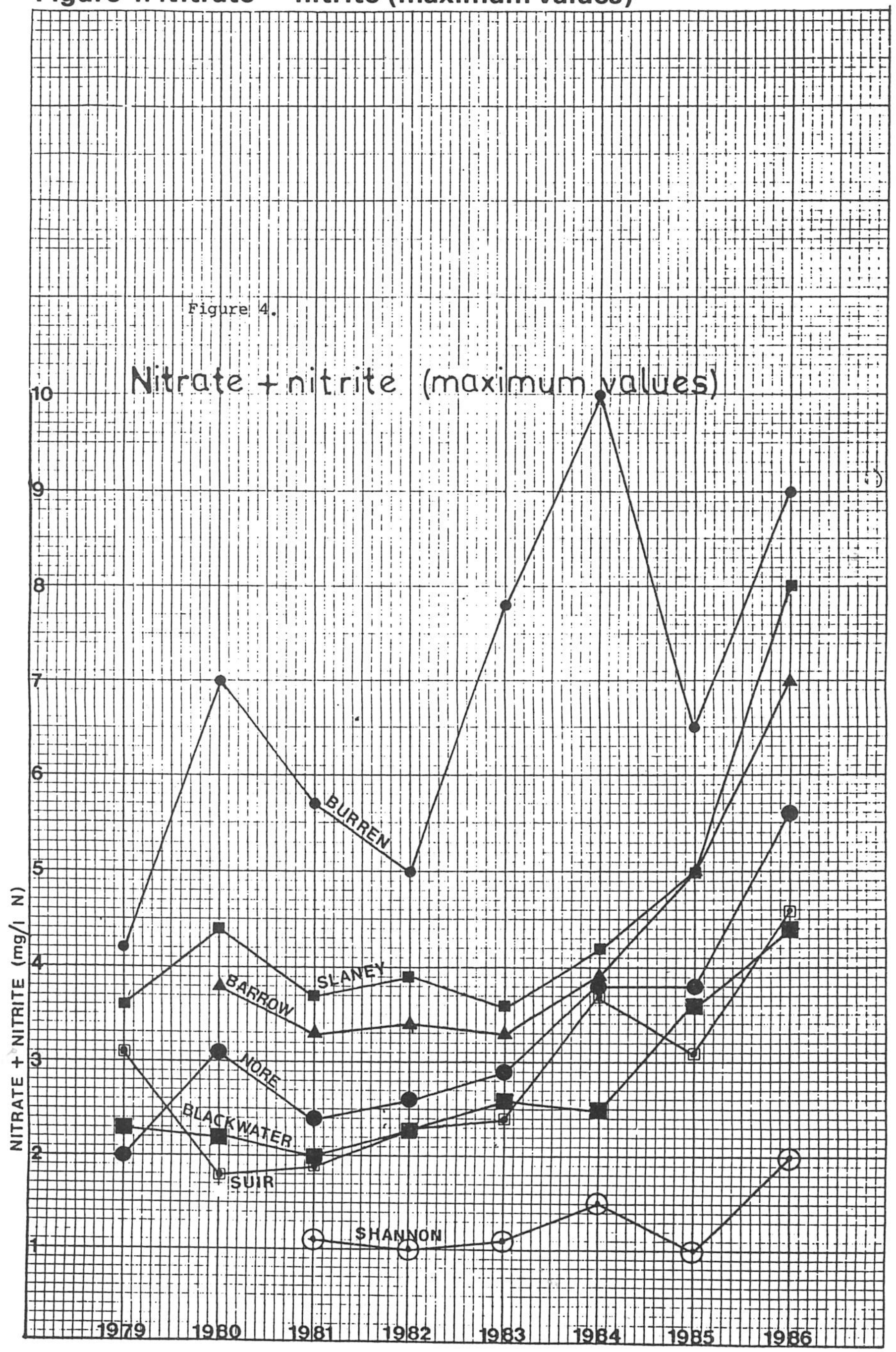
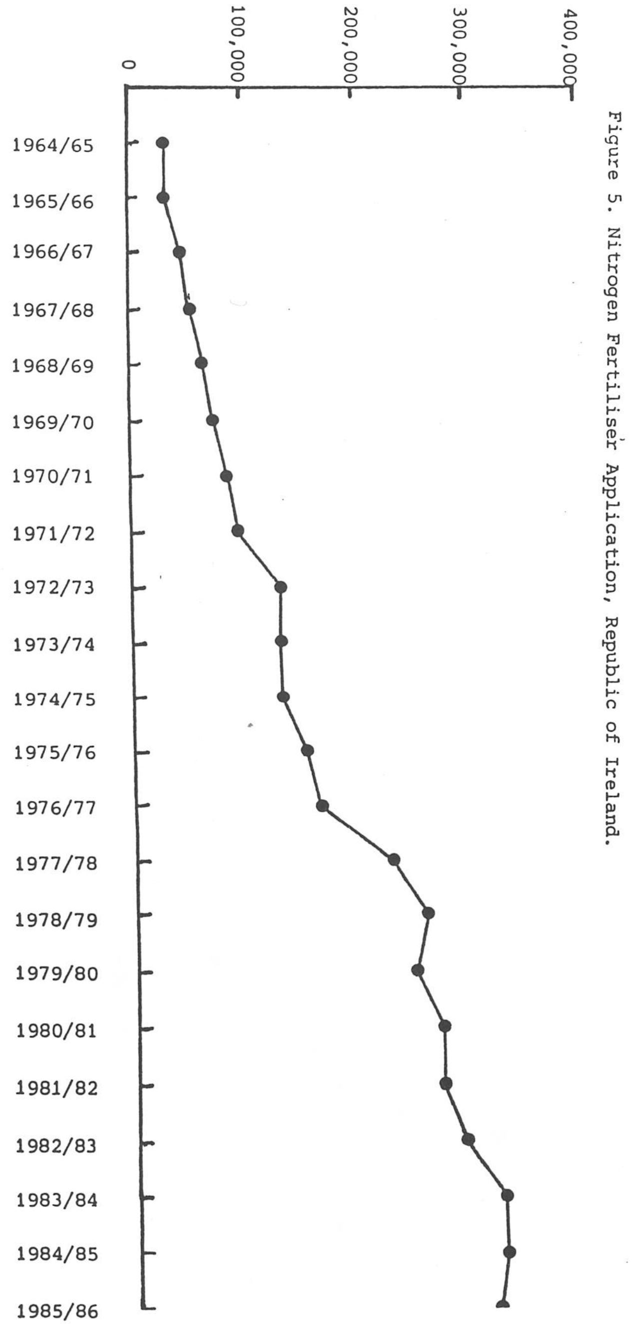


