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INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

INTERIM REPORT TO THE NATURE CONSERVANCY COUNCIL
ON ESTABLISHMENT OF HERB RICH SWARDS
(NCC/NERC CONTRACT NO F3/03/106 : ITE PROJECT NO 242)

T C E WELLS
MONKS WOOD EXPERIMENTAL STATION
ABBOTS RIPTON
HUNTINGDON

MARCH 1978

ESTABLISHMENT OF HERB RICH SWARDS

Report on progress during the year ending March 1978

Introduction

This report describes progress made during the first year of the projected five year investigation into the establishment and re-creation of herb rich swards on clay, alluvial and chalk soils in lowland Britain. It provides details of the grassland species collected during 1977-78 and attempts to make a preliminary analysis of the cost of collecting seed of different species. Results of germination tests made on 38 species stored for periods of up to 58 months are reported and the implications for future seed collection and storage discussed.

1. Seed collection

Fifty-eight species were collected by hand between 15 July and 25 September from 13 sites situated within a 50 mile radius of Monks Wood. The sites are listed in Table 1. A small amount of collecting was also done from roadside verges in Cambridgeshire, particularly of species such as Geranium pratense which was more abundant on verges than elsewhere. Unlike 1976, weather conditions during 1977 were unfavourable for seed collecting, the frequent, light showers of rain making the vegetation wet and also destroying much good seed which was ready for collection. Heavy wind, combined with rain, often caused the seed to shed when just ripe and for this reason alone, large quantities of Hordeum secalinum and Sanguisorba officinalis were lost. Despite these problems, 5088 gm of seed were collected, cleaned and prepared for storage (Table 2).

2. Seed cleaning

The same methods of cleaning the seed were used as described in last year's report. In all cases, a combination of sieving and blowing techniques were used, details for individual species being given in Table 2. Improvements in cleaning were made by altering the setting on the 'seed aspirator' and these new settings should be used in future.

3. Seed storage

Considerable progress was made this year in improving methods of storing seed. This should enable viability to be maintained for long periods. As was noted

previously, the two main conditions for retaining viability during storage are (a) low relative humidities and (b) low temperatures.

Experience this year has shown that seed can be effectively dried by placing it in a desiccator over silica gel for a period of 2-3 weeks, during which time, the desiccant may have to be changed once. Following this treatment, the samples of seed are placed in plastic containers over silica gel and the lids are sealed with tape. The small containers are placed inside larger containers for ease of handling and are stored at c. 2°C in a domestic refrigerator. Six months after storage, the seed is still dry and in perfect condition, with no evidence of fungal attack. Germination of four 'test' species has been excellent (> 90%).

4. Germination of seed stored for up to 5 years in dry conditions but at fluctuating room temperatures

Seeds, collected at intervals since 1972, stored in plastic boxes in an outside building (not centrally heated) were sampled at intervals of approximately a year and their germination tested in standard tests at either constant temperatures of 10°C and 20°C or at fluctuating temperatures of 10/5, 10/20, 15/5 or 15/20°C (16 hr day, 8 hr night). The results of these tests are summarised in Table 3. They provide a guide as to the ability of different species to retain their viability under storage conditions which, although far from ideal, are likely to be the only ones available at centres which do not specialise in seed work. The species may be divided into 4 groups:

1. Species which lose their viability completely after storage for periods of less than 54 months (the time when all viability is lost is given in brackets).

Campanula rotundifolia (54 months)
Centaurea nigra (c. 30 months)
Filipendula ulmaria (c. 30 months)
F. vulgaris (c. 30 months)
Hordeum secalinum (c. 15 months)
Leontodon autumnalis (c. 54 months)
Pimpinella saxifraga (c. 15 months)
Ranunculus acris (c. 15 months)
Sanguisorba officinalis (c. 15 months)
Scabiosa columbaria (c. 15 months)

2. Species whose viability decreased with storage, but which still retained some germination after 54 months

Achillea millefolium
Anthoxanthum odoratum
Chrysanthemum leucanthemum
Galium verum
Helianthemum chamaecistus
Poterium sanguisorba
Prunella vulgaris
Pulicaria dysenterica

3. Species which failed to germinate at any time
 Probably require special conditions (such as a cold treatment or a cycle of fluctuating temperatures) for germination, or seed infertile.

