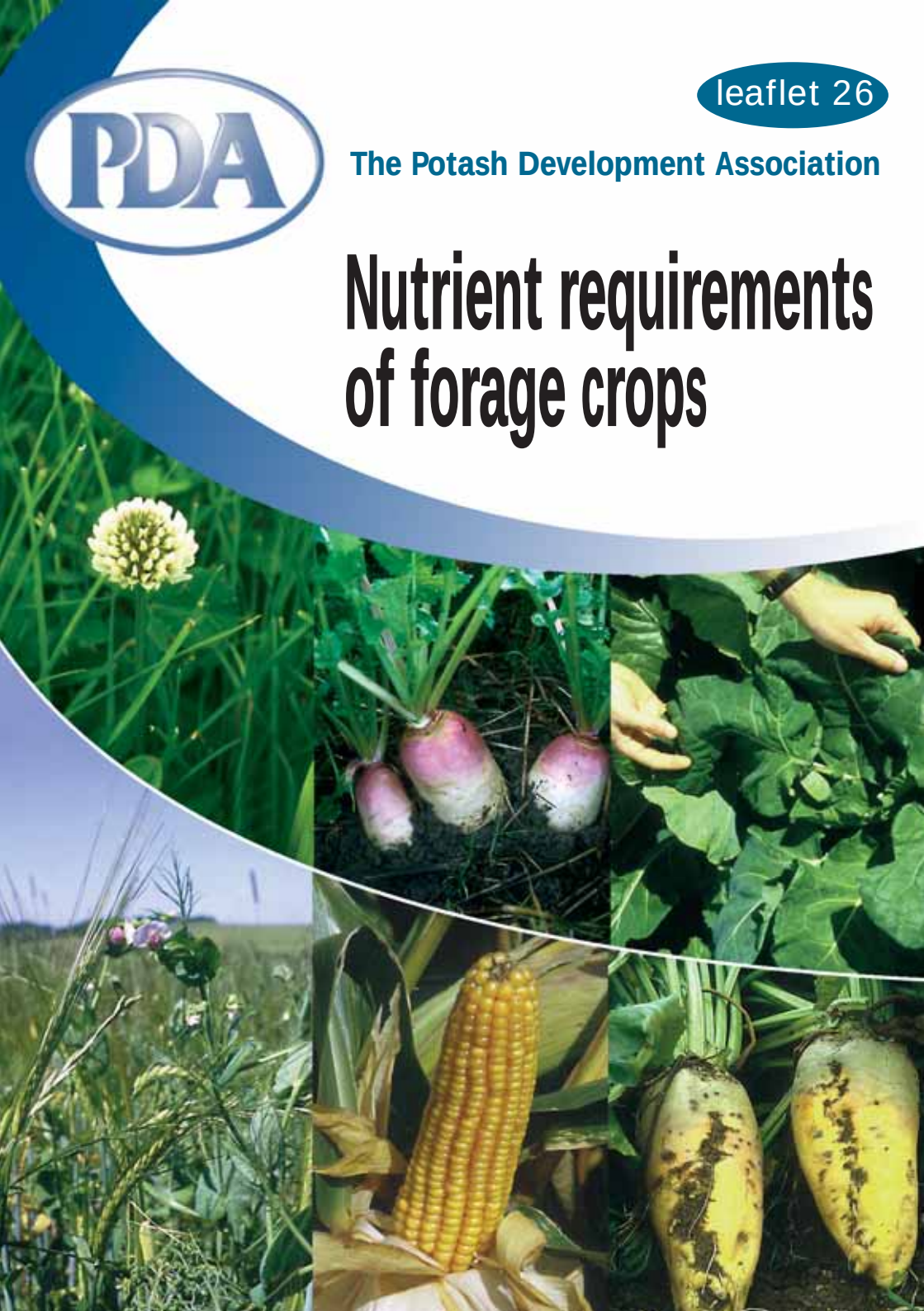
leaflet 26

The Potash Development Association

Nutrient requirements of forage crops



Introduction

Forage crops can produce very high yields of digestible nutrients and can be a useful means of reducing overall feed costs. Achievement of high yield is an essential requirement to achieve low unit cost and depends upon good husbandry and in particular, attention to crop nutrition. Annual forage crops also offer a very useful opportunity of utilising slurry or FYM to maximum advantage without the problems of sward contamination associated with grass.

A 3 year study undertaken by Kingshay Farming Trust and supported by the Potash Development Association has examined the nutritional needs and performance of a range of forage crops. The key results are reported in this leaflet.

The crops

The 3 year trial involved :-

Whole crop wheat
Italian ryegrass for silage (IRG)
Perennial ryegrass/white clover for silage (PRG)
Fodder beet
Kale
Maize for silage (1 year only)

Cover pictures kindly provided by Advanta Seeds UK Ltd.