Figure 5: Nitrogen Fertiliser Application, Republic of Ireland.



REFERENCES

1. *C.E.C. (Council of European Communities), (1975).* Council Directive of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water (75/440/EEC). Official Journal of the European Communities, No. L 194/26.
2. *A.P.H.A. (American Public Health Association). (1985).* Standard Methods for the Examination of Water and Wastewater. 16th Edition.
3. *Report on Nitrate levels in the River Burren. (1986).* A report by the Regional Water Laboratory to Carlow County Council.
4. *Webb W.B. and D.F. (1985).* Nitrate behaviour in streamflow from a grassland catchment in Devon, U.K. Water Research, Vol. 19, No. 8, pp. 1055-1016.
5. *Hill A.R. (1986).* Stream Nitrate-N loads in relation to variations in annual and seasonal run-off regimes. Water Resources Bulletin (American Water Resources Association). Vol. 22, No. 5, October 1986.
6. *Slack J.G. and Williams D.N. (1985).* Long term trends in Essex river water nitrates and hardness. Aqua, No. 2, 1985, pp. 77-78.
7. *Dept. of the Environment, U.K. (1986).* Pollution paper No. 26. Nitrate in water. H.M. Stationary Office London.
8. *Young C.P. (1985).* Nitrate in United Kingdom Freshwaters. paper presented at Les Nitrates dans L'Eau, Paris, October 1985.