Agrimonia eupatoria
Clinopodium vulgare
Conopodium majus
Euphrasia nemorosa
Gentianella amarella
 *Linum catharticum
Silaum silaus

* 1% germination in 2 tests

4. Species which increased their percentage germination with storage for up to 58 months

Carex flacca
Geranium pratense
Lotus corniculatus
Lychnis flos-cuculii
Medicago lupulina
Onobrychis viciifolia
Vicia cracca

Species in this group vary from those such as Carex flacca, which show no germination at all until more than 30 months old, to others, such as the legumes, which have a low percentage germination soon after harvest but which increases with age. All species in this group require some after ripening, presumably because of an immature embryo or because of the presence of inhibitors. Previous experiments with the legumes have shown that abrading the seed coat enhances germination, but this is not the case with Carex flacca or Lychnis, and with these latter species it seems that some after ripening is necessary.

The practical implications of these results are clear. Some seeds can be stored in conditions far from ideal yet still retain their viability, while others soon die. Where facilities for seed storage are lacking, either all seed collected must be sown in the same year of collection, or where this is not possible, only those species which retain their viability should be collected. Furthermore, when recommending seeds mixtures to local authorities and others for sowing in 'amenity areas', species which do not germinate in the first year should either be omitted, or the 'customer' told that the species will not be seen in the mixture in the first year. This will avoid at least disappointing the customer or, at worst, avoiding the innuendo that the customer had been misled.

5. Cost of Seed

The relative cost of seed of different species is likely to be the most important single factor in determining which species are included in 'wild flower mixtures'. As far as I am aware, there are no data on the cost of collecting wild flower seed - the only information on relative costs is contained in price lists of wild flower mixtures or single species contained in catalogues provided by commercial firms. For example, B. and S. Weed Seed Suppliers offer Hordeum secalinum and Rhinanthus minor at £56 per kg, Ranunculus acris at £64 per kg and Senecio vulgaris at £800 per kg. Mommersteeg's and British Seed Houses price "wild flora" mixtures containing 10-15 species at about £20 per kg. In contrast, the average price of agricultural grasses and turf grasses is only between 50p and £1.20 per kg.

In an attempt to obtain an estimate of the cost of collecting seed from 'wild' populations, a note was made of the time taken to collect seed of individual species during 1977. Knowing the time taken to collect a given quantity of seed, the cost of collecting and processing was calculated as £2.7 per hr using the following assumptions:-

- (1) Wages of seed-collector are £50 per $37\frac{1}{2}$ hour week.
- (2) Time taken for processing the seed and storing it is about equal to the time taken for collection.
- (3) No overheads are charged.

The estimated cost of collecting and processing 1 kg of each of 50 species is shown in Table 4. Data are arranged in £100 classes for convenience.

The data presented in this table gives a rough guide to the cost of seed of different species, but should be treated with caution for the following reasons:

- (a) 1977 was a difficult season for seed collection because of indifferent weather,
- (b) the calculation depends on the amount of seed collected in a given time. If extensive stands of the same species can be found, and visited when seed is ripe, the amount of seed collected is likely to be high, and the cost therefore would become lower,
- (c) in some cases, very small samples have been included, so any error factor is multiplied many times.

On the other hand, the sites chosen for seed collection were already known to previous collectors, and little time was 'wasted' in searching for new sites. Although the precise cost per kg will vary, the order of magnitude for the different species, agrees reasonably well with the price quoted by Augusta Product Developments Ltd, the main suppliers of "wild flora" seeds in this country. For example, Primula veris, Helianthemum chamaecistus, Leontodon autumnalis and Plantago media are priced at £500, £250, £700 and £120 per kg by Augusta, while my estimates are £110.188, £166, £339 and £124 per kg respectively.

