NUTRIENT MANAGEMENT PLANNING ON IRISH DAIRY FARMS

END OF PROJECT REPORT

ARMIS 4347

Authors

J. Mounsey[1,2,3], J. Sheehy[1], O.T. Carton[2]
and P. O'Toole[3]

[1]*Teagasc, Moorepark Research Centre, Fermoy, Co. Cork.*
[2]*Teagasc, Johnstown Castle Research Centre, Co. Wexford.*
[3]*Faculty of Agriculture, University College, Dublin, 4.*

**Johnstown Castle Research Centre
Wexford**

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SUMMARY

The objective of the work undertaken was to investigate nutrient use on intensive dairy farms. A survey of 12 dairy farms was undertaken in 1997 to determine nutrient management practices. These were compared with current nutrient advice and recommended practices. Data recording was completed by the farmer and supplemented by regular farm visits to assist with and validate the process.

The mean farm size was 64.8 ha with an average of 128 cows and an annual milk yield per cow of 5594 kg. The mean stocking rate was 2.58 Livestock Units/ha. Dairy cows accounted for highest proportion of the total livestock with most of the younger stock consisting of dairy replacements.

Approximately 80% of soil P levels were greater than 6 mg/l while 67% of soils had soil K levels in excess of 100 mg/l. The mean soil P and K levels on the grazing and silage areas were 11 and 128 mg/l, 12 and 117 mg/l, respectively.

The mean farm nutrient balance (inputs - outputs) established an annual surplus of N, P and K of 304, 18 and 53 kg/ha, respectively. The adoption of nutrient management plans instead of current practice would reduce N, P and K inputs on average by 44, 13 and 24 kg/ha, respectively. The use of the Teagasc revised P nutrient advice would further reduce the P input requirements by 2 kg/ha. On average the farms had 90% of the 16 week slurry storage capacity. Approximately 14, 42, 14 and 31% of the slurry was applied in spring, summer, autumn and winter, respectively. In all cases there was significant between farm variability.

The soil P fertility on the survey farms is skewed towards index 3 and 4 when compared with the average for all samples received at Johnstown Castle. There is no agronomic advantage in terms of crop or animal production for soils to have P levels in excess 10 mg/l. This result indicates that P inputs to farms of this type can be reduced in many cases without prejudicing production potential. The nutrient balance conducted highlighted the extent of the nutrient surpluses and the

between farm variability. The data suggest that there is not a serious nutrient surplus on the survey farms, which would require the use of additional off-farm land for slurry recycling, as obtains on pig and poultry farms. The study also indicates that although farm unit cost savings may be small in adopting nutrient management planning, overall farm savings may be significant. For example on the survey farms, savings of up to £2,000 can be achieved apart from the obvious positive environmental impact.

INTRODUCTION

Dairy farming, utilises about 0.25 of the agricultural land and provides the main income for about 30,000 farm families. It has been, for many years, the most profitable grass based farming enterprise in Ireland. Inorganic fertilisers and concentrates are an important input component of the dairy system. However, falling product prices require careful examination of input costs to maintain profitability. On highly stocked farms, fertiliser and concentrates can account for up to 0.20 and 0.25, respectively, of variable costs. Therefore, a review of their use and their associated practices is appropriate.

Water quality surveys over the last two decades show a steady increase in slightly to moderately polluted waters. Excessive applications of fertiliser phosphorus (P) levels has been highlighted in recent lake catchment studies as a contributor to the annual P load. Ireland's rapidly growing tourism industry depends on an unpolluted environment. A "clean and green" image is not only important for tourism but is also vital in terms of exploiting our national reputation as a producer of high quality food that must compete successfully in an increasingly deregulated world market place. This is another justification for reviewing nutrient practices on farms.

The objective of the work undertaken was to investigate nutrient use on highly stocked dairy farms. A survey of 12 such dairy farms was undertaken to determine nutrient management practices. These were compared with current nutrient advice and recommended practices.

MATERIALS AND METHODS

The nutrient use and management practices on intensive (stocking rate > 2.0 LU/ha) dairy farms was investigated by selecting twelve dairy farms. The farms were chosen from a group of Dairy MIS farmers participating in a Teagasc Moorepark project, which was monitoring grassland management performance. Consequently, these farmers had a background in data recording.