FERTILIZER USE AND GROWTH IN FARM OUTPUT, 1970-1980

L T Stafford
Irish Fertilizer Industries Ltd.,
Warrington Place,
Dublin 2

INTRODUCTION

Nitrogen use increased from 70,180 tonnes of nutrient N in 1970 to 247,535 tonnes in 1980. It is not unreasonable to enquire where the additional N went. The farm income crisis of 1979-1981 inevitably brought about a critical re-appraisal of farm practices. In 1981, the Minister for Agriculture, Alan Dukes, raised questions about the relatively low increases in output from farming in the 1970's as against the relatively high increases in inputs. A tendancy arose to suggest that inputs were high relative to output and that in general farmers should consider reducing inputs, including fertilizers. It was argued that the increased inputs had been 'income-led' rather than 'income-generating'. The case was comprehensively argued in May, 1982 by Attwood (1) in a paper on "The Nature and Causes of the Farm Income Problem". He stated that farm output increased by 27% between 1971 and 1980, while inputs increased by 47%. Between 1975 and 1980, output increased by 11% while inputs increased by 45%.

While specific attention was not drawn publicly to the increase in Nitrogen use, it is a fact that Nitrogen use increased by 353% between 1970 and 1980, and by 186% between 1975 and 1980. This very large level of Nitrogen use increase and the benefits which flowed from it are examined in this paper.

LIVESTOCK NUMBERS

When examining livestock numbers, 1970-1980 may be divided into two periods, 1970-1974 and 1974-1980. Stock numbers grew up to 1974 and failed to grow after that. Nobody has expressed any dissatisfaction about the 1970-1974 period. In fact, Brogan (2) stated that "up to 1974, the rate of Nitrogen usage was related to the size of the national herd. . ." There is therefore no concern up to 1974. In the 1974-1980 period, Nitrogen use continued to increase while stock numbers declined marginally.

Table 1. Livestock Numbers

Year	Livestock Numbers (million LU)	Index (1970100)	N Use Tonnes N	Index (1970100)
1970	5.40	100	70180	100
1971	5.59	104	85862	122
1972	5.76	107	96781	137
1973	6.15	114	129655	185
1974	6.43	119	120208	186
1975	6.39	118	133044	189
1976	6.21	115	152739	217
1977	6.35	118	166739	237
1978	6.32	117	230214	328
1979	6.36	118	263603	375
1980	6.17	114	247535	353

1970-74: 250,000 tonnes of extra N needed.
60,028 tonnes extra N applied.

Stocking rate experiments carried out by Browne (3), McCarthy (4) and Gordon (5), have been examined. It is calculated that approximately 0.25 tonnes of N are required to carry an additional livestock unit (as one approaches a stocking rate of one acre per livestock unit).

Since the national stock numbers increased by 1 million livestock units from 1970 to 1974, it might be expected that it would have been accompanied by an increase of 250,000 tonnes of N. In fact, N use only increased by 60,028 tonnes. The overall increase from 1970-1980 was 177,355 tonnes. Since the stock numbers declined from 1974-1980, assuming the 0.25 tonnes of N per livestock unit relationship to apply, one would expect N use to have increased by 192,500 tonnes between 1970 and 1980. This is close to the actual increase of 177,355 tonnes.

It is suggested that the stock numbers may have grown too quickly relative to Nitrogen input in 1970-1974. Thereafter there was a levelling-out period. During this period, provision of winter forage and overall feeding of animals improved markedly.

LIVESTOCK OUTPUT

In the early seventies, the average age of finished animals at slaughter was close to three years. This is very high and was a major source of inefficiency in our beef production. Better feeding would improve animal weight gains and reduce the age at slaughter without necessarily giving an increase in the total number of livestock units on the national farm at any one time. It is therefore necessary to examine the livestock output.

