Appendix 1

Glossary

Competitor = Grime (1973) states four consistent features of "competitive" species may be recognised. They are:
1. tall stature;
2. a growth form (usually a large densely-branched rhizome or expanded tussock structure) which allows extensive exploitation of the environment above and below the ground;
3. a high maximum potential relative growth rate and
4. a tendency to deposit a dense layer of litter on the ground surface.

Composting = the process of rotting due to microbial decomposition which may occur under aerobic or anaerobic conditions to render the nitrogen content of a material less immediately available and may alter the availability of nutrients.

FYM = farmyard manure = a mixture of farm animal dung and urine with bedding material, usually straw, in varying quantities and at various stages of decomposition which can be either fresh or stockpiled but is usually stored in a heap to rot down before use. The less decomposed the material the more readily available are the nutrients it contains and the more attention that needs to be paid to the weather and timing of application to avoid the loss of the nutrients or avoidance of harmful effects. FYM is a material which can be handled as a solid and is stackable having a dry matter of 30-50%. One cubic metre (1 m^3) is reckoned to weigh 0.9 tonne (although it can vary between 0.6-0.9 tonne depending on the consolidation, amount and density of the litter)

Grassland = land predominantly covered by grass species, *Graminae*, but not exclusively so; it can contain many other plants, fungi, mosses or other taxonomic orders. It is normally a sub-climactic (plagioclimax) vegetation type - trees are the natural vegetation in most parts of the world; but natural grassland is the commonest alternative where there is sufficient moisture for grass growth, but where the environment's conditions, prevent tree growth. These places are too high, too dry or too infertile for trees or are grazed intensively by wild animals, and may possibly be areas frequently swept by natural fires. The only natural grassland in Britain is small areas on high mountains where farm animals cannot reach. Almost any area managed as grassland becomes grassland.

Hay = dried plant fodder, usually composed of grass with other meadow species, stored for later feeding to animals.

Hay Meadow = meadow grassland mown for hay; and regularly reserved for that purpose but also capable of being grazed either before shutting-up or after cutting.

Meadow = grassland mown for hay **or silage**, and regularly reserved for that purpose.

MG3 = *Anthoxanthum odoratum - Geranium sylvaticum* meadow.

MG4 = *Alopecurus pratensis - Sanguisorba officinalis* flood meadow.

MG5 = *Cynosurus cristatus - Centaurea nigra* meadow and pasture.

MG6 = *Lolium perenne - Cynosurus cristatus* pasture.

MG7 = *Lolium perenne* leys and related grasslands.

MG8 = *Cynosurus cristatus - Caltha palustris* flood pasture.

MG9 = *Holcus lanatus - Deschampsia cespitosa* coarse grassland.

MG10 = *Holcus lanatus - Juncus effusus* rush pasture.

MG11 = *Festuca rubra - Agrostis stolonifera - Potentilla anserina* inundation grassland.

MG13 = *Agrostis stolonifera - Agrostis geniculatus* grassland.

M22 = *Juncus subnodulosus - Cirsium palustre* fen-meadow.

M24 = *Molinia caerulea-Cirsium dissectum* fen-meadow.

Midden = an area where excrement from animals (or even humans) is stored.

National Vegetation Classification (NVC) = vegetation commmunity types as defined by Rodwell (1991,1992) as set out in British Plant Communities Volumes 2 & 3 (see bibliography).

Neutral grassland = grassland on soils that are neither acidic or basic (ie alkaline). Mesotrophic grassland (MG) as defined by the National Vegetation Classification (NVC). This report covers the following NVC community types MG3, MG4, MG5, (with some relevance to improved/semi-improved/reverted grassland - MG6, MG7, MG9, MG10, wet grassland - MG8, MG11, and MG13,); where enclosed fields, usually below 350 metres above sea level, are managed for hay (and grazing), usually on brown-earth soils, clays or loams, with calcareous clay loams; but not on thin chalky soils. There are also other communities such as fen meadows (mires) sometimes cut for hay - M22, M23 and M24 which may also be managed in a manner consistent with this report.

Nitrification = the breakdown of organic material to form NO_3 and NO_2 by nitrifying bacteria. The resulting nitrate NO_3 and nitrate NO_2 can be further broken down (denitrified) and released as nitrogen (N) gas. Simultaneous nitrification and denitrification can be achieved by manipulating conditions within a waste treatment process.