Manure

Between 30-50 t/ha of manure was applied to each plot with the aim of applying the maximum rate of 250 kg/ha of total nitrogen then permitted. The manure used contained very typical levels of nitrogen and phosphate and slightly lower than average levels of potash. The rates applied on average provided a total of 221 kg/ha of nitrogen, 124 kg/ha phosphate and 234 kg/ha potash.

Nitrogen

It must be noted that nutrient content of manure varies widely and the individual samples, measured by laboratory analysis in this study, emphasised this difficulty. In a farm situation nitrogen content can be measured fairly accurately using one of the commercially available testing kits. Between 15-25% of the total N in the manure was assumed to be available for the forage crops in the trial, depending upon time of application. Supplementary nitrogen fertiliser was applied based on site history and individual crop yield potential. Rates were varied over the 3 years and were not designed to test the optimum rate of N for the individual crops on this site.

Average rates of available manure N + fertiliser N were :-

	N kg/ha
Wholecrop wheat	163
IRG	261
PRG/white clover	247
Fodder beet	129
Kale	211

Phosphate and potash

Phosphate and potash usage (manure + fertiliser) was based on soil analysis :-

	P_2O_5 kg/ha	K_2O kg/ha
Wholecrop wheat	125	216
IRG	129	276
PRG/white clover	130	275
Fodder beet	116	251
Kale	132	218

Yields and nutrient uptake

IRG and PRG/white clover

The Italian ryegrass and perennial ryegrass/white clover swards were cut 3 times in the season (4 times for the IRG in year 2) and produced excellent season yields of 13-15 t/ha dry matter.

Fodder beet

Only the roots of the fodder beet were harvested; the nutrient content of the tops was returned to the soil and has been excluded from the removal figures. If the tops had been recovered the total dry matter production of this crop at 17 t/ha was the highest of all forages. (The nutrient content of tops - higher protein, lower energy - would complement the reverse nutrient balance of the roots.)

Whole crop wheat

The whole-crop wheat yields of 14 t/ha DM compared favourably to the grass yields and involved only a single harvest.

Kale

Good crops of kale were grown, but in the first year, considerable in-field losses were sustained at harvest which were reflected in the poorer average recovered yields compared to the other crops

Maize

The maize results relate to only a single year and represent only modest performance.

The study confirmed that high yielding forage crops require very large amounts of potash to achieve maximum growth. This emphasises the importance of maintaining adequate reserves of nutrient in the soil – the aim is to maintain soils at index 2 for P and K.

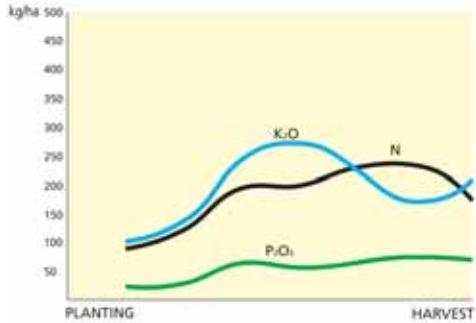
Peak uptake of phosphate and potash in this study were :-

Peak uptake during season kg/ha		
	Phosphate	Potash
Whole crop wheat	85	276
IRG *	58	312
PRG/white clover *	46	294
Fodder beet	100	710
Kale	92	696
Maize	55	240

