Economic Impact on Irish Dairy Farms of Strategies To Reduce Nitrogen Applications

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Summary

Economic research reported here analysed the likely impact on farm incomes of policies aimed at reducing nitrogen (N) applications on farms. Three types of policy were considered. First was a restriction of the intensity of livestock production to control amounts of organic nitrogenous material going on the land. That in the EU Nitrates Directive of 170 kg N per hectare was used (equivalent to 2 dairy cows per hectare). To this was added a restriction on the total amount of nitrogen applied of 260kg N/ha reflecting rules in the Rural Environment Protection Scheme (REPS). The third measure considered was a 10 percent tax on sales of manufactured nitrogenous fertilisers.

These measures to address nitrate pollution are under discussion in Ireland as the concentration of nitrates in waters in some areas has increased significantly.

Particular attention was paid to estimating the impact of the three constraints on specialist dairy farms, as they were most likely to have to restrict applications of N to comply. Many of these farms were in the five Munster counties selected for the study, namely Cork, Kerry, Limerick, Tipperary and Waterford. In these counties 39 percent of specialist dairy farms would have been affected both by Nitrates Directive restrictions on applications of nitrogen as organic material (animal wastes) and REPS rules on the total amount of nitrogenous material spread on farm land. A further 30 percent of these farms would be affected only by the restriction on total applications of N, as in the REPS rules. The remaining 31 percent of the specialist dairy farms would not have been affected by restrictions on N use under either the Nitrates Directive or REPS rules.

The potential economic impact of policies to constrain nitrogen use was simulated for a sample of specialist dairy farms in Munster. All of these farms started with levels of N applications in excess of one or both of the restrictions being considered. This policy simulation was carried out using individual farm Positive Mathematical Programming (PMP) models.

The results showed that compliance with restrictions on N use would reduce income on all of the selected farms. The results also indicate that these farms could partly or wholly offset the loss by increasing the efficiency of N use, or by increasing milk production per cow. However, the more a farm was above the regulation 2 Livestock Units (dairy cows) per hectare the larger the potential loss of income and the more difficult it would be to make good this loss. Farms starting with fewer than 2 LU/ha but applying in total more than 260 kgN/ha (REPS rule) would find that meeting this target would cause a lesser reduction in income. This loss would also be easier to offset by efficiency increasing measures.

With regard to the third scenario of imposing a 10% tax on sales of manufactured N fertilizers, the results showed this to be very ineffective in reducing the amounts used. In some cases the imposition of a tax would have no effect whatsoever on the amount of N used yet would slightly reduce incomes on all of the nation's farms.

1. The Problem of Nitrate Pollution of Water

In many European countries excessive nitrate levels in waters contribute to eutrophication and the contamination of drinking water sources (Rigby and Young, 1996; Dietz and Hoogervorst, 1991). In Ireland, the concentration of nitrates in waters is generally below the maximum acceptable concentration (MAC) set by the European Union (EU). Nevertheless, the concentration of nitrates in waters in some areas has increased significantly compared with normal background levels, creating some localized problems, notably in some areas of County Cork, where some wells have had to be closed for this reason.

Excessive levels of nitrates in water are usually associated with higher applications of artificial fertilizers and more intensive agricultural production. A study undertaken by Coulter (1996) identified areas of the country where water pollution by nitrates is most likely to occur. Waters with high nitrate levels are most likely to be found in areas where nitrogen (N) inputs from agricultural sources are highest and where soil conditions are most conducive to the movement of nitrate to water, particularly groundwater.

The most significant sources of N that pose a potential risk to groundwater are N inputs from livestock manure and manufactured fertilizers, also the release of N through a process of mineralization of organic matter on cultivated soils. Coulter (1996) estimated the N loadings from animal manure, chemical fertilizers and mineralization for district electoral divisions (DEDs) throughout the country. Based on his estimates N from animal manure is the largest single source of N input with an average of 87 kg per hectare per year compared to 47 kg from chemical fertilizers and 6 kg from N mineralization.

The areas with the highest levels of total diffuse N from all sources are the more productive land areas in the south and east of the country. High N loadings from animal manure occur in counties Cork, Tipperary and Limerick and are accounted for by intensive dairying in these areas.