Nitrogen (N) = the most important fertiliser element in FYM. It is present in most farm wastes, usually combined with other elements as NO_3 or ammonium (NH_4) compounds. N can be lost as a gas from manures due to microbial digestion during storage or lost when manure is left lying on the field (with ammonia by a process called 'volatilisation'), in addition to being lost as nitrate or NO_3 by leaching due to rainfall.

Pasture = grass grazed by farm animals without being regularly or frequently mown.

Phosphate (phosphorus) = one of the three main fertiliser nutrients in FYM. The phosphorus content of a fertiliser may be declared as 'P' (phosphorus) or P_2O_5 (phosphate); P x 2.29 = P_2O_5.

Potash (potassium) = one of the three most important plant food nutrients in FYM. Potassium content may be declared as 'K' or K_2O (potash); K x 1.2 = K_2O.

Ruderal = a plant or species that is associated with disturbance (ie the temporary, if frequent, activities of herbivores, pathogens or humans who trample, mow or cultivate and from phenomena such as wind-damage, drought, frost, fire, or soil erosion which causes partial or total destruction of the plant biomass) but lives in low stress environments where there are otherwise few limits to photosynthesis. Ruderals are often weeds which have high demands for nutrients and/or are intolerant of competition.

Semi-natural = areas altered by human influence or management in the past, which has taken on a natural aspect due to the period over which the influences have persisted. Grassland may be described as 'semi-natural' if it contains a substantial

proportion of native flora and fauna and if managed (by controlled grazing, cutting or burning; or other human activity), without mechanical or manual soil disturbance or re-seeding in living memory and without other disturbance or inappropriate practices including the use of inorganic fertilisers, excessive lime, agrochemicals or other substances which are anticipated to change the vegetation.

Shutting-up = the practice of preventing grazing or other use of grassland in order to allow the above ground dry matter to increase or 'bulk-up' for a more worthwhile cut (or grazing) at a later date.

Silage = plant material cut for later use as animal feed, and conserved for feeding after a period of anaerobic fermentation. Silage is usually cut at an earlier stage of plant growth with a lower dry matter than hay when it has a higher feed value to the animal. It may be stored in towers, feed clamps covered by polythene sheeting or made as big bales which are either wrapped in polythene or placed in polythene bags.

Slurry = a mixed solution of animal dung and urine, possibly with other waste liquids added, including 'dirty water' from yards or other areas, but containing insufficient solids (eg bedding, wasted food, and 'foreign objects' lost in the slurry) to form more than a crust when stored or spread; dry matter content typically ranges from 2-10%. The nitrogen content of this is rapidly available to plants when spread unlike nitrogen from well-rotted (composted) farm yard manure.

Stress-tolerator = a species which is able survive or thrive in conditions which restrict photosynthetic production, such as shortages of light, water and mineral nutrients, or sub-optimal temperatures.

Weeds = in agricultural terms, the plants 'out of place' either because they occur too frequently for the liking of the land manager or owner or are plants which are not deliberately sown or grown, and which compete for light, nutrients and water with desirable species.

Appendix 2

Typical analysis of farmyard manures

ADAS Database information

Manure Type	No of Samples	Mean	Q1-Q3*	Min-max
I. Cattle FYM:				
Dry matter (%)	[44]	28.0	19-33	16-60
Total N (Kg t^{-1} FW)	[44]	6.7	4.7-8.4	2.3-17.2
NH_4-N (Kg t^{-1} FW)	[25]	0.76	0.2-1.1	0.1-3.2
$P_2 0_5$ (Kg t^{-1} FW)	[30]	4.1	2.4-5.6	1.3-10.9
$K_2 0$ (Kg t^{-1} FW)	[30]	12.3	6.4-17.2	3.9-40.8
pH	[27]	8.6	8.2-9.0	7.7-9.2
C:N ratio	[18]	22	11-32	9-61
II. Pig FYM:				
Dry matter (%)	[10]	27.6	22-30	18-49
Total N (Kg t^{-1} FW)	[9]	8.6	6-12.7	4.9-13
NH_4N (Kg t^{-1} FW)	[4]	0.5	0.2-0.8	0.16-0.81
$P_2 0_5$ (Kg t^{-1} FW)	[10]	10	5.8-12.6	2.9-23.6
$K_2 0$ (Kg t^{-1} FW)	[9]	7.6	3.0-11.1	2.1-16.4
pH	[4]	8.3	7.7-8.6	7.5-8.6
C:N ratio	[3]	12.5	10.9-13.6	10.9-13.6