Since the weight of seeds of individual grassland species varies considerably (Table 5) it could be argued that the most meaningful comparison to make, would be the cost of the same number of seed, since it is usual to attempt to sow a given number of seed per unit area of land. This approach is used in Table 6, which shows the estimated cost of 1,000 seed of each of 45 species, using the data in Table 4 as a basis.

Conclusions

1. The cost of collecting, cleaning and storing seed obtained from wild populations is high compared with agricultural grass mixtures.
2. Means of reducing costs which require investigation are (i) growing species in single species stands on a small plot basis and (ii) growing species

under glasshouse conditions. Both methods are being investigated and results will be available in 2 years time.

3. Because seed of 'wild flora' is expensive, seed rates recommended for amenity grass/herb mixtures will certainly be lower than the rates currently used in turf grass situations or in agriculture. It seems likely that the amount of herbs used in amenity mixtures will have to be small and research is needed to find strains of non-aggressive grasses which are compatible with the less competitive herb mixtures.

Table 1. Sites from which seed was collected during 1977, with an indication of those species which were especially abundant and easily collected

1. Abbots Ripton railway embankment, Cambs 52/217795
Centaurea nigra, Chrysanthemum leucanthemum
2. Barnack Hills and Hole, Cambs 53/075045
3. Barton Hills, Beds 52/094300
Zerna erecta
4. Castor Meadows, Cambs 52/124978
Lychnis flos-cuculi, Sanguisorba officinalis
5. Knocking Hoe MNR, Beds 52/132306
Crepis capillaris, Helianthemum chamaecistus, Hypochoeris maculata,
Leontodon hispidus, Poterium sanguisorba, Thymus pulegioides, Briza
media, Helictotrichon pratense, Koeleria gracilis, Trisetum
flavescens, Zerna erecta
6. Lolham Bridges, Cambs 53/110069
Geranium pratense
7. Monks Wood, Cambs 52/200300
Prunella vulgaris
8. Peakirk, Cambs 53/168061
Medicago lupulina
9. Stanford PTA, Suffolk 52/893900
Hypochoeris radicata
10. Sutton Heath, Cambs 53/085003
Ranunculus acris, R. bulbosus
11. Totternhoe Knolls, Beds 42/978223
Anthyllis vulneraria, Lotus corniculatus, Linum catharticum, Onobrychis
viciifolia, Primula veris, Prunella vulgaris, Rhinanthus minor, Thymus
pulegioides
12. Upwood, Cambs 52/252825
Cerastium holosteoides, Ranunculus acris, R. bulbosus, Sanguisorba
officinalis, Alopecurus pratensis, Holcus lanatus, Hordeum secalinum,
Trisetum flavescens
13. Woodwalton Marsh, Cambs 52/213810
Rhinanthus minor, Trifolium campestre, Anthoxanthum odoratum,
Carex flacca

Table 2. List of 58 grassland species collected during 1977, with details of method of cleaning.

<u>Species</u>	<u>Amount collected (gm)</u>	<u>Date collected</u>	<u>Method of cleaning</u>
<i>Agrimonia eupatoria</i>		12 Sept	
<i>Alopecurus pratensis</i>	403.0	25 July -- 1 Aug	Whole inflorescences picked, shattered by hand
<i>Anthyllis vulneraria</i> (1)	232.0	4--23 Aug	None
(2)	119.0	Nov 1977	None. Grow at Bush, Edinburgh
<i>Asperula cynanchica</i>	0.08	16 Sept	Rubbed, blown at 4
<i>Betonica officinalis</i>	2.28	12 Sept	Chaff picked by hand, blown at 4
<i>Blackstonia perfoliata</i>	2.85	20 Sept	Capsules picked off stalks, crushed. Sieved on .35 mesh, not blown (seed too small)
<i>Briza media</i> (1)	26.63	27 July	Blown at 2
(2)	13.21	25--26 July	Blown at 2
<i>Campanula glomerata</i>	0.46	15 Sept	Capsules rubbed to remove seed. Sieved to remove large chaff. Blown at 3. Insect damage to capsules.
<i>Campanula rotundifolia</i>	2.18	13--16 Sept	As for <i>C. glomerata</i> . Much weevil damage to capsules.
<i>Carex flacca</i>	40.5	26 July -- 2 Aug	Passed through 1.4 mm sieve. Blown at 3.
<i>Centaurea nigra</i>	14.37	30 Aug -- 15 Sept	Whole heads picked, dried in trays. Rubbed, blown at 5.
<i>Centaurea scabiosa</i>	36.42	13--14 Sept	Blown at 3, plus hand picking of large detritus.
<i>Cerastium holosteoides</i>	1.81	1 Aug	Whole heads picked. Shaken to release seeds. Blown at 3.
<i>Chrysanthemum leucanthemum</i> (1)	69.74	28 July	Individual heads picked, crushed by hand. Sieved using 1 mm--3.35 mm sieve, blown at 3.
(2)	496.0	Aug	Grown at Bush. This is the yield from 30 plants.