The data collection was organised around farm visits and farmer recording. Each farm was visited initially followed by subsequent monthly visits to audit the data collected by the farmer. During the initial visit to each farm a detailed survey of all the land farmed was undertaken.

The soil type of each farm was classified on the basis of published County Soil Surveys or the General Irish Soil Map in conjunction with local knowledge. A comprehensive soil sampling programme of all the land farmed was undertaken during the winter of 1996. The cropping programme for 1997 for each soil sampling area was noted. The farmer kept the following records: monthly stock numbers and animal movements; the location, date and rate of all fertiliser and manure applications; forage sales and purchases and manure imports/exports from or to the farm. Data on milk production, fertiliser and concentrate purchases were extracted from the Dairy Mis recording sheets. Slurry samples were taken from each farm and analysed. The storage capacity of all slurry tanks, lagoons and dungsteads was determined.

A nutrient balance (NB) was calculated for each farm based on the difference between the inputs and outputs. The nutrient inputs were fertilisers, concentrates and miscellaneous which included straw and atmospheric deposition. Outputs were generally livestock and sales. Published values were used to calculate the nutrient concentrations of the input and output variables.

Nutrient management plans (NMP) were prepared for each farm. Total nutrient use from these plans was compared to recorded nutrient use.

The NMPs used either the Teagasc 1994 Phosphorus (P) recommendations (Gately, 1994) or the more recently revised P nutrient advice (Teagasc, 1996). The potential savings in both the quantity and cost of fertiliser purchases were calculated.

The measured slurry storage capacity was calculated and compared with the estimated storage requirement, which was based on national standard figures for manure storage.

RESULTS

Farm location and general description: The 12 dairy farms were located in counties Cork, Tipperary, Waterford, Limerick, Kerry and Laois.

A summary description of the survey farms is presented in Table 1. Farms ranged in area from 36 to 142 ha with a mean size of 64.8 ha. With the exception of farm D, which was on a gley soil of the Abbeyfeale series, all farms were on well drained soils. The average herd size was 128 cows within the range 45 to 365. The mean annual milk yield per cow was 5594 kg ranging from a low of 4572 kg to a high of 6255 kg/cow. The resulting mean stocking rate was 2.58 Livestock Units (LU)/ha varying from 2.17 to 2.91 LU/ha. Dairy cows accounted for highest proportion of the total livestock with most of the younger stock consisting of dairy replacements.

Soil fertility: A total of 257 soil samples were analysed for pH, P and potassium (K). The mean soil pH was 6.3 within the range 5.3 to 7.2. Soil P levels varied from a minimum of 0.7 mg/l to a maximum of 51.1 mg/l with a mean value of 11.7 mg/l. The mean soil K level was 132 mg/l within the range 30 to 300 mg/l. Approximately 80% of soil P levels were greater than 6 mg P/l while 66% of soils had soil K levels in excess of 100 mg/l (Fig. 1). The mean soil P and K levels on the grazing and silage areas were 11 and 128 mg/l, 12 and 117 mg/l, respectively. There was within farm variability in soil P and K levels. This is illustrated in Figure 2 .

Table 1. A general description of the twelve dairy farms surveyed

FARM	AREA(HA)	SOILTYPE	NO. COWS	MILK YIELD (KG/COW)	SR (LU/ HA)
A	37	loam-clay/loam	64	5652	2.45
B	59	loam	120	5513	2.76
C	42	loam	45	6255	2.75
D	69	silty/loam-silty clay/loam	146	4572	2.32
E	39	loam-clay/loam	66	5427	2.18
F	36	light loam	71	6084	2.48
G	69	light loam	109	5783	2.79
H	77	light loam	154	5558	2.78
I	142	light loam	365	5747	2.58
J	86	light loam	200	6072	2.91
K	68	loam	118	5342	2.80
L	51	loam-clay/loam	83	5054	2.17
Mean	64.8		128	5594	2.58