Q1 = lower quartile) = 50% of samples
Q3 = Upper quartile)

Cattle slurry analysis in relation to dry matter content

D.M. (%)	Total N (kg/m³)	Total $P_2 0_5$ (kg/m³)	Total Potash $K_2 0$ (Kg/m³)
10	4.1	2.0	4.7
8	3.6	1.6	4.2
6	3.0	1.2	3.5
4	2.4	0.9	3.1
2	1.8	0.6	2.5
	P = <0.001	< 0.001	< 0.001
	p^2 = 5.1%	47%	18%

198 samples

Appendix 2 (cont)

Pig slurry analysis in relation to dry matter content

D.M. (%)	Total N (kg/m³)	Total P_2O_5 (kg/m³)	Total Potash K_2O (kg/m³)
10	7.5	5.0	4.2
8	6.4	4.0	3.7
6	5.4	3.0	3.2
4	4.3	2.0	2.7
2	3.3	1.0	2.2
	P = < 0.001	< 0.001	< 0.001
	r^2 = 54%	84%	20%

132 samples

Poultry manure analysis in relation to DM content

D M (%)	Total N (kg/m³)	Total P_2O_5 (kg/m³)	Total K_2O ((kg/m³)
80	43	34	24
70	38	30	21
60	33	26	18
50	28	21	15
40	23	17	12
30	18	13	8
20	13	9	5

101 samples

Typical sheep manure analysis (fresh weight)

kg t^{-1}

5.9 total N

1.5 NH_4- N

1.8 P_2O_5

2.9 K_2O

Appendix 3

Details and current prices of ADAS analytical services (April 1995)

		Price (ex. VAT)
Soil 01	**Routine soil analysis for field crops and grassland** pH, lime requirement, phosphorus, potassium, magnesium Minimum 1000 g required per field. *	6.90
Soil 02	As above, but including soil texture*	7.10
Soil 12	**Soil Mineral Nitrogen Service** - two soil depths (0-30 cm and 30-60 cm) - dry matter, ammonium nitrogen, nitrate-nitrogen total nitrogen, and nitrogen recommendation for a specific crop. Sampling by an ADAS Consultant is required for this service.	P.O.A.
ORGM 01	**Fertiliser value of organic manures** - dry matter, pH, ammonium-nitrogen, total nitrogen (fresh), phosphorus, potassium, magnesium, sulphur, ash. Minimum 1 kg required.	70.00
GRAS 02	**Grass Check Service** - dry matter, elemental nitrogen, phosphorus, potassium, magnesium, sodium, sulphur, N: S, N: K, K: Mg, K: Na ratios. Contact your local ADAS office for packaging arrangements. This service indicates if any elements are deficient/in excess.	25.00
HAYS 01	**Hays for livestock** Dry matter, crude protein, MADF. Minimum sample size 200 g.	

* Other nutrients (total or available) can be analysed on request. Siingle elements and prices are provided overleaf.

A form LA1 should accompany all samples to ADAS

Analytical Chemistry
'Woodthorne'
Wergs Road
Wolverhampton
WV6 8TQ

Tel: 0902-693385
Fax: 0902-743602

Sampling instructions can be given as required - to ensure consistency of sampling. Interpretation can also be given, usually at extra cost, please ring your **local** ADAS office, if interpretation required; not the number above.

Single elements

Single element prices

In addition to the most frequently requested combinations of elements given on proceeding pages, prices for individual elements are provided below to enable consultants to construct their own combinations. These prices apply to soil, plant, sludge and slurry samples. Where applicable please state on the sample submission form if 'total' or 'extractable' elements or both are required. Where lower detection limits are required, eg food, water etc, please telephone the Analytical Chemistry Help Line 01902 693190/693290 before sending the sample.

•	Phosphorus, potassium, magnesium, calcium, sodium, copper, iron, manganese, zinc.	£8.00 (a)	£2.00 (b)
•	Aluminium*, cadmium, chromium, lead, nickel.	£10.00 (a)	£3.50 (b)
•	Chloride	£10.00	
•	Sulphur	£12.00	
•	Boron	£15.00	
•	Molybdenum, vanadium, cobalt	£18.00 (a)	£12.00 (b)
•	Arsenic, mercury, selenium	£18.00 each	

a = first element
b = second or subsequent elements

If you wish to use any combination of elements on this page please telephone the helpline for a quotation. Prices for other elements are available on request.