<i>Cirsium acaule</i>	4.11	13 Sept	Hand pulled, pappus rubbed off. Blown at 5.
<i>Crepis capillaris</i> (1)	0.11	12 Sept	Pappus rubbed off, blown at 2 and 3
(2)	0.40	29 July	
<i>Daucus carota</i> (1)	103.0	12 Sept	Heads rubbed, seed passed through 2mm and 1 mm sieves. Block for 1 min at 3.
(2)	369.0	Oct) Collected from individually spaced plants grown at Bush.
(3)	84.0	Oct	
<i>Festuca rubra</i> (1)	17.0	Sept	Grown at Bush. Yield of 5 plants.
(2)	51.0	Sept	Grown at Bush. Yield of 5 plants.
<i>Filipendula vulgaris</i> (1)	6.08	12 Sept	Fruiting heads rubbed into box, sieved, blown at 3.
(2)	13.35	15,16 Sept	Fruiting heads rubbed into box, sieved, blown at 3.
<i>Galium verum</i> (1)	0.06	12 Sept	Fruits rubbed, blown at 3. Grown at Bush. Yield from 25 plants.
(2)	145.0	Sept	
<i>Geranium pratense</i> (1)	5.19	25 Aug) Capsule broken by hand.) Sieved (3.35 mm). Rubbed) and blown at 11.
(2)	12.05	2-22 Aug	
<i>Helianthemum chamaecistus</i>	81.28	29 July -- 3 Aug	Fruit capsules crushed by hand, sieved (1.44 mm). Blown at 7 for 1 minute.
<i>Heracleum sphondylium</i>	1.37	12 Sept	Sieved to remove dirt.
<i>Hordeum secalinum</i>	14.18	30 Aug	Broken by hand.
<i>Hypochoeris maculata</i>	6.19	27 July	Crushed, shaken to separate seed from pappus. Blown at 5-6.
<i>Hypochoeris radicata</i>	18.80	26 July	Shaken. Blown at 5. Repeated four times.
<i>Koeleria cristata</i>	1.76	4 Aug	Blown at 2.
<i>Lapsana communis</i>	50.26	2 Aug	Sieved (1.4 mm).
<i>Lathyrus pratensis</i>	4 seeds	12 Sept	
<i>Leontodon autumnalis</i>	2.00	12 Sept	Pappus rubbed off, blown at 4.
<i>Leontodon hispidus</i> (1)	11.68	27 July -- 3 Aug	Pappus rubbed off. Blown at 4.
(2)	0.36	12 Sept	