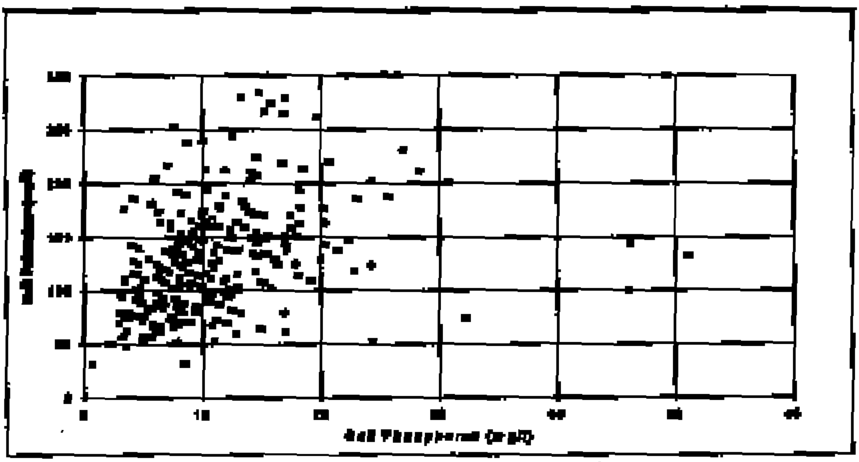

Figure 1: Distribution of soil P and K levels on the twelve survey farms

Landuse & Distribution of Soil K Levels on Farm J

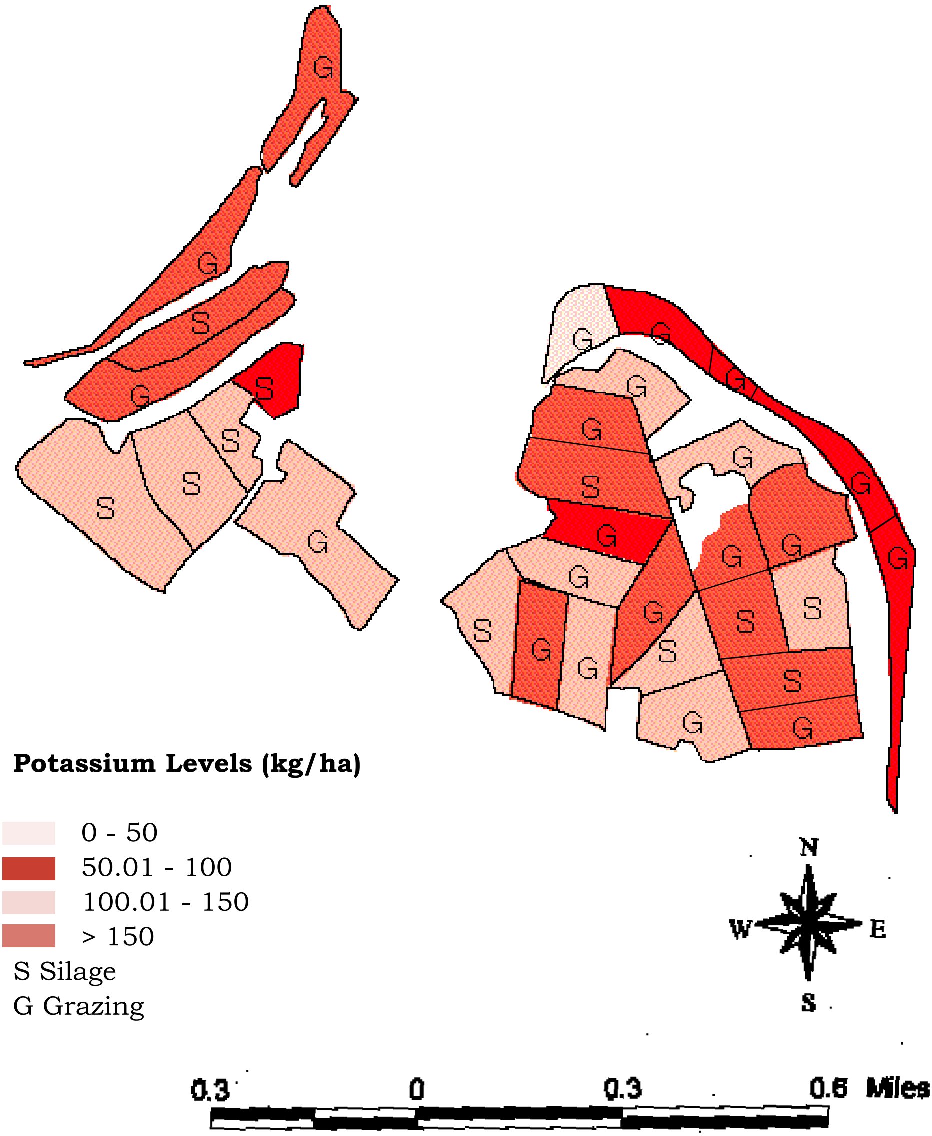

Figure 2. Map of one of the surveyed farms showing distribution of soil P fertility and land use

Farm nutrient balances: The difference between the nitrogen (N), P and K inputs and outputs or nutrient balance was calculated for each farm (Table 2).