2. Pollution Abatement Strategies and Policies

A number of measures can be adopted to deal with pollution from agriculture. Farmers can voluntarily adopt a code of `good practice' and improve N management on their farms. However, voluntary measures alone are often insufficient to ensure the adequate management of environmental resources and government intervention may be required.

Environmental management is typically seen as a two-stage process. Firstly, the environmental authority determines a set of standards for environmental quality, and secondly, officials introduce a regulatory system to attain these standards. There are two broad regulatory strategies available for attaining prescribed environmental standards:

1. a command and control (CAC) approach under which the environmental authority specifies how polluters are to behave; and
2. a system of economic incentives through which the authority creates economic inducements for abatement activities but leaves polluters free to determine their own response to these inducements (Oates, 1985).

In Ireland, and in most other EU countries, a CAC approach rather than a system of economic incentives is used to control pollution from agriculture. Legislative measures have been used to deal with water pollution, one of the principal negative environmental effects of agricultural activities. The water pollution problem has been addressed at national level through the introduction of legislation, the Local Government (Water Pollution) Act 1977 and the Local Government (Water Pollution) Amendment Act 1990, and at EU level through the implementation of a series of directives. These directives have been adopted by member states and include the Drinking Water Directive (80/778/EEC), the Groundwater Directive (80/686/EEC) and the Nitrates Directive (91/676/EEC). The objective of the Nitrates

Directive is to reduce water pollution caused, or induced, by nitrates from agricultural sources and to prevent further pollution (Duggan, 1992). The EU also introduced Agri-Environmental Measures under the 1992 CAP reforms to deal with the problem of pollution from agriculture.

Under the Nitrates Directive member states are required to identify waters affected, or likely to be affected, by nitrate pollution and to designate vulnerable zones. Action programs in respect of these zones must be established within two years of designation. The Directive requires the monitoring of waters to determine nitrate concentrations. Where nitrate pollution breaches the EU standards of 50 mg/l, or are likely to do so in the absence of pollution controls, the Directive requires that stringent legally binding measures be taken in respect of farm practices to reduce nitrate losses to water. The Directive states that: `These measures will ensure that, for each farm or livestock unit, the amount of livestock manure applied to land each year, including by the animals themselves, shall not exceed a specified amount per hectare. The specified amount per hectare being the amount of manure containing 170 kg N. However, for the first year of the action program Member States may allow an amount of manure containing up to 210 kg N' (OJEC, 1991, 91/L375/EEC;7).

To date no vulnerable zones have been designated under the Nitrates Directive in Ireland. However, nitrate levels have been increasing in recent years, and in a number of areas are showing trends, which, if unchecked, could threaten the 50 mg/l standard set out in the Directive (Department of Environment, 1996).

In the 1992 CAP reforms, Agri-Environmental Measures were introduced as part of the measures accompanying changes in market organization rules. The Agri-Environment or Rural Environment Protection Scheme (REPS), as it is known in Ireland, came into operation in 1994. The aim of this scheme, which is voluntary and open to all farmers throughout the country, is to encourage farmers to farm in an environmentally friendly manner. A farmer participating in the scheme receives an annual payment for doing so, and must implement a number of measures on the farm, the most important of which is to follow a nutrient management plan that has been prepared for the farm. The objective of this measure is to minimize nutrient losses from agriculture and thereby protect/improve the quality of water resources. Limits on N application rates are imposed under this measure. The total amount of N to be applied to grassland is limited to 260 kg per hectare. The permitted level of N from animal and other organic wastes is limited to 170 kg per hectare (Department of Agriculture, Food and Forestry, 1996).

3. Occurrence of N Applications in Excess of Limits Set under The Nitrates Directive and REPS

The farms most likely to apply N in excess of the limits set under the Nitrates Directive and the REPS scheme are intensive dairy farmers in the southern part of the country. The threat of pollution from nitrates is greatest in this region due to the large concentration of intensive specialized dairy farms. In 1991, 57% of all specialist dairy farms were located in Munster (CSO, 1994).

