High-yielding maize – are you matching P and K off-takes?

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Over 85% of maize grown in Ireland is now sown under plastic. The advent of plastic coupled with advances in maize breeding, has led to significantly higher maize yields than 30-plus years ago. Cob yield and maturity has improved significantly. The current Teagasc fertiliser advice (Table 1) is based on a crop yielding 15t dry matter per hectare (~ 18.5t/ac fresh material @ 30% DM). However, in a high-yielding year like 2019, are farmers applying enough P and K to match crop off-takes?

A maize crop has a large demand for major nutrients such as N, P and K and high-yielding crops on south-facing favourable sites can produce maize silage yields which exceed the standard advice. When planning the nutrient applications for a maize crop it is important to consider the following factors to ensure the crops nutrient demands are satisfied:

- Soil fertility levels (P, K and Mg) and soil pH.
- Crop yield potential.
- Availability of cattle slurry or alternative organic fertilisers.

The first step is to take a fresh soil sample or consult previous soil samples to establish the soil pH, P and K levels. Apply lime where recommended to adjust the target soil pH 6.5. Apply recommended levels of P and K as per the soil test but consider the site yield potential (aspect, elevation and starting soil fertility). Table 1 shows nutrient advice for a crop of maize silage yielding 15t/ha dry matter (DM) and receiving 33m³/ha of cattle slurry.

The available N, P and K values for cattle slurry have been taken into account in Table 1 and fertiliser advice adjusted. Suggested fertiliser products are also shown and these products may change depending on soil test results and organic manure type and application rates.

Efficient use of organic manures can supply large amounts of N, P and K for maize crops and offers the opportunity to reduce production costs. It is recommended to test the nutrient content of organic fertilisers such as cattle slurry to ensure the crops N, P and K requirements are balanced correctly.

Nutri2Cycle project

Nutri2Cycle is an EU Horizon 2020-funded project. One of its core objectives is to examine how grains produced on arable farms to feed animal/poultry production systems can incorporate nutrient rich bio-based fertilisers such as cattle slurry, poultry manure and emerging bio-based fertilisers such as dairy processing sludge into arable systems to move towards closure of N, P and C loops. Table 2 shows the typical values for organic fertilisers applied in the trial.

Nutri2Cycle will run for four years. The arable site was established on the tillage farm of Sylvester Bourke, Arklow, Co Wicklow. Each year, for the next four years, the same trial site plots will receive recycled organic

Table 1: Nutrient advice (N, P and K) for a continuous maize (kg/ha), assuming a dry matter yield of 15t/ha and an application of 33m³/ha of cattle slurry

N, P & K soil index	Nutrient advice (kg/ha)			Cattle slurry @ 33m³/ha			Nutrients required as fertiliser (kg/ha)			Suggested fertiliser programme
	N[1]	P	K	N	P	K	N	P	K	Product and rate kg/ha
1[2]	180	70	250	33	13	105	147	57	145	695kg 12-8-20 + 138kg Urea[3]
2[2]	180	50	225	33	13	105	147	37	80	460kg 12-8-20 + 270kg Urea[3]
3	180	40	190	33	26	115	147	14	75	280kg 10-5-25 + 330kg Urea[3]
4	180	20	120	--	--	--	147	0	120	390kg Urea[3] + 240kg 50% K

[1] Nitrogen advice for continuous maize (Soil N Index 1) assumed
[2] Cattle slurry P & K reduced to 50% and 90% availability, respectively on index 1 and 2 soils
[3] Fertiliser N source is protected urea (urea + NBPT) unless incorporated. Omit slurry application on Index 4 soils

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bio-based fertiliser balanced to crop nutrient requirements using conventional mineral fertiliser appropriate to the crop grown in that year as part of the overall rotation. Crop performance, soil fertility and organic matter effects of treatments including bio-based fertilisers will be compared to conventional mineral fertiliser and control plots over the course of the project. As part of the project, a similar experiment with a greater number of bio-based fertilisers is also running on grassland at Johnstown Castle.

In the first year (2019) maize was the crop grown, and preliminary results show that the fertiliser programmes incorporating organic manures yielded as well as the mineral only fertiliser programmes, showing potential for cost savings and delivering carbon in addition to just N, P, K and S from the mineral fertilisers.

Maize yield and crop off-takes

One of the interesting findings from examining the trial data was the trend for soil P and K levels at the recommended fertilisation rate to drop between planting and harvest. Table 3 shows the P and K status of the soil before planting the maize and after harvesting the maize.

The plot yields of maize recorded in this trial were approximately 24t dry matter per ha (~ 29.5t/ac fresh material @ 30% DM). This highlights the importance of maintaining optimum soil fertility (P and K Index 3) and producing high yields of maize silage.

On this site, table 3 shows that both P and K levels dropped, with K levels dropping from Index 3 to Index 2. This drop can firstly be explained by the very high yield of maize silage harvested and the large removal of nutrients (P and K) at harvest time. Secondly, the soil type in this field is a sandy loam and soil P and K levels will change more rapidly compared to a heavy soil type containing more clay.

The higher the clay fraction, the larger the supply of P and K in the soil and this reserve of soil P and K replenishes the soil's available P and K from season to season. In the 2019 trial the maize yield exceeded the fertilisation advice yield by 9 t DM/ha, the high-yielding maize crop removed a significant proportion of the available P and K. In order to maintain optimum fertility status (Index 3) on this soil type it will be important that the slurry is returned before the next crop is planted or additional P and K is applied in the form of fertiliser.

Table 2: Available nutrient content for organic fertilisers (kg/m^3 or tonne)

Organic fertiliser	DM (%)	N	P	K	S
Cattle slurry	6.3	1.0	0.8	3.5	0.4
Poultry manure	55	11.5	5.5	12	4
Broiler manure	60	14	6	18	2.5
Activated[1] dairy sludge	11	2.0	3.8	0.5	0.6
Actisoft[2] dairy sludge	28	2.1	30	1.1	0.8

[1] Sludge from dairy food processing wastewater treated by aeration and a biological flocculation with Alum (aluminium flocculent) dosing;
[2] Lime treated dairy food processing sludge

Table 3: Soil test results before sowing the maize crop and after harvesting

Time of sampling	Soil P level (mg/L)	Soil K level (mg/L)
Before planting	9.5 (Index 3)	109 (Index 3)
After harvesting	8.66 (Index 3)	89 (Index 2)