Table 2: Calculated farm nutrient balances (inputs - outputs) (kg/ha)

FARM	N BALANCE	P BALANCE	K BALANCE
A	+303	+36	+142
B	+280	+22	+68
C	+268	+20	+63
D	+272	+8	+9
E	+314	+10	+40
F	+349	+26	+90
G	+367	+6	+28
H	+318	-9	-5
I	+249	+42	+ 4
J	+408	+24	+75
K	+320	+31	+105
L	+198	-3	+11
Mean	+304	+18	+53

A mean annual surplus (+) of inputs over outputs was identified for N, P and K. There was a mean annual surplus of 304 kg N/ha. There was a twofold difference between farms with the N surplus ranging from 198 to 409 kg/ha. An average annual P surplus of 18 kg/ha was found with the individual farm values ranging from a deficit of 9 kg/ha to a surplus 42 kg/ha. The mean K surplus was 53 kg/ha. Again there was between farm variability ranging from a deficit of 5 kg/ha to a surplus of 142 kg/ha.

Fertilisers, concentrates and miscellaneous contributed to the nutrient inputs on the farms. The relative contribution of each source was calculated (Table 3).

Table 3: Contribution of the components to total nutrient inputs (%)			
	N	P	K
Fertiliser	0.88	0.67	0.60
Concentrates	0.08	0.31	0.22
Miscellaneous*	0.04	0.02	0.18

*bedding materials/atmospheric deposition.

Fertiliser was the main contributor to the major elements inputs supplying 88, 67 and 60%, of the total N, P and K inputs, respectively. The contribution of concentrates to inputs varied between nutrients accounting for 31, 22 and 8% of the P, K and N, respectively. Bedding materials/atmospheric deposition accounted for 2 and 18% of the P and K inputs, respectively. There was considerable between farm variability in the contribution of the fertiliser and concentrate components to the inputs. For example, the contribution of fertiliser and concentrate to total N inputs ranged from 80 to 93% and 2% to 15%, respectively. Similarly for P the respective contributions of fertilisers and concentrates to the inputs ranged from zero to 92% and from 8 to 99%. The range of K contributions from fertilisers and concentrates to total K inputs were zero to 89% and 5 to 68%, respectively.

Milk sales accounted for on average 84% of N export from the farms, ranging from 64 to 95% (Table 4). Meat sales contributed to 15% of the N exports within the range 5 to 28%. Milk sales was the main source of P export at 75% of total P output. This ranged from 59 to 93% between farms. Meat sales contributed 24% of the P exports with individual farm values ranging from 7 to 42%. Milk sales was the main sources of K export, 92%, ranging from 57 to 98%. Meat sales averaged 6% of the K exports, ranging from 1 to 14%. The contribution of miscellaneous to nutrient exports was on average less than 2%.

Table 4: Contribution of the components to total nutrient outputs (%)			
	N	**P**	**K**
Milk	0.84	0.75	0.92
Meat	0.15	0.24	0.06
Miscellaneous*	0.01	0.01	0.02

* Sales of silage etc.

The nutrient outputs as a % of nutrient inputs were calculated. On average 17, 40 and 32% of the N, P and K, respectively, imported onto the farms were exported in produce. There was considerable variation between farms with one farm having a net export of P and K i.e. exports > imports.

Nutrient management plans: Nutrient management plans were prepared for each of the farms. These were based on soil test results, crop use, stocking rates and the Teagasc 1994 fertiliser recommendations for N, P and K (Gately,1994). A second P management plan was also developed to take account of the Teagasc revised P recommendations (Teagasc, 1996). The nutrients actually used on the farms were compared with those based on Teagasc recommendations (Table 5). On average actual nutrient use in 1997 exceeded those that would have been recommended if Teagasc nutrient advice had been followed. The effect of the revised P nutrient advice (P96) is interesting in that the difference is relatively small at 2 kg/ha. There is a large between variation with some farms using more nutrients than would have been advised and others less. The variation is not consistent for the three nutrients.