Five Munster counties, namely Cork, Limerick, Kerry, Waterford and Tipperary constituted the study area for this analysis. While dairy production is most intensive in these counties it does not mean that all dairy farmers in the region apply N in excess of the limits set under the Nitrates Directive or the REPS scheme. In fact, N applications on 31% of specialist dairy farms in the selected study area were below the limits set under the Nitrates Directive and the REPS scheme. Of the remaining 69% of farms, 39% exceeded the limits set on the use of N under both the Nitrates Directive and REPS while 30% exceeded only the total N limit that applies under the REPS scheme.

For the purpose of this study, data for a sample of 120 specialist dairy farms from the selected study area was obtained from the 1996 National Farm Survey[3]. Estimates of the amount of N per animal from different types of animals came from the Department of Agriculture, Food and Rural Development (DAFRD).

Analysis of the rates of N applied per hectare on the selected farms indicated that N application rates increased with the amount of milk produced on the farm. Thus, for the purpose of this study the sample of farms was divided into five subgroups according to quota size. The size categories were: (i) less than 10,000 gallons; (ii) 10,000 - 25,000 gallons; (iii) 25,000 - 40,000 gallons; (iv) 40,000 - 60,000 gallons; and (v) over 60,000 gallons.

Farms in size class (i), less than 10,000 gallons of quota, had relatively low levels of N per hectare from organic and inorganic sources (Table 1a).

Table 1a. Average Applications of Nitrogen on Munster Sample of Specialist Dairy Farms by Size Category

Size Category and Milk Quota	Average N from Organic Sources	Average N from Inorganic Sources	Average Total N	Total Number of Farms
Gallons	**kg/ha**	**kg/ha**	**kg/ha**	**Number**
(i) Under 10,000	102	74	176	6
(ii) 10,000 - 25,000	123	121	244	28
(iii) 25,000 - 40,000	152	178	340	40
(iv) 40,000 - 60,000	186	251	437	23
(v) Over 60,000	183	254	407	23
Overall	**156**	**183**	**339**	**120**

Table 1b. Numbers of Sample Farms Outside and Inside Regulatory Limits for applications of Nitrogen

Size Category and Milk Quota	Using over 170 kg N/ha organic and over 260 kg N/ha total	Using under 170 kg N/ha organic but over 260 kg N/ha total	Using under 170 kg N/ha organic and under 260 kg N/ha total	Total Number of Farms
gallons	**Number of Farms**			
(i) Under 10,000	0	1	5	6
(ii) 10,000 - 25,000	3	8	17	28
(iii) 25,000 - 40,000	14	15	11	40
(iv) 40,000 - 60,000	17	6	0	23
(v) Over 60,000	15	7	1	23
Total	**49**	**37**	**34**	**120**

As the farms in size class (i) would be largely unaffected by the restrictions on N use that would apply under the Nitrates Directive and the REPS scheme, they were excluded from further analysis.

Two farms from each of the size categories (ii)-(v) were selected for analysis in this study, giving a total of eight farms. Of the two farms selected in each size category, one used over 170 kg organic N/ha and over 260 kg total N/ha (farms 1(ii) - (v)), and would therefore be affected by both the Nitrates Directive and REPS type regulations on N use, while the other one used under 170 kg N/ha from organic sources but over 260 kg N/ha in total (farms 2(ii) - (v)) and would be affected by REPS type regulations only.

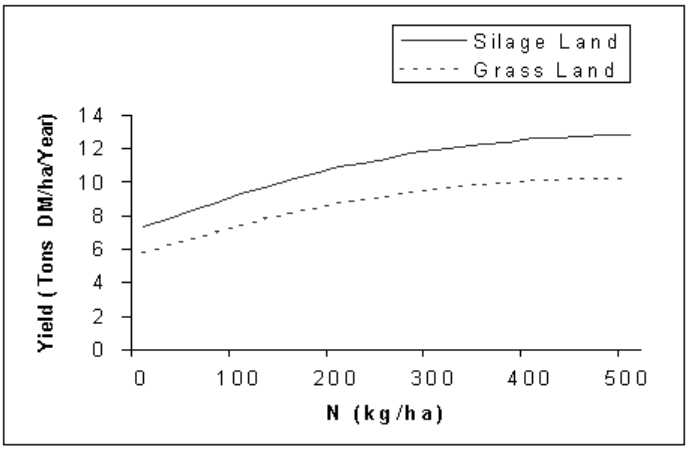
4. Estimation of the Economic Impacts of Abatement Measures

4.1 Methodology

This report examined the likely impact on farm income of a number of different policy measures aimed at reducing N applications. The potential impact of these policy measures was analyzed by simulating farmer profit maximizing behaviour using Positive Mathematical Programming (PMP) models.