* Price for extractable aluminium available on application

Appendix 4

Hay yields from Cockle Park and Rothamsted

Table of Hay Yields from Cockle Park 1897 -1980 (from Coleman, Sheil & Evans 1987)

Plot	Hay yield in fresh weight ie @ 85% DM	Hay yield - effect of FYM per year	Total benefit to hay yield over period between FYM applications	Amount of FYM applied per cycle	Average increase in yield of hay per T of FYM applied
	kg ha^{-1} $year^{-1}$	kg ha^{-1} $year^{-1}$	kg ha^{-1} $cycle^{-1}$	T ha^{-1} $cycle^{-1}$	kg ha^{-1} $cycle^{-1}$
1	6496	+3942	+3942	20 / year	197.1
4	4824	+2270	+4540	20 / 2 years	227.0
5	5120	+2566	+10264	40 / 4 years	256.6
6	2554	-	-	Nil	-

Table of First Crop Yields from Rothamsted 1920 -1959 (from Warren & Johnston 1964) - converted from dry matter to fresh weights assuming 85% DM and from imperial units to metric to enable comparison with above

Plot	Yield	Yield effect of FYM per year	Benefit over period between FYM applications	Amount of FYM applied per cycle	Average increase in yield of hay per T of FYM applied
	kg ha^{-1} $year^{-1}$	kg ha^{-1} $year^{-1}$	kg ha^{-1} $cycle^{-1}$	T ha^{-1} $cycle^{-1}$	kg ha^{-1} $cycle^{-1}$
3	1213.65	-	-	Nil	-
Unlimed 19	3167.3	+1953.6	7814.6	35 / 4 years	223.3

Table of Crop Dry Matter Yields from Rothamsted 1920 -1959 (from Warren & Johnston 1964) - converted from imperial units to metric

Plot	First crop yield	Second crop yield	Total	Amount of FYM applied per cycle	Average increase in total grass DM yield per T of FYM applied
	kg ha^{-1} $year^{-1}$	kg ha^{-1} $year^{-1}$	kg ha^{-1} $cycle^{-1}$	T ha^{-1} $cycle^{-1}$	kg ha^{-1} $year^{-1}$
3	1031.6	452.9	1484.5-	Nil	-
Unlimed 19	2692.2	1056.7	3748.9	35 / 4 years	64.7
Difference due to FYM	+261%	+233%	+253%		

Appendix 5

Total nutrients supplied by cattle manure

The table below gives an indication of the range or values given for total nutrients supplied by cattle manure (in kg per tonne fresh weight) according to various references:

		Total N	P_2O_5	K_20	Mg
Anon, 1976 b	p7 Bullocks;	5.7	3.6	8.8	
	Dairy Cow	4.8	3	4.7	
	Dairy Cow	3.6	1.1	3.2	
	Cow	4.2	3.1	2.6	
	Overall Median	6	3	7	0.4
	p57- stored 6 months	6	4	4	0.7
MAFF 1994a	**p8**	**6**	**3.5**	**8**	
Archer, 1985	p128;	-	3	7	0.4
Cooke, 1975	p15 - ranges - averages	3-22 6	0.4-9.0 2.3	4-12 6.02	
Dyson, 1992	p5; Fresh cattle	6.5	3.5	8	
Garner, 1957	p23; Bullocks	6	3	8	
Hunter, 1931	p356; Bullock	6.2	2.6	7.2	
	Cow	4.3	1.9	4.4	
	p361 Average	5.3	2.3	5.6	
Moore, 1968	p102; Bullock	5	2	6	
Moore, 1968	p102; Cow	4	1.5	4	
Smith, 1991	p4;	-	3	7	
Weir, 1936	p396 (American);	4.45 - 5	2.85 -3.45	3.6 - 4.8	
Wrightson, c1875	p112 - Fresh	6.43	2.64	5.82	
Wrightson, c1875	p112. - 6 months old	6.06	3.83	4.91	

Consistently fattening cattle tend to produce higher nutrient manure; with nitrogen, the proportion is *c*75-85% for dairy cattle, and 90-95% for beef cattle according to Henzell & Ross, 1973, quoted in Whitehead & Raistrick 1993). If the reader requires, some of the above authors cite the manure of calf, horse, sheep, pig, poultry (hens, ducks, geese), etc. Note the changes in storage occur due to dry matter losses, leaching and ammonia volatilisation.