Table 5: The difference between actual fertiliser use and that based on Teagasc 1994 N and K recommendation using both the 1994 P (P94) and 1996 (P96) recommendations (kg/ha).				
Farm	**N**	**P94**	**P96**	**K**
A	44	25	31	109
B	-15	9	14	33
C	-9	20	19	46
D	48	-9	-3	-28
E	59	8	11	-19
F	96	18	17	37
G	84	5	3	3
H	63	0	0	-1
I	-18	37	37	-11
J	113	16	17	43
K	72	27	27	72
L	-12	2	2	-7
Mean	44	13	15	24

Slurry storage capacity: The slurry storage capacity on each of the farms was measured. The 16 week storage requirement for the number and type of animals on each farm was calculated. The measured storage capacity was compared with the 16 week requirement (Table 6).

Table 6: The measured slurry storage capacity, the calculated 16 week storage requirements and the capacity (measured/16 week requirement)			
Farm	**Measured storage (m^3)**	**The calculated 16 week storage requirement (m^3)**	**Capacity (Measured/16wk requirement)**
A	750	619	121
B	1486	1121	133
C	495	475	104
D	409	1190	34
E	941	600	157
F	545	621	88
G	1523	1367	111
H	1273	1420	90
I	1727	2838	61
J	1705	2184	78
K	500	1415	35
L	545	759	72
Mean	996	1217	90

The slurry storage capacity on the farms ranged from 409 to 1727 m^3 reflecting the differences in the number of animals housed. On average the farms had 90% of the 16 week storage requirements. However, this ranged from 34 to 157% between farms.

Slurry nutrient analysis: A total of 20 slurry samples were taken from the storage tanks between February and August. The mean slurry dry matter was 6.4 g kg-1 (6.4%), ranging from 45 to 84 g/kg. The mean slurry N content was 28 kg/10 t, which varied from 18 to 38 kg 10/t. The mean P content was 5.2 kg/10 t, ranging from 3.1 to 8.5 kg/10 t. The mean K content was 31.2 kg/10 t, which ranged from 21 to 55.7 kg/10 t.

Slurry spreading date and method: The timing of the manure or slurry applications for each farm was recorded. In summary, 14, 42, 14 and 31% of the slurry was applied in spring, summer, autumn and winter, respectively (Table 7).

Table 7: The % of total slurry applied in each season

SEASON	%
Spring (Feb-April)	14
Summer (May-July)	42
Autumn (Aug-Oct)	14
Winter (Nov-Jan)	31

Almost one quarter of the slurry produced was applied in May which coincides with removal of the first cut silage crop. There was considerable between farm variability within the range none to 62% of total slurry applied at this time. A further 12% and 5% of the slurry was applied in July and August, respectively, which coincides approximately with removal of the second silage cut.

The slurry was applied either by the farmer or by the contractor or both (Table 8). It was generally applied by vacuum tanker fitted with a splash plate. Over 80% of the slurry was applied to silage land with the remainder applied to the grazing area.

Table 8: The slurry spreading operator, the method of application and the crops to which it was applied

Farm Code	Operator	Method of application	Applied to silage	Applied to grazing
A	contractor	splashplate	80	20
B	self	splashplate	65	35
C	self	splashplate	100	0
D	contractor	splashplate/umbilical	75	25
E	contractor	splashplate	100	0
F	contractor	splashplate	80	20
G	self	splashplate	65	35
H	self	splashplate	70	30
I	self/contractor	splashplate/umbilical	90	10
J	self/contractor	splashplate/umbilical	100	0
K	self	splashplate	90	10
L	self	splashplate	85	15
Mean			83	17

Types of fertiliser used: The type of fertiliser N, P and K used on each farms was recorded. Urea and calcium ammonium nitrate (CAN) accounted for 45 and 33%, respectively, of the fertiliser N used. Sulphate of ammonia accounted for 6% of fertiliser N inputs. The other fertiliser N sources used were generally in the form of compound with P and K, including 24-2.5-10, 10-10-20,18-6-12, 24-2.5-10 and 27-2.5-5.

The most commonly used P fertilisers used were in the form of P and K compounds with Super Phosphate (16% P) accounting for only 5% of total fertiliser P use. Phosphorus in compound with K, 0-10 -20 and 0-7-30, provided 46% of P supply. Similarly, for K these two compounds supplied 50% of K inputs.