4.2 Farm Models

The farm models maximized the total gross margin for each farm. A number of farming activities and production and resource constraints were included in the models. The livestock activities included were: dairy cows; 0-1 year old female cattle; 0-1 year old male cattle; 1-2 year old female cattle; 1-2 year old male cattle. Purchases of fertilizer N, feed production and purchases of concentrate feed were included as separate activities. The amount of N used on farm and the amount of concentrates purchased was determined within the model. Feed production activities represented the effect of N on grass and silage production at different levels of application (Fig. 1).



A number of constraints were included in the farm models as follows:

1. All land was owned and none was rented in or out;
2. The milk quota was owned and was equal to the level of observed milk production. No additional renting or leasing of quota was allowed;
3. A replacement balance constraint was included in the models, ensuring that the dairy herd was maintained at its observed level. A herd life of five years was assumed, requiring that 20% of the herd be replaced annually;
4. All grass and silage fed to animals was produced on farm.
5. Labour was constrained to that available on farm;
6. A number of feed requirement constraints were included in the model to ensure that animal feed requirements were satisfied in terms of grass, silage and concentrates.

5. Economic Analysis and Results

Policy makers can use either Command and Control (CAC) or economic measures to achieve a reduction in the amount of N applied to farmland. CAC measures usually consist of restrictions on N use while economic incentives normally consist of a tax on inputs or outputs. This study examined the likely impact on farm activities of three separate policy measures aimed at reducing N applications namely:

1. Restriction of stocking rate to 2 LU/ha reflecting the Nitrates Directive limit of 170 kg N/ha on applications of N in organic material;
2. Restriction of total applications of N to grassland of 260 kg N/ha, which, when taken with restriction A, reflects the REPS rules; and
3. Taxation of manufactured nitrogenous fertilizers at 10 percent of their value.

Measures A, B and C were examined for the more intensive farms with one per size class numbered 1(ii)-(v), while measures B and C were the only measures relevant to the less intensive farms numbered 2(ii)-(v) in this study.

Restrictions on the use of N are likely to have at least some negative economic impact on intensive dairy farmers. The severity of the impact is determined to a large degree by initial conditions on the farm and the design of the policy. The intensity of production (LU/ha), the ratio of dairy cows to other livestock and the efficiency of utilization of N are important in determining the economic impact of restrictions on N use. If farmers are faced with restrictions on N use, which will result in a decline in their income it is quite plausible that they will try to offset this reduction by adjusting the pattern of their operations and may also raise productivity.

Impacts on farm income are thus shown after allowing for profit maximizing adjustments. In addition, results show the effects of two strategies that could be adopted to minimize the impact of restrictions on N use namely:

1. An increase in the efficiency of N use by, for example, following Teagasc recommendations on the rates and timing of N use (Coulter, 2001). This was illustrated by a 5 percent increase in the response of production from grass to the units of nitrogen applied.
2. An increase in milk yield per cow, demonstrated by a yield increase of 100 gallons.

5.1 Impact of Policy Measure A (Nitrates Directive) on Farms 1(ii)-(v)

The estimated impact of policy measure A on farms 1(ii)-(v) is outlined in Tables 2a, b, and c. The result was that all four farms would scale back their cattle enterprise leading to a reduction in family farm income. As expected, the highest reduction (15%) occurs on the farm in size category (v), the most livestock intensive farm (Table 2b).