Table 2. Volume of Livestock Output

Year	Index (1970100)
1970	100
1971	107.6
1972	116.6
1973	116.3
1974	121.1
1975	128.4
1976	114.3
1977	121.1
1978	126.6
1979	124.5
1980	124.7

It can be seen in Table 2 that this also increased up to 1974/75. It is worthy of note that it increased significantly faster than stocking rates which suggest that faster animal growth and earlier slaughtering were in fact achieved. Unfortunately, however, livestock output remained static after 1974/75. Notwithstanding that, it is worthy of note that animal output in 1978, 1979 and 1980 was 25% up on 1970 while the stocking rate was up by 16%. The output of animals from the system is a more important criterion than the number of animals in the system.

MILK YIELDS

The volume of livestock products index published by the CSO is very largely an indication of milk yields though other products such as eggs are also taken into account. Estimates of milk yield per cow by Connolly, Bord Bainne and Kearney, AFT (7), are also given in Table 3.

Table 3. Milk Yields

Year	Volume Livestock Products (1970100)	Milk Yield per Cow (gal/cow)	Milk Yield Index (1970100)	Total Cows (millions)
1970	100	470	100	1.71
1971	103	480	102	1.78
1972	110	471	100	1.89
1973	119	477	101	2.15
1974	117	458	97	2.21
1975	123	505	107	2.04
1976	132	530	113	1.97
1977	143	551	117	2.09
1978	159	618	131	2.09
1979	162	613	130	2.11
1980	161	613	130	2.04

From 1970 to 1974 there was a 17% growth in output of livestock product while there was a slight decline in milk yield per cow. The increase in milk output came therefore as a result of increased cow numbers. The small decline in milk yield per cow in this period is not very surprising. It is very diffiult to achieve any increase in milk yield per cow in a period of herd expansion. This is largely due to the fact that herd expansion necessitates low culling and partly also, that the farmer's attention and efforts are diverted to 'carrying more stock' during an expansionary phase.

In the 1975-1980 period, total cow numbers declined somewhat but the number of dairy cows continued to increase but at a slower pace. The most outstanding feature of this period was the rapid growth in milk yield per cow leading to very substantial increases in milk output. The index of volume of livestock products increased from 117 in 1974 to 161 in 1980.

Many factors contributed to the increased cow productivity including increased concentrate feeding, improved genetic potential of the cow and earlier calving. It is true to say that improved growth of grass from grazing and conservation were also major contributors. Killen (6) estimated that between 1976-1981, 11 gallons per cow improvement was due to an earlier calving and 48 gallons per cow was due to increased concentrate feeding. It is assumed that the same holds for 1975-1980. The total increase in that period was 108 gallons per cow. When the 59 gallons per cow accounted for by Killen are subtracted, 49 gallons per cow remain unaccounted for. It is submitted that the bulk of this residual 49 gallons per cow resulted from improved grassland productivity and utilisation in which Nitrogen use is a key element.

It should also be remembered that 11 gallons per cow were obtained as a result of earlier calving (Killen). Earlier calving is not feasible without increased conservation of grass both in terms of quantity and quality. Nitrogen plays a key role in lifting the volumes and quality of silage.

WINTER FEED

While the improved provision of winter feed is already taken account of under livestock output and milk yields, it is worthy of examination in its own right. There has been a very serious shortfall in the provision of conserved forage for the national animal population in Winter. Very rapid growth in silage-making occurred in the 1970's. The total tonnages of silage in Table 4 are ACOT estimates. Application rates are taken from the Fertiliser Use Surveys. The acreage was calculated by assuming a yield of 6.5 tonnes of silage per acre at 60 kgN/ha and 8.0 tonnes at 120 kgN/ha (with a linear response to N between 60 and 120 kgN/ha).

Table 4. Winter Feed

Year	Tonnes of Silage	Acres of Silage	N Applied to Silage (kg N/ha)	Tonnes N Applied to Silage	% of Total N
1970	3,481,000	527,424	64	13,582	19
1971	4,507,000	675,205	67	18,095	21
1972	5,485,902	812,726	70	22,756	24
1973	6,650,000	985,185	70	28,333	22
1974	8,130,000	1,196,175	72	34,401	26
1975	9,000,000	1,195,219	101	48,382	36
1976	10,000,000	1,333,333	100	53,333	35
1977	10,500,000	1,329,114	116	61,670	37
1978	11,000,000	1,329,405	116	61,684	27
1979	11,200,000	1,417,721	(116)	65,782	25
1980	12,400,000	1,569,620	(116)	72,830	29

It appears therefore that approximately 30% of all Nitrogen is applied to silage.