Fertiliser N application dates: The first and last date for spreading fertiliser N and the rate of application on each farm was recorded (Table 9). The mean starting date of N applications was the 17thof January, with the earliest application on the 12th of January and the latest on the 28th of January. The mean application was 60 kg N/ha, this varied from 57.5 to 83.75 kg/ha. With the exception of one farm urea was used. The mean final date of N applications was the 2nd of October, starting on the 13th of September and finishing on the 30th of October. The mean application was 33 kg N/ha. CAN was used on 8 farms, with the remaining 4 farms using Urea.

Table 9: Dates and rates of first and last N applications on surveyed farms.						
	FIRST N APPLICATION			LAST N APPLICATION		
FARM	DATE	KG/ HA	TYPE	DATE	KG/ HA	FORM
A	14-Jan	57.5	Urea	21-Sept	36.25	CAN
B	27-Jan	57.5	Urea	30-Sept	37.5	CAN
C	14-Jan	62.5	Urea	21-Sept	25	CAN
D	25-Jan	57.5	Urea	30-Oct	31.25	CAN
E	14-Jan	83.75	CAN	8-Oct	25	CAN
F	17-Jan	57.5	Urea	13-Sept	33.75	CAN
G	14-Jan	57.5	Urea	6-Oct	33.75	CAN
H	12-Jan	57.5	Urea	8-Oct	31.25	Urea
I	28-Jan	57.5	Urea	27-Oct	25	Urea
J	14-Jan	57.5	Urea	6-Oct	37.5	Urea
K	14-Jan	57.5	Urea	21-Sept	50	Urea
L	17-Jan	57.5	Urea	13-Sept	33.75	CAN
Mean	17-Jan	60.1		2-Oct	33.33	

DISCUSSION

Nutrient use and management practices are not necessarily linked to the calendar year and should preferably be reviewed over a longer time span. Therefore, care is required in drawing definitive conclusions from these results which were collected over a 12 month period from January to December 1997. They are, however, indicative and provide a rational basis for nutrient management advice.

The average stocking rate (SR) of the project farms was 2.58 LU/ha, ranging from 2.17 to 2.91 LU/ha. This compares with SRs of 2.17 and 1.47 LU/ha, on specialist dairy farms and the national average, respectively, (Fingleton, 1997). The average milk yield was 5594 kg/cow, ranging from 4572 to 6255 kg/cow. This is 1.2 times higher than 4648 kg/cow, the average milk yield for specialist dairy farms. The average farm size was 64.8 ha, ranging from 36 to 142 ha. This compares with 36.9 for specialist dairy farms and 28 ha, the national average (Connolly, 1998). The project farms therefore represent the "leaders" of the more intensive dairy farmers.

Soil Fertility: The mean soil test P level on the farms was 11.7 mg/l. This value is similar in magnitude to the mean soil test P level of 12.4 mg/l from 447 soil samples taken from 30 intensive dairy farms in a 1994 survey. It is higher than the national average soil P test level of 8.3 mg/l (Coulter *et al.*, 1996). The soil P fertility on the survey farms is skewed towards index 3 and 4 when compared with the average for all samples received at Johnstown Castle (Figure 3).

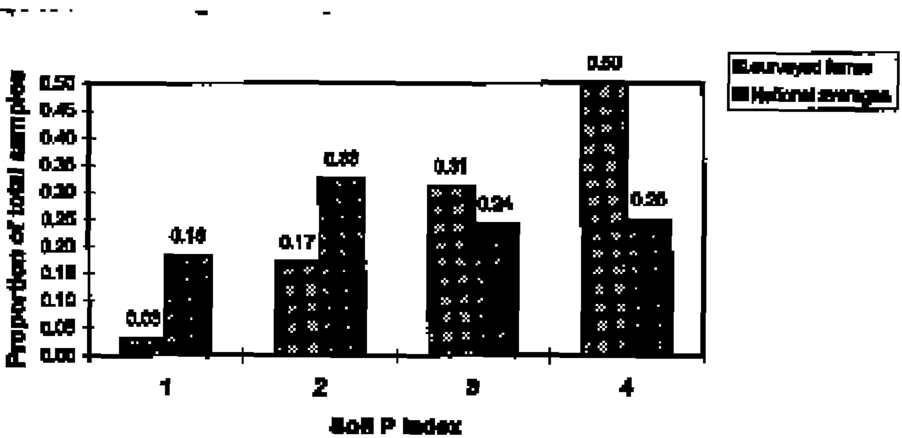

Figure 3: Distribution of soil test P levels in the four Teagasc indices for the surveyed farms and the "national" average based on all soil samples received at Johnstown Castle.