Table 2a Intensity of Production on Farms 1(ii)-(v) before and after enforcement of Policy A (Nitrates Directive)

	Farm Size Category			
	(v)	**(iv)**	**(iii)**	**(ii)**
	Intensity: Livestock Units per hectare			
Before Restriction				
All livestock	2.6	2.3	2.1	2.3
of which dairy cows	1.7	1.6	1.5	1.2
After Restriction				
All livestock	2.0	2.0	2.0	2.0
of which dairy cows	1.7	1.6	1.5	1.2

Table 2b Changes in Farm Income on Farms 1(ii)-(v) following enforcement of Policy A (Nitrates Directive)

	Farm Size Category			
	(v)	**(iv)**	**(iii)**	**(ii)**
	Percent change in farm income			
After adjustment through changing levels of activity	-15	-9	-1	-3
Efficiency of N use increased by 5% and adjustment in levels of activities	-13	-6	+1	+3

Milk yield increased by 100 gallons/cow and adjustment in levels of activities	-10	-5	-3	+6

Increasing the efficiency of N use would offset some of the negative effect of complying with restriction A on the farms in size categories (iv) and (v) and would lead to a slight increase in income on the farms in the other two size categories.

Increasing the milk yield per cow would reduce the negative effect of complying with restriction A on three of the four farms and would lead to an increase of 6% in family farm income on the farm in size category (ii).

5.2 Impact of Policy Measure B Combined with A on Farms 1(ii)-(v): the REPS scenario

The impact of policy measure B combined with A on farms 1(ii)-(v)is outlined in Tables 3a, b and c, reflecting the effects of constraints on applications of N in the REPS rules.

Table 3a Intensity of Production on Farms 1(ii)-(v) before and after adoption of Policies A and B: the REPS scenario

	Farm Size Category			
	(v)	**(iv)**	**(iii)**	**(ii)**
Intensity				
Before Restrictions	463	**540**	482	450
Total N kg/ha				
Stocking Rate LU/ha	2.6	2.3	2.1	2.3
Of which dairy cows	1.7	1.6	1.5	1.2
After Restrictions				
N kg/ha	260	260	260	260
Stocking Rate LU/ha	2.0	2.0	2.0	2.0
Of which dairy cows	1.7	**1.5**	1.5	1.2

In order to comply with the restrictions on N use all four farms must reduce their livestock numbers and their use of inorganic sourced nitrogen. Farmers scale back their cattle enterprise first, as cattle production is less profitable than dairy production. That would be enough for farms in size categories (ii), (iii) and (v) to comply with restrictions on N use. However, this is not so for the farm in size category (iv). In order for this farm to comply with the restrictions it must reduce the number of cattle to the minimum required for replacement of the dairy herd and it must also reduce the size of its dairy herd by three. This results in a significant reduction in farm income (22% excluding receipts from REPS). Compliance with policy measure B would lead to a reduction in income on all four farms (Table 3b).

Increasing the efficiency of N use or increasing the milk yield per cow would offset some of the negative economic impact of complying with Restriction B but the overall effect would still be negative on all four farms.

Table 3b Changes in Farm Income on Farms 1(ii)-(v) following adoption of Policies A and B: the REPS restrictions on nitrogen

Percent Change in farm income after restricting N but before entering REPS				
	Farm Size Category			
	(v)	**(iv)**	**(iii)**	**(ii)**
After adjustment through changing levels of activity	-15	-22	-12	-9
Efficiency of N use increased 5% and adjustment in levels of activities	-13	-14	-7	-1
Milk yield increased by 100 gallons/cow and adjustment in levels of activities	-14	-16	-10	-3

Complying with the restrictions in this scenario would remove an obstacle to these farmers participating in REPS. While farmers complying with these regulations could be eligible to participate in the REPS scheme they may have to improve buildings and other facilities on the farm to do so. Participating in the scheme could thus lead to an increase in overhead costs while also bringing entitlement to receipts from the Scheme. A study by McEvoy (1999) indicates that overhead costs on farms participating in REPS increased by 21%. Taking into account the payments farmers would receive and assuming a 21% increase in overhead costs the results indicate that farms in size categories (ii) and (iii) would cut their losses by participating in the REPS scheme when faced with REPS type restrictions on applications of N (Table 3c).

Table 3c Changes in Farm Income on Farms 1(ii)-(v) following adoption of Policies A and B: Participation in REPS

	Farm Size Category			
	(v)	**(iv)**	**(iii)**	**(ii)**
	Percent change in farm income with REPS			
After adjustment through changing levels of activity	-16	-26	-8	-3
Efficiency of N use increased 5% and adjustment in levels of activities	-15	-17	-4	+4
Milk yield increased by 100 gallons/cow and adjustment in levels of activities	-15	-19	-6	+3

For the farms in size categories (iv) and (v), participating in REPS would mean a further reduction in farm income of 4% and 1% respectively. This is due to the fact that the increase in overhead costs would more than offset the payments received, as these are restricted to a maximum of £5,000 per farm.