In 1970, 13,502 tonnes of N were used for silage while 72,830 tonnes were used in 1980. An additional 59,328 tonnes were used in 1980.

TILLAGE

Both the grain acreage and the Nitrogen application per acre to grain increased over the period 1970 to 1980. The total production of grain increased very substantially as a result. The production per acre also increased steadily, (see Table 5).

Table 5. Tillage

Year	Grain Acres '000	Grain Production '000 tonnes	Production per acre
1970	931.2	1,373	1.47
1971	954.0	1,571	1.65
1972	918.6	1,430	1.56
1973	852.0	1,296	1.52
1974	852.0	1,205	1.41
1975	828.4	1,725	1.64
1976	838.0	1,691	1.49
1977	919.6	1,695	1.88
1978	957.5	1,705	1.78
1979	990.0	1,830	1.85
1980	1001.4	1,934	1.93

Assuming that 30 kgN/ha were applied to grain in 1970 and 70 kgN/ha in 1980 (These assumptions have been made taking the data in Fertilizer Use Surveys into account), the total usage of N on grain increased from 11,174 tonnes in 1970 to 28,040 tonnes in 1980. This amounts to an additional 16,866 tonnes. 561,000 additional tonnes of grain were produced in 1980. It is therefore extremely difficult to question the increased input of N. To suggest that grain output only increased by 41% while N input increased by 144% is a gross distortion of the true situation.

It is estimated that an additional 2,000 tonnes were used on root crops. Therefore it is estimated that 19,000 tonnes of the increase between 1970 and 1980 went onto tillage crops.

FARM MANAGEMENT

There is no evidence to suggest that Nitrogen is misused at farm level. On the contrary it is clear from the Mitchelstown Co-Op survey in Table 6 (8) and from the A.F.T. 1980 Farm Management Survey in Table 7 that the higher users of Nitrogen achieve substantially better results.

Table 6. Mitchelstown Co-Op Survey

N. Use	Stocking Rate
43 lb N/Acre	0.52 Cows/Acre
65 lb N/Acre	0.62 Cows/Acre
107 lb N/Acre	0.84 Cows/Acre
127 lb N/Acre	0.90 Cows/Acre

It is clear from Table 7 that 50% of all the Nitrogen used on grassland is used on 21% of the grassland area which stocks dairy cattle at better than 1.5 acres/l.u. This area produces 38% of all grassland output. It is submitted that the growth in use of N on grassland is very largely concentrated on these farms and that output has increased very substantially on them. The increase production on such progressive farms has been masked in national output figures by declining production on other farms. Evidence of such an effect over the period 1973 to 1977 was compiled by Boyle (9).

Table 7. Grassland

Dairy Systems

	More intensive farmers				Less intensive farmers				
Acres/LU	<1.10	1.1-1.25	1.25-1.5		1.5-1.75	1.75-2.0	>2.0		All
% Total Grassland	6.5	5.3	9.3	21.1	9.1	7.0	10.8	26.9	48.0
% of Grassland N	20.4	12.7	16.4	49.5	11.4	6.2	5.2	22.8	72.3
ib N/acre	178.4	136.3	101.4	133.9	71.9	51.4	27.3	48.7	86.1
% of Gross Output	14.8	9.7	13.5	38.0	10.5	6.5	6.8	23.8	61.8
% Output/Land	2.3	1.8	1.5	1.8	1.2	0.9	0.6	0.9	1.3