There is no agronomic advantage in terms of crop or animal production for soils to have P levels in excess 10 mg/l. This result indicates that P inputs to farms of this type can be reduced in many cases without prejudicing production potential. The fact that 20% of the soils are in P index 1 and 2 suggests there is a requirement for P on some of these farms.

The mean soil test K level for the project farms was 132 mg/l which is the agronomically recommended level. The results show that soil K levels are higher on these farms compared with the national average (Figure 4).

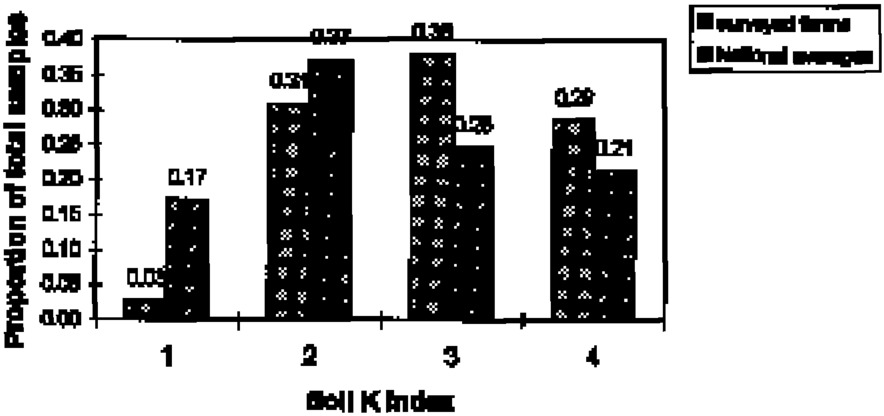

Figure 4: Distribution of soil test K levels in the four Teagasc indices for the surveyed farms and the "national" average based on all soil samples received at Johnstown Castle.

There was considerable within farm variation in soil fertility, with a tendency for high fertility in land in close proximity to the farmyard and for lower fertility levels in out-farms and rented land. The issue of the distribution of nutrients within the farm should therefore be addressed as part of any review of farm nutrient practices. The use of a farm map showing the soil fertility levels can be useful in highlighting the issue (Figure 2).

Farm nutrient balances: Nutrient balances are a useful tool in terms of not only assisting in selecting the best nutrient management strategy but also as a demonstrative tool for nutrient flows on farms. The value of the farm nutrient balance exercise is therefore indicative both in terms of identifying nutrient surpluses or deficits and their extent.

The mean N balance was a surplus of 304 kg/ha (Table 2), ranging from 198 to 409 kg/ha. This value is similar to that of Verbruggen et al (1996) who calculated a mean N balance of 307 kg/ha, for 42 Flemish dairy farms. The reported N balance for EU dairy farms was 300 kg/ha (Brouwer **et al.**, 1995). Achieving N balance on farms is difficult because of the ubiquitous nature of the element in the system. However, dairy farmers must minimise the surplus as N losses are creating problems for both water and air quality.

The mean P balance was a surplus of 18 kg/ha, ranging from a deficit of 9 kg/ha to a surplus of 42 kg/ha. This is lower than the 25 kg/ha surplus reported by Walsh (1995), in a P balance study of 10 dairy farms in North Mayo. However, within a European context the annual P surplus appears relatively modest when compared with reported P surpluses of 92, 49 and 38 kg/ha in Brittany, the Netherlands and Belgium, respectively, (Brouwer et al., 1995). Achieving P balances is preferable on farms that have achieved the agronomically recommended level of soil P fertility. It is worth noting that the P imports in concentrates is greater than those for either the N and K (Table 3). This relatively large contribution of concentrates to P imports is probably not being fully considered and thus adding to the P surplus.

The average nutrient balance for K was a surplus of 53 kg/ha, ranging from -5 to 143 kg/ha. This is higher than the 10.3 kg/ha surplus reported by Culleton *et al.*, (1994) for the Johnstown Castle dairy unit.

The value of the nutrient balance exercise conducted for this study is in terms of highlighting the extent of the nutrient surpluses and the between farm variability rather than in terms of the mean surpluses identified. The data suggests there is no serious nutrient surplus on these farms that requires the use of off farm land similar to the situation on pig or poultry farms. Nutrient balances can be improved by changing existing nutrient management decisions.