<i>Linum catharticum</i> (1)	0.94	23 Aug	Crushed, sieved (1.00 mm). Blown at 3.
(2)	0.25	5 Aug	Crushed, sieved (1.00 mm). Blown at 3.
<i>Lotus corniculatus</i> (1)	10.72	14-15 Sept	Pods split by hand, rubbed together. Sieved (2 mm).
(2)	6.48	23-26 Aug	Blown at 8.
<i>Lychnis flos-cuculi</i>	15.45	28 July	Seed shaken from capsules, sieved (1 mm). Blown at 3.
<i>Medicago lupulina</i> (1)	26.55	2-5 Aug	None
(2)	86.30	25 Aug	None
<i>Melandrium album</i>	53.24	25 Aug	Blown at 5.
<i>Onobrychis viciifolia</i> (1)	52.4	23-26 Aug	None
(2)	38.99	24 Aug - 15 Sept	None
<i>Picris hieracioides</i>	0.78	16 Sept	Pappus rubbed off, blown at 4.
<i>Pimpinella saxifraga</i>	0.29	15 Sept	Ripe fruits rubbed off, blown at 3.
<i>Plantago lanceolata</i> (1)	1.06	13 Sept	Crushed, sieved (1.4 mm). Blown at 8.
(2)	30.82	30 Aug	Crushed, sieved (1.4 mm). Blown at 11.
(3)	13.92	5 Aug	Crushed, sieved (1.4 mm). Blown at 11.
<i>Plantago media</i>	50.75	13-15 Sept	Heads rubbed between hands, sieved. Blown at 4.
<i>Poterium sanguisorba</i> (1)	0.40	29 July	Blown at 4-5.
(2)	177.0	Aug	Grown at Bush as spaced plants, yield from 17 plants.
<i>Primula veris</i> (1)	3.58	14-15 Sept	Rubbed out of capsules.
(2)	7.72	1-22 Aug	Sieved to remove large chaff. Blown at 5.
(3)	24.39	23 Aug	Sieved (1.4 and 2.0 mm). Blown at 6.
(4)	680	Aug	Grown at Bush, from 100 plants.
<i>Prunella vulgaris</i> (1)	4.79	30 Aug	Sieved (1.4 mm). Blown at 4.
(2)	5.98	22 Aug) Crushed, sieved (1.4 mm).
(3)	8.87	2 Sept) Blown at 4.
(4)	5.44	24 Aug)
(5)	648.00	Aug	Grown at Bush. Yield from 39 single-spaced plants.

Ranunculus sp. (1)	1.76	2 Aug	Blown at 4
(2)	4.52	28 July	Blown at 4
(3)	20.69	25 July - 1 Aug	Blown at 4
Reseda lutea	0.91		Shaken, rubbed to remove seed. Sieved (1.4 mm).
Reseda luteola	18.10	16 Sept	Dried inflorescences rubbed, shaken, sieved. Blown at 4.
Rhinanthus minor (1)	28.00	26 July - 2 Aug	Shaken from capsules. Blown at 3.
(2)	70.55	4-23 Aug	Blown at 3-4.
Rumex acetosa (1)	29.85	30 Aug	None
(2)	107.57	1 Sept	None
Sanguisorba officinalis (1)	3.8	30 Aug	Crushed by hand, blown at 4.
(2)	0.98	1 Sept	Sieved (2 mm). Blown at 4.
Scabiosa columbaria	35.21	13-15 Sept	Blown at 4.
Silaum silaus	7.98	12 Sept - 30 Aug	Sieved (1 mm).
Thymus pulegioides (1)	0.01	16 Sept	Rubbed, blown at 3.
(2)	0.72	26 Aug	Rubbed, blown at 3.
Tragopogon pratensis (1)	0.37	12 Sept	Pappus broken off by hand.
(2)	2.17	29 July	Blown at 4.
(3)	20.25	2 Aug	Pappus rubbed off. Blown at 4.
Trifolium campestre	1.67	2-22 Aug	?
Trisetum flavescens	11.93	30 Aug	Hand rubbed.
Vicia angustifolia	1.67	2 Aug	Passed through 3.35 mm sieve.
Vicia hirsuta	0.36	12 Sept	Pods split by hand.
Zerna erecta	306.0	27 July	Shaken vigorously into plastic bag.

Table 3. Effect of storage on mean percentage germination of 38 grassland species stored for up to 58 months.