Survey of hay meadows

Section 1

Site name:	Site area: (ha)
Grid reference: OS	Grassland type: (NVC or equivalent) If site has more than grassland type, please complete additional form and label A,B,C, etc.
Site type (eg SSSI, NNR)	
Date site received statutory protection: (If not received, please state N/A)	Soil type: Predominantly sandy / silty / clay / peaty (delete as necessary)
Drainage: Good / moderate / poor / occasionally floods (delete as necessary)	

1.Has the site ever received agricultural improvement?	**YES/NO**
2a Has lime been applied to the site in the last 12 years?	**YES/NO**
2.b If so, how much please?	
3.a Have any other fertilisers, or flood silt, been applied to the site in the last eight years?	**YES/NO**
3.b If so, which please?	
4. Please give details of any spot or overall treatments for weeds in the last eight years, especially mentioning if this was linked to farmyard manure applications previously?	

Section 2

Please complete all boxes in Section 2, inserting N/A for 'not applicable' and N/I for 'no information'.

PTO

Thank you for your help

Form completed by:	Please return this form to:
Name ..... Address .... Tel:	Richard Jefferson English Nature Northminster House Peterborough PE1 1UA

Section 2 (cont'd)

A. Hay

1.a Please state the usual hay cutting dates OR give actual dates:

1987	1989	1991	1993
1988	1990	1992	1994

b. What limits cutting date? .....

2. Is silage ever taken from the site? YES/NO

3. Please give usual hay yields (per cut) in tonnes/hectare or bales/acre

Cut 1

Cut 2

Please give no. & approx. weight of bales, if known, or bale type, if not stating yield in t/ha. (State units)

4. Please give grazing period dates before/after hay cuts are taken and state stock type(s) and stock numbers at each date of grazing:

Grazing periods	Stock types/breeds at each grazing period	Stock numbers at each grazing period

5. Is the field ever topped by a mower? YES/NO

6. Do the animals eat imported hay, silage, straw or other fodder when producing the manure? YES/NO

7. a. If 'imported' fodder is fed, or imported bedding use, is it weedy? YES/NO

b. If weedy, please state species of weeds found

c. Is imported hay ever fed on the site *in situ*? YES/NO

Section 2 (cont'd)

B. Manure

1. State type of manure applied to the site **since 1 September 1986**

FYM/Slurry/Other (please give details)/**None** (please ring appropriately

2. When was this farmyard manure last applied to the site - including month of application?

3. a. What is the usual period in years between FYM applications?

   b. What limits this?

4. a. What is the usual or most recent rate of FYM applied? (t/ha)

   b. What limits this?

5. Please state type and number of animals producing the manure; and straw quantity and type used for bedding:

   Livestock type (eg suckler cows - Hereford X Friesians) .....

   No. of animals producing manure: .....

   Quantity of straw bedding: ..... (Tonnes)

   Bedding straw type used (eg wheat straw) .....

   Number of days livestock housed: ..... days

6. How long is the FYM stored before spreading? ..... Months

7. Is the FYM stored: Indoors /outdoors / mixture (if so, give proportions)?

8. a. How is the manure applied?

   b. Does the application damage the site and, if so, how?

9. What do the animals eat when producing the manure? (state type and quantity of fodder and supplementation, if possible)

10. a. Has the site soil, hay or farmyard manure ever been analysed? **YES/NO**

    b. If Yes, please give details

Section 2 (cont'd)

C. Changes in the sward

1. a. Have any changes in the vegetation occurred after the application of manure? **YES/NO**

   b. If Yes, please give details:

2. a. Do you plan any management changes, from the answers given above? **YES/NO**

   b. If Yes, please give details:

3. a. Has the site deteriorated or improved since notification or designation?

   Improved/Deteriorated (in terms of species abundance/decline, weed ingress

   b. Why?

4. What differences have you noticed where FYM has not been applied, compared to where it has been used?

5. Please state if rabbits, moles or geese common

6. Please give other comments (attach other information if necessary

Please photocopy if you need additional forms or ask Richard Jefferson at English Nature Head Office for more copies. Thank you for your help.