Nutrient management plans: Mean reductions of fertiliser N, P and K inputs of 44, 13 and 24 kg/ha, respectively, could be made (Table 5) if these farms were to adopt nutrient management planning compared with actual nutrient applications in 1997. This could result in a saving of approximately £34/ha in fertiliser costs or an average of £2,000 at farm level. Dils **et al.**, (1998) reported potential savings of £11/ha in fertiliser input costs on adoption of nutrient management plans in a study of 33 farms in the Lough Erne catchment. It should be noted that these farmers were not as intensive as those in the present survey. It is interesting to note the between farm impact on fertiliser costs/savings ranges from an increased cost of £6/ha on one farm to savings of over £60/ha on a number of farms.

The results suggest the adoption of Teagasc nutrient management planning advice will have its largest impact on reducing mean P inputs from approximately 21 to 8 kg/ha. For these dairy farmers this means a reduction in milk production cost of 0.1 pence/l of milk produced. It is worth noting that adoption of the Teagasc's revised P nutrient advice only result in a reduction of 2 kg P/ha compared with the older, 1994, recommendations. This may appear surprising but the effect of the revised P nutrient advice on reducing P inputs is greater at lower rather than higher SR.

Nitrogen fertiliser inputs would be reduced by on average by 44 kg/ha if Teagasc advice were followed. This is an overall reduction of about 14% compared with current use which is probably smaller than might have been expected. The impact of the savings on unit milk production costs will be small.

Slurry storage capacity: On average 90% of the 16 week slurry storage capacity was available on these farms. The mean slurry dry matter, 64 g/kg, is similar to that found in a recent survey of cattle manures on Irish farms. This suggests some dilution with extraneous water. Therefore, the available storage capacity on farms may be less. Improvements in slurry storage capacities are expensive.   It has been estimated that seven of the 12 farms would have to invest approximately £21,000 (range £3027-£44439) to upgrade their storage capacity to 16 weeks. This is a large capital investment requirement. Simple strategies like diverting clean water away from storage tanks will optimise the use of existing storage facilities.

Slurry spreading date and method: Approximately 30% of the slurry produced on these farms is applied during winter months. Care is required in any interpretation of this result as this was only a one year calendar survey. However, it is preferable if the slurry were applied during the growing season. Less than half the farmers rely on contractors which may have an impact on slurry spreading date which is outside the farmers control. Not surprisingly the vacuum tanker and splash plate is the most common spreading method. It is worth noting that 25% of these dairy farmers had contractors using the umbilical system of slurry spreading. This may suggest that in the future there will be the emergence of specialist manure contractors who will be capable of providing a more complete manure spreading service as is the case presently in the Netherlands.

Types of fertilisers used: It is interesting to note that the traditional P and K compounds account for almost 50% of the supply of these nutrients. The potential appears to exist for a reduction in the use of these in favour of the high N compounds which may be useful in terms of achieving the reductions in nutrient inputs.

Fertiliser N applications: Teagasc recommends that fertiliser N applications finish in early September. These results indicate late autumn N applications, up to almost the end of October are not uncommon. This practice is probably emerging as the move towards extended grazing in autumn develops. While this practice will reduce costs associated with indoor feeding it is important to consider the possible negative impacts on ground water quality in vulnerable areas.

CONCLUSION

The results of this study provide some useful indicators on how nutrient management practices might be improved on intensive dairy farms. Both the nutrient balance and nutrient management planning exercises clearly identify the potential to reduce nutrient inputs on intensive dairy farms. The potential impact of the practice is reflected in the relatively high proportion of soil samples in soil P index 4. However, the high between farm variability in the variables examined, indicates the need to examine each case individually and that generalisations require careful qualification. While unit cost savings are small when expressed in context of cost per gallon of milk, savings may be significant when expressed on a whole farm basis. Slurry storage capacities may appear at first to be adequate but the slurry dry matters suggest dilution with extraneous water which will reduce effective storage capacity. The capital costs of increasing slurry storage capacity is high on some farms. However, on some farms the potential exists to partially meet such costs from the savings in fertiliser inputs.

Dairy farmers should adopt nutrient management planning. The reduction in the nutrient inputs achievable will have potentially beneficial environmental impacts. Innovative strategies to encourage voluntary uptake are required.

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