Age of seed (months)	3-7	11-15	27-30	48-58	3-7	11-15	27-30	48-58
Test conditions	10°C	10/5°C	10/5°C	10/20°C	20°C	15/5°C	15/5°C	15/20°C
<i>Achillea millefolium</i>	ND	79	ND	15	ND	79	ND	15
<i>Agrimonia eupatoria</i>	ND	ND	ND	1	ND	ND	ND	0
<i>Agrostis stolonifera</i>	ND	ND	ND	26	ND	ND	ND	31
<i>Anthoxanthum odoratum</i>	30	13	11	6	28	10	16	13
<i>Campnula rotundifolia</i>	ND	16	ND	0	89	43	ND	1
<i>Carex flacca</i>	0	0	0	54	1	1	3	44
<i>Centaurea nigra</i>	ND	2	4	0	94	44	13	0
<i>Chrysanthemum leucanthemum</i>	95	81	1	65	95	97	2	58
<i>Clinopodium vulgare</i>	ND	ND	ND	0	ND	ND	ND	0
<i>Conopodium majus</i>	0	0	0	0	0	0	0	0
<i>Dianthus armeria*</i>	ND	ND	ND	97	ND	ND	ND	97
<i>Euphrasia nemorosa</i>	0	0	0	0	0	0	0	0
<i>Filipendula ulmaria</i>	ND	ND	13	0	ND	ND	45	0
<i>F. vulgaris</i>	85	29	0	0	86	58	2	0
<i>Galium verum</i>	40	24	2	7	93	60	32	2
<i>Gentianella amarella</i>	0	0	0	0	0	0	0	0
<i>Geranium pratense</i>	ND	4	5	7	ND	8	10	18
<i>Helianthemum chamaecistus</i>	13	4	11	2	8	8	3	2
<i>Hordeum secalinum</i>	ND	52	0	0	ND	43	ND	0
<i>Leontodon autumnalis</i>	3	6	1	0	85	9	3	0
<i>Linum catharticum</i>	0	0	0	0	1	1	0	0
<i>Lotus corniculatus</i>	26	17	8	43	20	19	2	55
<i>Luzula campestris</i>	ND	ND	ND	5	ND	ND	ND	9
<i>Lychnis flos-cuculii</i>	1	0	1	66	11	93	34	64
<i>Medicago lupulina</i>	ND	ND	19	90	ND	ND	11	85
<i>Onobrychis viciifolia</i>	ND	30	39	71	ND	39	42	91
<i>Ononis spinosa</i>	ND	ND	ND	61	ND	ND	ND	50
<i>Pimpinella saxifraga</i>	2	4	0	0	12	2	0	0
<i>Plantago media</i>	ND	0	2	8	ND	7	1	17
<i>Poterium sanguisorba</i>	46	28	26	0	82	50	37	3
<i>Prunella vulgaris</i>	ND	0	ND	1	94	17	ND	2
<i>Pulicaria dysenterica</i>	ND	ND	5	2	ND	ND	23	2
<i>Ranunculus acris</i>	ND	32	ND	0	ND	10	ND	0
<i>Sanguisorba officinalis</i>	2	7	0	0	31	10	ND	0
<i>Scabiosa columbaria</i>	58	5	ND	0	84	5	ND	0
<i>Serratula tinctoria</i>	ND	ND	ND	1	ND	ND	ND	6
<i>Silvaum silaus</i>	ND	ND	0	0	ND	ND	0	0
<i>Vicia cracca</i>	11	ND	ND	47	11	ND	ND	41

* seed 97 months old

ND = no data

Table 4. Estimated cost of collecting, cleaning, labelling, indexing and storing 1 kg of each of 50 species from 'wild' populations

