THE EFFECTS OF FARM MANAGEMENT PRACTICES ON SOIL POTASSIUM LEVELS IN SILAGE FIELDS ON DAIRY FARMS

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Grass silage is the single most important source of winter feed on Irish farms with almost 25 million tonnes ensiled annually. The yield of grass harvested has a huge impact on the cost of feeding silage - light yielding crops make expensive silage whereas heavy-yielding crops spread the costs over a greater tonnage. Perennial ryegrass is capable of producing high yields under conditions of good soil fertility and adequate fertilizer. To produce good quality grass silage on a consistent basis requires adequate soil fertility. In particular there must be sufficient reserves of lime, nitrogen (N) phosphorus (P), potassium (K) and in some cases, sulphur (S), available to the crop.

Professional site investigations for IFI farmer clients where there were poor silage production responses to fertilizers showed that in nearly all cases the fields that had disappointing yields of grass had inadequate reserves of soil K. Between 1996 and 2001 usage of K fertilizer declined by 31% on Irish farms. Silage fields, particularly those where two cuts are harvested per annum require high inputs of K. Some 63% of silage fields cut twice for silage are now considered low or deficient in K (Teagasc, 2000).

During the summer of 2002 a study was undertaken to investigate farm management practices that may be contributing to low soil K levels on dairy farms. The study was done by way of a survey. A total of 100 questionnaires were circulated to farmers in counties Clare, Limerick, Tipperary, Cork and Kerry. Circulation of the questionnaires was done by post or in some cases distributed at Teagasc Discussion Group meetings. A stamped, self-addressed envelope accompanied each questionnaire. The main criteria for inclusion in the survey were as follows:

- All farms surveyed were dairy farms.
- All farmers were known to be 'good' grassland managers.
- There was no imported slurry used in any of the farms.
- Only farms that had soil analysis conducted between autumn 1997 and spring 2002 were included.

The farms ranged in size from 18 hectares to 144 hectares. Of the respondents, 20% were participants in REPS, 15% were extensive (< 2 LU/Ha) but not in REPS while 65% were intensive (>2.2 LU/Ha) dairy farmers. The main soil textural types on the farms surveyed were loam 54%, clay 28% with the remaining 18% being a mixture of sand, peat, sandy loam and peaty clay.
All soil test results examined were from soil samples analysed at Teagasc Johnstown Castle Soil Test Laboratories between autumn 1997 and spring 2002.

The purpose of the survey/questionnaire was to elicit information on the following key areas:

- Number of silage cuts harvested per annum;
- Slurry storage facilities on the farm;
- An estimate of the volumes of slurry applied to silage fields;
- Average amount of fertilizer K applied to silage fields;
- The relationship between distance from slurry pit and soil K levels;
- Soil test data reports from Autumn 1997 to Spring 2002

RESULTS AND DISCUSSION

Of the 100 questionnaires circulated 55 were returned. Seven did not have soil test results within the last 5 years. One farm had no soil results for silage fields and the remaining farm was importing pig slurry. This left 46 valid surveys. It would have been more favourable if the return rate was greater. However, little could be done to improve this under time and work constraints.

K Status of Soils on Survey Farms

A total of 405 soil samples were analysed. The mean soil K level was 121 mg/l for grazing fields, 92 mg/l for 1 cut silage fields and 90 mg/l for 2 cut silage fields on the surveyed farms. The corresponding national K values for 2001 reported by Teagasc Soil Testing Laboratories, Johnstown Castle were 125 mg/l for grazing, 101 mg/l for 1 cut silage and 93 mg/l for 2 cut silage. The survey showed that soil K levels on grazing fields and on fields where two cuts of silage were normally harvested were similar to Teagasc data. However, soil K levels on fields where one cut of silage was usually taken show lower K readings than Teagasc figures.

K Status of Silage Fields on 46 Survey Farms

Out of a total of 405 soil test results from the 46 farms there were 181 soil test K results from silage fields. Table 1 gives a breakdown of the K values by soil index for one cut and two cut silage fields on the surveyed farms.

Table 1 Distribution of Soil K Status by Soil Index for 1 and 2 Cut Silage Systems

	One Cut Silage		Two Cut Silage	
Index	**Number Samples**	**%**	**Number Samples**	**%**
1	19	16	10	16
2	60	51	35	55
3	26	22	10	16
4	13	11	8	13
Total	118	100	63	100

The results show that a somewhat higher percentage of soils were at K index 1 and 2 in the current study than reported in national surveys. This study found that 67% of samples from 1-cut silage fields and 71% of samples from 2-cut silage fields were at soil K index 1 and 2, respectively. The corresponding national K values reported by Teagasc (2000) were 62% of 1-cut silage fields were at Index 1 and 2 and 64% of 2-cut silage fields were at K Index 1 and 2 (Table 2).