Increasing milk yield per cow or increasing the efficiency of N use while participating in the REPS scheme would reduce the negative effect of complying with restrictions on nitrogen use on all four farms. The farm in size category (ii) would achieve a 3% to 4% increase in farm income by participating in REPS and adopting one of these measures. Increasing efficiency of nutrient use by 5% has a more beneficial effect on farm income than increasing milk yield per cow by 100 gallons because increasing milk yield per cow involves extra costs in terms of animal feed.

5.3 Impact of Policy Measure B on Farms 2(ii)-(v): REPS limits on total applications on less intensively stocked farms

The estimated impact of policy measure B (REPS) on those farms that were only above the overall limit on N applications of 260kg/ha (farms 2(ii)-(v)) is outlined in Tables 4a, b, and c. All four farms would have had to reduce applications of N (Table 4a).

Table 4a. Intensity of Production on Farms 2(ii)-(v) before and after adoption of Policies A and B: the REPS scenario

	Farm Size Category			
	(v)	**(iv)**	**(iii)**	**(ii)**
Before Restriction B				
N kg/ha	312	350	298	420
Stocking Rate LU/ha	1.8	1.8	1.7	2.0
Of which dairy cows	0.9	1.1	1.1	1.1
After adopting Restriction B				
N kg/ha	260	260	260	260
Stocking Rate LU/ha	1.7	1.6	1.6	1.7
Of which dairy cows	0.9	1.1	1.1	1.1

The results indicate that all four farms would experience a decline in farm income as a result of complying with constraints on applications of N in REPS regulations (Table 4b).

Table 4b. Changes in Farm Income on Farms 2(ii)-(v) following adoption of Policies A and B: the results from REPS restrictions

	Farm Size Category			
	(v)	(iv)	(iii)	(ii)
	Percent change in income with reduced N			
After adjustment through changing levels of activity	-2	-3	-2	-8
Efficiency of N use increased 5% and adjustment in levels of activities	+3	+1	+3	-1
Milk yield increased by 100 gallons/cow and adjustments in levels of activities	+2	-2	-2	-2

The reduction in farm income is less than that experienced by farmers who would be affected by restrictions on organic sources of N via stocking rate reductions (farms 1(ii)-(v)). This loss would also be easier to offset by efficiency increasing measures.

Participation in the REPS scheme with the attendant increases in overhead costs and receipt of REPS payments would offset income loss on farm 2(iii) and reduce it on farms 2(iv) and 2(ii) (Table 4c). However, of the eight farms considered in this study only farm 2(iii) would be likely to get an increased income by participating in the REPS scheme. This is the farm that requires the smallest reduction in total N use in order to comply with REPS regulations.

Table 4c Changes in Farm Income on Farms 2(ii)-(v) following adoption of Policies A and B: Participation in REPS

	Farm Size Category			
	(v)	**(iv)**	**(iii)**	**(ii)**
	Percent change in farm income with REPS			
After adjustment through changing levels of activity	-2	-1	+8	-3
Efficiency of N use increased 5% and adjustment in levels of activities	+3	+3	+13	+4
Milk yield increased by 100 gallons/cow and adjustment in levels of activities	+2	0	+8	+2

5.4 Impact of Policy Measure C (Tax on Nitrogen) on Farms 1(ii)-(v) and Farms 2(ii)-(v)

The estimated impact of policy measure C on the eight selected farms is outlined in Tables 5 and 6. The introduction of a 10% tax on manufactured nitrogenous fertilizer would be very ineffective in reducing the amount of N used on all eight farms. The tax would have no effect on the amount of N used on farms 1(v) and 1(iii) (Table 5), or on farms 2(v) and 2(iii) (Table 6).