<u>£ < 100</u>	<u>£</u>	<u>£400-500</u>	<u>£</u>
Zerna erecta	2	Campanula glomerata	464
Rumex acetosa	2-7	Lychnis flos-cuculii	437
Plantago lanceolata	7-97		
Melandrium album	13		
Onobrychis viciifolia	13-52	<u>£500-600</u>	
Medicago lupulina	23-152	Koeleria cristata	506
Chrysanthemum leucanthemum	29-34	Leontodon hispidus	525-583
Anthyllis vulneraria	29	Picris hieracioides	573
Alopecurus pratensis	30		
Reseda luteola	37		
Hypochoeris radicata	47	<u>£600-800</u>	
Hordeum secalinum	47	Vicia hirsuta	617
Daucus carota	52	Cirsium acaulon	657
Rhinanthus minor	57-241	Cerastium holosteoides	749
Centaurea nigra	61-94	Reseda lutea	742
Filipendula vulgaris	67-221		
Tragopogon pratensis	67-584		
Blackstonia perfoliata	75	<u>More than £1,000</u>	
		Inum catharticum	c. 1,400-3,500
<u>£100-200</u>		Thymus pulegioides	c. 1,875
Prunella vulgaris	100-248	Crepis capillaris	c. 2,227
Lotus corniculatus	104-629	Campanula rotundifolia	4,933
Scabiosa columbaria	119		
Vicia angustifolia	129		
Plantago media	124		
Primula veris	110-188		
Ranunculus spp.	130-767		
Carex flacca	133		
Centaurea scabiosa	160		
Helianthemum chamaecistus	166		
Silaum silaus	169		
Geranium pratense	171-168		
Sanguisorba officinalis	176-532		
<u>£200-300</u>			
Hypochoeris maculata	218		
Trisetum flavescens	226		
Briza media	253-511		
Trifolium campestre	268		
Betonica officinalis	296		
<u>£300-400</u>			
Leontodon autumnalis	339		

Table 5. Live seed weight (mg) of 80 grassland species, estimated by weighing 5 samples of 20 seeds or fruits. Only undamaged seed used.

Species	Wt. of 1 seed or fruit (mg)	No. of seeds or fruits in 1 gm
<i>Alopecurus pratensis</i>	0.50	2,000
<i>Angelica sylvestris</i>	1.44	694
<i>Anthoxanthum odoratum</i>	0.39	2,564
<i>Anthyllis vulneraria</i>	3.59	278
<i>Betonica officinalis</i>	1.70	588
<i>Briza media</i>	0.51	1,961
<i>Campanula glomerata</i>	0.18	5,555
<i>Campanula rotundifolia</i>	0.067	14,925
<i>Carex demissa</i>	0.80	
<i>Carex flacca</i>	0.905	1,104
<i>Carex hirta</i>	0.346	289
<i>Carex otrubae</i>	1.13	884
<i>Carex ovalis</i>	0.68	1,470
<i>Carex panicea</i>	2.50	400
<i>Carex pendula</i>	0.84	1,190
<i>Carex spicata</i>	2.10	476
<i>Carlina vulgaris</i>	1.03	9,708
<i>Centaurea nigra</i>	2.02	500
<i>Centaurea scabiosa</i>	7.41	134
<i>Centaurea erythrea</i>	v. low	
<i>Chrysanthemum leucanthemum</i>	0.342	2,924
<i>Cerastium holosteoides</i>	0.19	5,263
<i>Cirsium acaulon</i>	5.06	197
<i>Clinopodium vulgare</i>	0.417	2,398
<i>Conopodium majus</i>	2.35	425
<i>Crepis capillaris</i>	0.145	6,896
<i>Dactylis glomerata</i>	0.97	1,111
<i>Daucus carota</i>	0.92	1,088
<i>Euphrasia nemorosa</i>	0.013	7,352
<i>Festuca rubra</i>	0.133	754
<i>Filipendula vulgaris</i>	1,149	870
<i>Galium verum</i>	0.628	1,592
<i>Gentianella amarella</i>	0.153	6,335
<i>Geranium pratense</i>	7.80	128
<i>Helianthemum chamaecistus</i>	1.323	755
<i>Hieracium pilosella</i>	0.152	6,578
<i>Hippocrepis comosa</i>	3.785	264
<i>Hypochoeris maculata</i>	1.75	571
<i>Hypochoeris radicata</i>	0.80	1,250
<i>Knautia arvensis</i>	7.28	137
<i>Koeleria cristata</i>	0.196	5,102
<i>Lathyrus pratensis</i>	9.10	109
<i>Leontodon hispidus</i>	1.087	919
<i>Leontodon autumnalis</i>	1.02	1,063
<i>Linum catharticum</i>	0.191	5,249
<i>Lotus corniculatus</i>	1.536	651
<i>Lychnis flos cuculii</i>	0.181	5,509
<i>Medicago lupulina</i>	2.078	481
<i>Melandrium album</i>	1.215	826
<i>Onobrychis viciifolia</i>	14.109	70
<i>Ononis spinosa</i>	5.387	169