Table 2 Comparison of Soil K Levels (Index 1 & 2) on Surveyed farms with National Soil K Levels Reported by Teagasc

	46 Survey Farms	National
1 Cut	67%	62%
2 Cut	71%	64%

Median K Status of Silage Fields on Surveyed Farms

The soil test K values for the 46 survey farms were also categorised by soil K Index. The 46 farmer questionnaires were divided into four soil indices based on the median soil K results from soil samples taken from silage fields. Median values were used instead of mean values to avoid any unusual results, which would distort the data. The results are presented in Table 3. The results show that a large majority of the farms surveyed were classed as being either low (Index 2) or deficient (Index 1) in K. Only 9 farms were at the target K Index 3 and only 4 farms displayed high median soil K levels (Index 4) in silage fields.

Table 3 Distribution of Farms by Soil K Index

Soil K Index	Soil K Status	No. farms	%
1	Very Low	5	11
2	Low	28	60
3	Medium	9	20
4	High	4	9
Total		46	100

K Recommendations for Silage Crops:

Current Teagasc advice assumes that all slurry produced by animals from silage and concentrates during the wintering period is applied to silage ground. On this basis an annual application of 33,000 litres of slurry per hectare returns 142 kg K/ha. Table 4 details the average Teagasc fertilizer K recommendation (1 & 2 cut silage) at each Index for the 46 farms if the recommended rates of slurry were spread on silage fields.

Table 4 Teagasc Recommended Rates of Slurry and K Fertilizer for Silage on 46 Survey Farms

Soil K Index	Fertilizer K (kg/ha)	Slurry 33,000 l/ha	Total K Recommendation
1	47	142	189
2	49	142	191
3	7	142	149
4	0	142	142

Total K applied for silage

The total quantities of K applied to silage fields as fertilizer and cattle slurry in the present study are outlined in Table 5. As is evident from Table 5 farms at soil K Index 2 and 3 (37 farms) were applying the recommended amounts of slurry to silage fields. In contrast on the K Index 1 farms below recommended levels of slurry were being applied to silage fields while on K Index 4 farms there was surplus slurry being spread for silage.

Table 5 Total K (kg/ha) Applied to Silage Fields on the Farms Surveyed

Soil K Index	Fertilizer K	Slurry	Total
1	60	123*	183
2	67	139*	206
3	69	136*	205
4	59	177*	236

*Data supplied by Teagasc 2001 formed the basis for calculating the amount of K available from cattle slurry.

The present study found that the average amount of fertilizer K applied for silage in 2002 was 66 kg K/ha across all farms. The rate of K applied to silage fields observed in the present study is higher than those reported by Teagasc Fertilizer Use Survey 2002 on dairy farms at 53 kg K/ha.

Mean rates of fertilizer K applied to silage fields (both 1 and 2 cuts) in the present study were categorised by soil K Index and are also detailed in Table 5. The results show that there was very little difference between the rates of fertilizer K

applied regardless of soil index. Thus, identical rates of fertilizer K were applied at K Index 1 and K Index 4 i.e. 60 and 59 kg/ha, respectively.

Table 6 compares the amounts of K applied on the surveyed farms with levels recommended by Teagasc (Table 4). This table shows that there was a direct relationship between total K applied to silage fields and soil K levels on the 46 farms surveyed. Above recommended rates of fertilizer K were applied to silage fields on the 46 farms surveyed ranging from +13 kg/ha at Index 1 to +59kg/ha at Index 4. At soil K Index 1 the total amount of K applied to silage fields was broadly in line with recommendations. A shortfall in K from slurry was balanced with extra fertilizer K. At soil K Index 2 there was 15 kg K/ha being applied above recommended levels. Fertilizer K was the source of this surplus. At soil K Index 3 excess fertilizer K was leading to a K surplus (56 kg/ha) on the surveyed farms, while at soil K Index 4 excess fertilizer K and slurry were contributing to a surplus of 94kg K/ha. It should be noted that no analysis was done on the quality of the slurry on the farms surveyed.

Table 6 Difference between Recommended K and Applied K (kg/ha) to Silage Fields on the Farms Surveyed

Soil K Index	Fertilizer K	Slurry	Total
1	+13	-19	-6
2	+18	-3	+15
3	+62	-6	+56
4	+59	+35	+94

The survey shows that there was a slight deficit in the total K applied to silage fields on farms at soil K Index 1 while silage fields at K Index 2 were receiving sufficient K when slurry and fertilizer application rates were combined. This evidence suggests that even where recommended K levels were applied to low and very low K soils there was no improvement in soil K levels

Nutrient Management

In the present study 30% of the farmers surveyed indicated that slurry was not returned to all silage ground every year. In addition slurry was applied to silage fields during November and December on 20% of the farms. This possibly suggests that slurry was applied under less than ideal conditions on some of the farms. Considering that correct slurry application dates and rates were not fully observed on all the farms in the current study would suggest that somewhat lower levels of slurry was being returned to silage fields than indicated in Table 5.

Slurry Storage

While the present survey did not investigate the quality of slurry storage facilities on the farms concerned data presented in Table 7 would indicate that the farms with higher soil K levels in silage ground had a greater amount of slatted slurry available on their farms.