Drystock Systems

	More intensive farmers				Less intensive farmers				
Acres/LU	<1.10	1.1-1.25	1.25-1.5		1.5-1.75	1.75-2.0	>2.0		All
% Total Grassland	2.3	2.0	4.5	8.8	6.5	5.8	22.0	34.3	43.1
% of Grassland N	3.1	3.3	3.2	9.6	4.6	3.2	6.4	14.2	23.8
lb N/acre	90.0	109.0	46.0	71.8	46.0	36.0	19.0	27.0	36.1
% of Gross Output	3.6	2.9	4.7	11.2	5.2	4.0	10.4	19.6	30.8
% Output/Land	1.6	1.5	1.0	1.3	0.8	0.7	0.5	0.6	0.7

In figure 1, the ratio of % output over % grassland i.e. the productivity of the land is plotted against the Nitrogen use per acre. In the dairy sector, the relationship is remarkably linear suggesting that Nitrogen is used extremely efficiently by dairy farmers. In the beef sector (figure 2) there is also a good linear relationship revealing higher productivity at higher rates of N. However, the efficiency of utilisation of N though good is not as good as in the dairy sector. Stocking rates are much lower in the beef sector.

Figure 1. Dairy Grassland Productivity

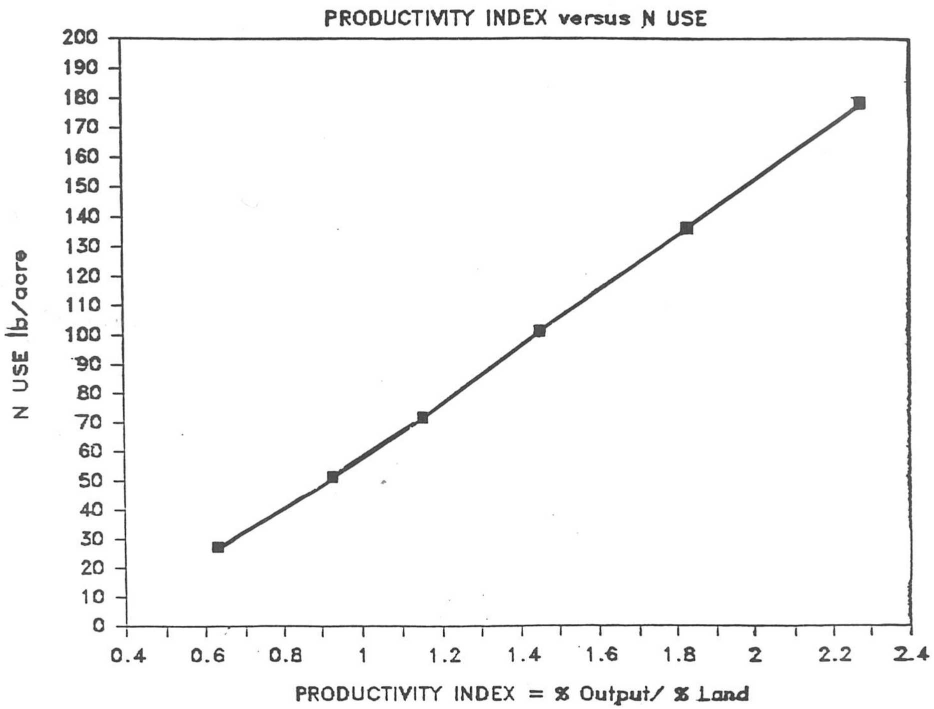
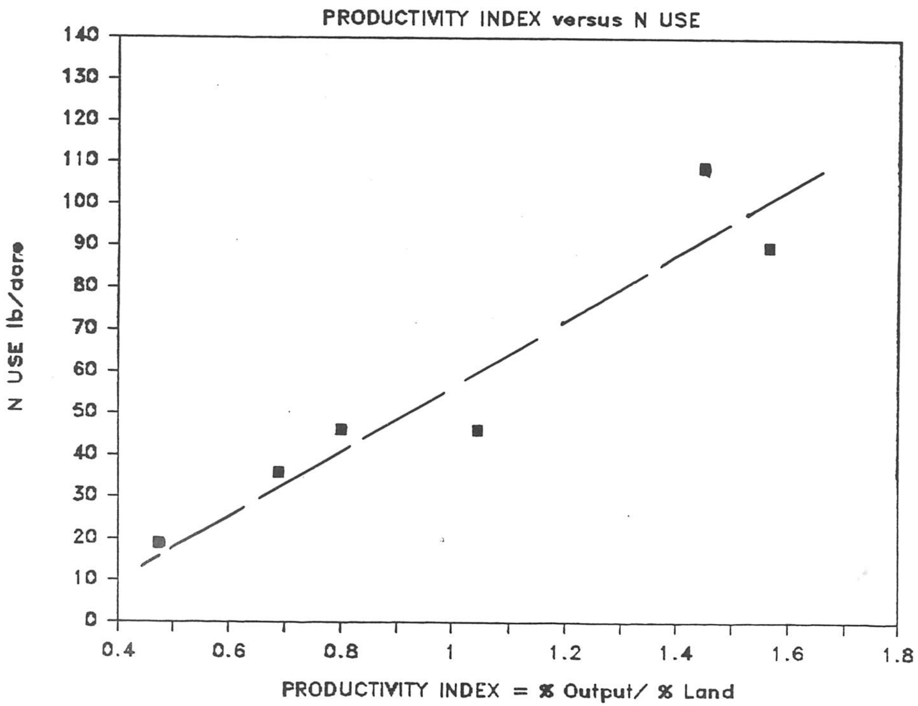