<i>Pimpinella saxifraga</i>	1.318	758
<i>Plantago lanceolata</i>	2.633	379
<i>Plantago media</i>	0.492	2,032
<i>Potentilla erecta</i>	0.55	1,818
<i>Poterium sanguisorba</i>	4.56	219
<i>Primula veris</i>	0.92	1,111
<i>Prinella vulgaris</i>	1.058	945
<i>Ranunculus acris</i>	2.12	471
<i>Ranunculus repens</i>	2.35	425
<i>Reseda lutea</i>	0.73	1,369
<i>Reseda luteola</i>	0.23	4,347
<i>Rhinanthus minor</i>	3.71	269
<i>Rumex acetosa</i>	2.547	392
<i>Sanguisorba officinalis</i>	3.11	321
<i>Scabiosa columbaria</i>	1.36	735
<i>Silaum silaus</i>	2.108	474
<i>Stellaria media</i>	0.21	4,761
<i>Stellaria graminea</i>	0.20	5,000
<i>Succisa pratensis</i>	1.218	820
<i>Thalictrum flavum</i>	0.948	1,055
<i>Thymus drucei</i>	0.1585	6,451
<i>Thymus pulegioides</i>	0.15	6,666
<i>Tragopogon pratense</i>	7.10	140
<i>Trifolium pratense</i>	1.492	670
<i>Trisetum flavescens</i>	0.172	5,797
<i>Veronica chamaedrys</i>	0.199	5,012
<i>Vicia angustifolia</i>	8.994	111
<i>Vicia cracca</i>	14.00	71
<i>Zerna erecta</i>	5.94	168

Table 6. Estimated cost of 1,000 seed, using as basis for calculation the costs calculated for the collection, storage, cleaning etc. of seed and the weight of 1 seed.

<u>Species</u>	£
Reseda luteola	0.0085
Chrysanthemum leucanthemum	0.0099-0.0116
Rumex acetosa	0.0179
Melandrium album	0.0179
Zerna erecta	0.0119
Plantago lanceolata	0.0185-0.2559
Alopecurus pratensis	0.0180
Trisetum flavescens	0.0390
Hypochoeris radicata	0.0397
Medicago lupulina	0.0478
Daucus carota	0.0478
Plantago media	0.061
Lychnis flos-cuculii	0.0793
Campanula glomerata	0.0835
Primula veris	0.0990-0.1692
Filipendula vulgaris	0.0770-0.2540
Koeleria cristata	0.0992
Prunella vulgaris	0.1058-0.2624
Carex flacca	0.1205
Centaurea nigra	0.1220-0.1880
Anthyllis vulneraria	0.104
Briza media	0.1290
Rhinanthus minor	0.2119
Lotus corniculatus	0.1598-0.966
Scabiosa columbaria	0.1619
Onobrychis viciifolia	0.1857-0.7429
Helianthemum chamaecistus	0.2199
Cerastium holosteioides	0.1433
Linum catharticum	0.2667-0.668
Ranunculus spp.	0.276-1.62
Leontodon autumnalis	0.3189
Thymus pulegioides	0.2907
Crepis capillaris	0.3229
Campanula rotundifolia	0.3305
Silaum silaus	0.356
Trifolium campestre	0.40
Hypochoeris maculata	0.3818
Betonica officinalis	0.5034
Sanguisorba officinalis	0.548-1.65
Leontodon hispidus	0.571
Reseda lutea	0.5420
Tragopogon pratensis	0.5360-4.67
Vicia angustifolia	1.16
Centaurea scabiosa	1.19
Geranium pratense	1.33-1.31

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