Table 5 Estimated Impact of Policy Measure C (Tax on Nitrogen) on Farms 1(ii)-(v)

	Farm Size Category			
	(v)	**(iv)**	**(iii)**	**(ii)**
Intensity				
Before Tax applied	**463**	540	**482**	450
Total N kg/ha				
Stocking Rate LU/ha	2.6	2.3	2.1	2.3
Of which dairy cows	1.7	1.6	1.5	1.2
After Tax applied				
Total N kg/ha	**463**	520	**482**	383
Stocking Rate LU/ha	2.6	2.3	2.1	2.0
Of which dairy cows	1.7	1.6	1.5	1.2
	Percent Change in Farm Income			
Change after allowing activity levels to adjust	-1*	-2*	-1*	-3

* No change in levels of activities

Table 6 Estimated Impact of Policy Measure C on Farms 2(ii)-(v)				
	Farm Size Category			
	(v)	**(iv)**	**(iii)**	**(ii)**
Intensity				
Before Tax applied	312	350	298	420
Total N kg/ha				
Stocking Rate LU/ha	1.8	1.8	1.7	2.0
Of which dairy cows	0.9	1.1	1.1	1.1
After Tax applied				
N kg/ha	**312**	296	**298**	358
Stocking Rate LU/ha	1.8	1.7	1.7	1.9
Of which dairy cows	0.9	1.1	1.1	1.1
	Percent Change in Farm Income			
Change after allowing activity levels to adjust	-2*	-2	-1*	-2
* No change in levels of activities				

The effect of the tax on farms 1(iv) and 1(ii), 2(iv) and 2(ii) would be relatively small. The tax would lead to a reduction in farm income of no more than 3% on any of the eight selected farms.

6. Conclusions

The aim of this research project was to estimate the potential economic impact of environmental regulations on Irish dairy farms. The results of the study indicate that about 31% of specialist dairy farms in the five selected counties would be unaffected by restrictions on applications of nitrogen in the Nitrates Directive and REPS type regulations. This suggests that these farms may benefit from participating in REPS in so far as they would not have to reduce their use of nitrogen from either organic or inorganic sources in order to be in REPS. However, they may have to make some improvements to farm buildings and facilities and the cost of such improvements may outweigh receipts under this scheme making it unattractive for some farmers, particularly those with large farms.

National Farm Survey data indicates that 39% of specialist dairy farms in the selected study area would be affected by restrictions in both the Nitrates Directive and REPS type regulations. Reductions in stocking of grassland to achieve levels of N from organic sources stipulated as the eventual target in the Nitrates Directive, would have a much more significant impact on the more livestock intensive farms. The results indicate that a farm starting with 2.6 livestock units per hectare would experience a 15% drop in farm income whereas a farm with 2.3 livestock units per hectare would experience a 9% drop in income through conforming with the 2 Livestock Units per hectare limit. Addition of REPS type restrictions on the total amount of N applied would have a more significant impact on farm income than the stocking restrictions alone. The impact of such REPS restrictions would, as expected, be much more significant on farms with very high levels of total N use. For example, farm 1(iv) which applied 344 kg of N in manufactured fertilizer and in total 540 kg per hectare would experience a 22% reduction in farm income, while farm 1(ii) which applied 450 kg N in total would experience a 9% drop in income.

The remaining 30 percent of specialist dairy farms in this Munster sample would be affected only by restrictions on total N applied. These farms would suffer a much smaller decline in income than those affected by restrictions on N from organic sources as well as on the overall total. Farmers with particularly high levels of N use would experience the greatest reduction in income.

The results indicate that all the affected farms could reduce the negative economic impact of restrictions on N use by increasing the efficiency of utilization of N and by increasing milk production per cow.

The results show that imposing a 10% tax on manufactured nitrogenous fertilizer would be very ineffective in reducing its use. In some cases the imposition of a tax would have no effect whatsoever on the amount of N applied. However, a tax would depress the income of all farms whether or not their applications of N violated `good practice'.

Participation by dairy farmers in the REPS scheme is quite low in Ireland, and particularly by intensive dairy farmers in the southern region of the country. In order to participate in the scheme farmers have to comply with restrictions on N use and very often have to make improvements to farm buildings and facilities. The reason many farmers cite for not participating in the scheme is that the cost of compliance with the regulations and the cost of farm improvements outweigh the payments they would receive under the scheme, particularly as these are capped at £5,000 per farm. The results presented above confirm that this is the case.

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[2] Rural Economy Research Centre, Teagasc, Dublin.

[3] The National Farm Survey is an annual survey undertaken by Teagasc.