Table 8.

	1970 Tonnes	1970 % Total N	1980 Tonnes	1980 % Total N	% of N Growth
Tillage	21243	30	40262	16	11
Silage	13582	19	72830	29	33
Pasture (including Hay)	35175	50	134443	54	56

Figure 2. Drystock Land Productivity



CONCLUSIONS

It is clear from Table 8 that 11% of the Nitrogen growth went to the tillage sector, 33% was used for silage and 56% was used on pasture. There was a dramatic increase in the output of grain over the same period and the provision of silage increased by more than 300%.

Stocking rates increased from 1970 to 1974, not from 1975 to 1980. It is arguable that stock numbers increased too quickly relative to N inputs in 1970 to 1974, and that there was an element of catching up in 1975 to 1980.

Livestock output improved by 25% as opposed to the 16% increased in livestock numbers. Milk yield per cow which was static in 1970 to 1974 increased by 21% from 1975 to 1980 and by 30% overall from 1970 to 1980.

Some allowance must be made for the fact that increased output on the intensifying farms which were responsible for the bulk of the increased Nitrogen was masked in the national farm data by a large number of poor farmers whose output remained static or even declined. When farms are disaggregated, it becomes clear that Nitrogen was used very efficiently. Boyle (9) wrote "we also examined the relationship between returns and the use of nitrogen and concentrates in 1981. As with our findings for 1977 we found no evidence that on average variable inputs were being over-used." Higgins (10) examined the following inputs: purchased feed, fertilizer, seed and hired labour and concluded "there is no evidence to support the contention that farmers are wasting variable inputs, given their system of farming and methods of production."

REFERENCES

1. Attwood E.A. — "The Nature and Causes of the Farm Income Problem." Paper read to the Statistical and Social Inquiry Society of Ireland on 20.5.1982
2. Brogan J.C. et al. — "Trends in Soil Fertility in the Republic of Ireland." Paper read to Fertiliser Association of Ireland on 27.11.1981.
3. Browne D. — Quoted by McCarthy D. in Proceedings of Milk Production Seminar 1979 A.F.T.
4. McCarthy D. — Proceedings of Milk Production Seminar 29-31st May, 1979 A.F.T.
5. Gordon F.J. et al. — Milk Production in Northern Ireland (May 1981).
6. Killen L. — The Outlook for Cattle and Milk Supplies. Proceedings of 1982 A.F.T. Economics Conference.
7. Connolly K., Bord Bainne, Kearney B., A.F.T. — Private Communications.
8. Doody K. — Report on Mitchelstown Co-op. Dairy Survey 1981.
9. Boyle J.E. — Some Agricultural Productivity Puzzles Re-examined. Proceedings 1982 A.F.T. Economics Conference.
10. Higgins J. — Relative Economic Efficiency of Irish Farms. Proceedings 1982 A.F.T. Economics Conference.

Notes