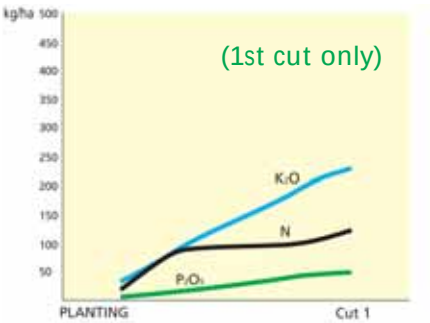
* *Peak in a single cut*

Nutrients taken up by the growing crops

Whole crop wheat

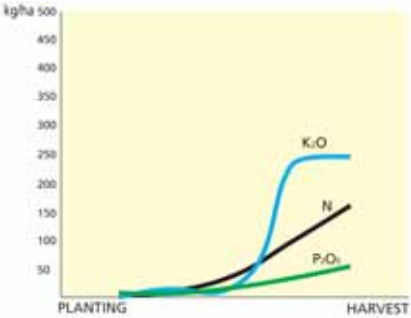


IRG

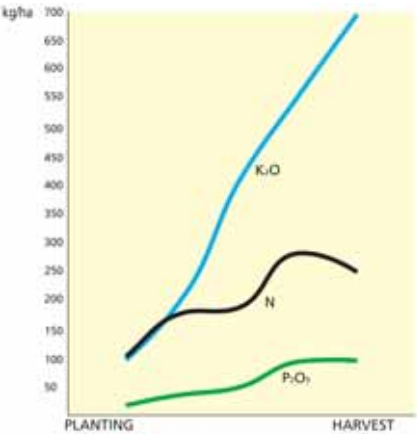


PRG/white clover

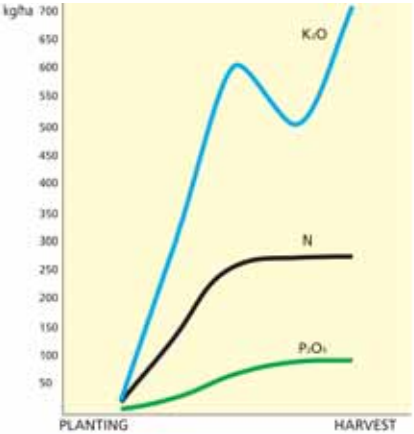
Maize



Kale



Fodder beet



Nutrient removal

The study provided useful figures for phosphate and potash removal from the field by high yielding forage crops. The basis of phosphate and potash manuring depends upon estimation of nutrient removed – see the section on basic P and K policy on page 8. The nitrogen offtake is also shown in order to indicate the relative quantities of nutrient present in the crop. (Nitrogen removal is not a guide to the quantity of N required). It is notable that in all cases considerably more potash was removed than nitrogen. Potash removal was between 3-6 times greater than phosphate removal.

Average annual yields and nutrient removal

	Fresh yield t/ha	DM yield t/ha	Nutrient removed kg/ha		
			N	P_2O_5	K_2O
Whole crop wheat	39	14.4	181	69	212
IRG					
Cut 1	34	5.2	126	48	229
Cut 2	31	5.5	115	41	197
Cut 3	19	3.8	79	28	109
Cut 4	6	1.0	52	5	34
Total per year	**90**	**15.5**	**341**	**122**	**570**
PRG/white clover					
Cut 1	31	5.0	121	41	208
Cut 2	27	4.5	105	35	190
Cut 3	18	3.2	81	24	116
Total per year	**76**	**12.7**	**307**	**100**	**514**
Fodder beet					
Tops (returned)	44	4.4	114	28	241
Roots	78	12.6	113	55	314
Kale	58	6.7	164	53	287
Maize (1 year only)	33	8.9	130	55	216

Estimating P and K removal

It is interesting to compare the P and K offtake of the forage crops in this trial with standard published figures. The general trend in this study was for phosphate removals to be slightly lower than standard and potash removals to be higher. The standard figures for fodder beet derive from the sugar beet crop and in view of the large difference for potash, it is clear that the standard figure for fodder beet should be revised.

Phosphate and potash removed

	kg per fresh tonne of yield			
	Kingshay study		Standard figures	
	P_2O_5	K_2O	P_2O_5	K_2O
Whole crop wheat	1.8	5.4	na	na
IRG	1.4	6.3	1.7	6.0
PRG/white clover	1.3	6.8	1.7	6.0
Fodder beet	0.7	4.0	0.8	1.7
Kale	0.9	5.0	1.2	5.0
Maize (silage)	1.7	6.5	1.4	4.4

Phosphate fertiliser requirements

The manure dressing provided a total of 124 kg/ha P_2O_5. This was similar to the offtake by the IRG but for other crops provided between 24-70 kg/ha more phosphate than was removed. Over a period of years, this rate of manuring would increase soil P levels. Phosphate inputs to the rest of the rotation should be reduced or omitted to avoid levels being built up beyond index 3.

Potash fertiliser requirements

The manure application provided a total of 234 kg/ha K_2O which was sufficient potash to replace that removed in the wholecrop wheat and maize but left a deficit of 80 kg and 53 kg after the fodder beet and kale. The very large offtake of potash in the intensively cut grass resulted in a serious annual shortfall of 280-314 kg/ha of potash which would need to be made up by application of potash fertiliser each year to prevent soil reserves from being depleted rapidly.

Basic P and K policy

Total nutrient requirements should be calculated on the following basis :-

Index 0	**Crop offtake + 50 kg/ha**
Index 1	**Crop offtake + 25 kg/ha**
Index 2	**Crop offtake**
Index 3	**50% of crop offtake**
Index 4	**Nil**

The nutrient contribution of manure should then be estimated using standard values of **total** content of phosphate and potash if the soil index is 2 or more and using **available** content if soil index is 0 or 1.
60% of total phosphate and 90% of total potash in FYM or slurry can be regarded as available.
Fertilisers should be used to make-up the difference between total requirements and nutrients provided by manures.
Soil analysis should be used every 4-5 years to check on any changes in soil reserves.

With acknowledgements to Kingshay Farming Trust, Bridge Farm, West Bradley, Glastonbury, Somerset BA6 8LU. Tel: 01458 851555, http://www.kingshay.com

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The Potash Development Association
is an independent technical organisation formed to support the efficient use of potash fertiliser in the UK

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