Table 7 Slurry Storage on Survey Farms Categorised by Soil K Index

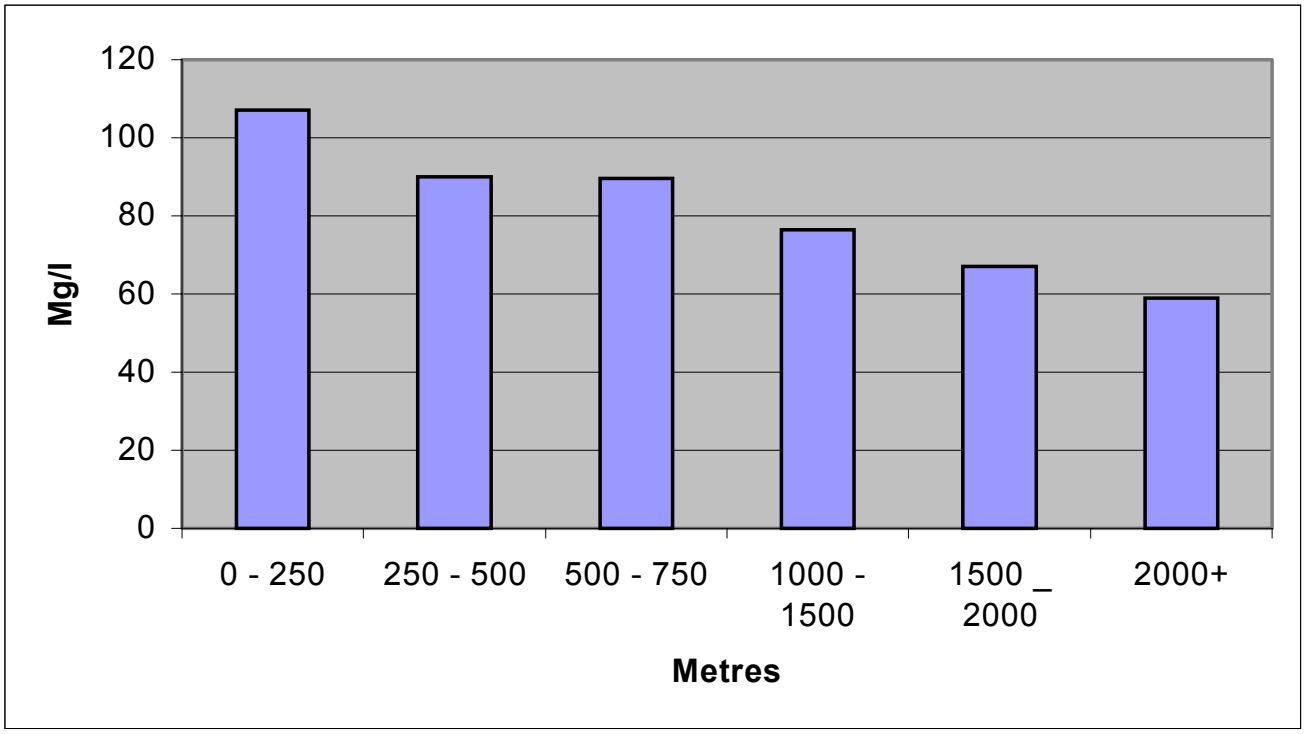
Soil K Index	% Slatted	%Open	%Dungstead
1	38	58	4
2	63	32	5
3	81	16	3
4	71	26	3

Relationship between Slurry Travel Distance and Soil K Levels on The Survey Farms

The relationship between the distance from the slurry storage facilities and soil K levels in silage fields was examined in this study. The data show that the further the distance between the slurry pit and the silage field the lower the soil K levels were. Data in Figure 1 suggest that distance from slurry storage facilities influences soil K levels in silage fields. Mean Soil K levles in silage fields on the survey farms declined substantially from 106 mg K/l to < 60mg K/l with increasing travel distance from 0-250m to 2 Km +.

The findings in this study suggest that insufficient slurry is being applied to silage fields on dairy farms where there is a good distance between the silage field and the slurry source. The problem is even greater where two cuts of silage are usually cut per annum. Ideally only the silage fields closest to the yard should be cut for second cut silage. However, this is not always possible. The findings from the present survey suggest that there is a greater requirement for fertilizer K on silage fields a good distance from the slurry pit.

Figure 1: Relationship Between Soil K And Distance From Slurry Pit



CONCLUSIONS

- The study found that there was a direct relationship between the total amount of K applied for silage and soil K Index on the farms surveyed.

- The study showed that there was a decline in soil K levels in silage fields the further the distance from the slurry storage facilities. On the assumption that farmers don't change the rate of fertilizer applied for silage based on distance of fields from the farm yard, this suggests that insufficient slurry is being returned to silage fields that are a good distance from the slurry pit.

- While the study did not conduct an assessment of the quality of wintering facilities on individual farms surveyed, it was observed that farms with higher soil K levels in silage fields had a greater amount of slatted slurry available on their farms.

- Proper nutrient management guidelines were not followed on many of the farms studied.

- Teagasc fertilizer recommendations were not adhered to on the majority of the farms surveyed.