RESEARCH REVIEW OF FORAGE PRODUCTION

Bowley

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Introduction

Most of the data presented here has appeared in annual reports on forage crop production that date back to 1949. The data within each section is presented in more or less the progressive order that the research was conducted. Hopefully, the information may serve as background material for future research and possibly may be of use for teaching and extension in forage crops.

In many cases, two or three year averages are presented with no analysis of variance information shown because most studies were not analysed over years. Individual year analysis will be found in old reports. The data is also generally presented in the English form because of old summaries and the usefulness of that form for farm meetings.

No attempt has been made to summarize all the research findings or all the studies conducted. On the contrary, only those which were felt might be useful have been included.

The late Professor Robert Keegan would chuckle and call this a summary of "forty years in the wilderness"; however, my tenure has only been thirty-seven years. During those years, it was my good fortune to have worked in a stimulating environment of hard working faculty, technicians and research station personnel. One person has worked with me for thirty-four years and my gratitude goes out to him, David E. Clarke, for our happy association, and indeed to all.

R.S. Fulkerson
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PURE STAND, MIXTURE, QUALITY SECTION

Forage species and mixtures have been evaluated periodically for yield performance since the department was first formed. More recently, some evaluations have been enlarged to include an estimate of forage quality.

Species and mixtures were assessed quite extensively during 1940 - 50 era to sort out the most productive species and their best mixture combinations. Recently, some simple mixtures are again being appraised with the objective or reducing the grass content.

During the past forty years, many new species such as birdsfoot trefoil, crown vetch, tall and red fescue, etc., have found a place in pastures and problem areas in this province. No new species, however, have made any significant inroad into the stored feed acreage. Because forages are frequently stored as silages and their role in livestock rations have changed considerably during the past decade or so, it appears that it is again time to re-evaluate some species. Crops like tall fescue, tall oatgrass, red and sweet clover, and newly developed species from ryegrass - fescue crosses should be assessed for their stored feed potential.

Many forage species and mixture combinations have been evaluated for hay yield. The data presented here, however, are only from those studies that helped clarify the role of forages and served as the basis of some forage recommendations in the province. Details can be found in previous reports.

Table 1. Species-mixture evaluation, D.M./lbs./ac., 3 year mean

Association	Hay cut 1	Aftermaths total - 2	Total DM	% Legume cut 1/yr 3
Timothy (Tim)	4200	700	4900	
Orchard (Or)	3120	1020	4140	
Brome (Br)	2720	900	3620	
Meadowfescue (MF)	3260	620	3880	
Reed canary (RC)	2440	1100	3540	
Alfalfa (Alf)	4600	3420	8020	
Ladino (Lad)	2520	1780	4300	
Alf + Tim	5520	3080	8600	32
Alf + Or	5180	3240	8400	35
Alf + Br	4980	3260	8240	50
Alf + MF	5520	3700	9200	50
Alf + RC	4920	3300	8220	48
Lad + Tim	4700	2040	6740	14
Lad + Or	4400	2500	6900	12
Lad + Br	4040	2000	6040	5
Lad + MF	4340	2200	6540	16
Lad + RC	4340	2180	6520	15
Alf + Lad + Tim	5020	3060	8060	30
Alf + Lad + Or	4960	2920	7880	28
Alf + Lad + Br	4560	3140	7680	26
Alf + Lad + Tim + Or	5100	2720	7820	19
Alf + Lad + Tim + Br	5480	3300	8780	46
Alf + Lad + Or + Br	4840	2780	7620	22
Alf + Lad + Tim + Or + Br	5340	3320	8660	40
Alf + Lad + Tim + Or + Br + MF	5500	2760	8260	22
L.S.D. 0.05	640	—	1060	
C.V.	14.4	—	11.4	

1 - no nitrogen applied to grasses

Nitrogen was not applied to grasses hence the modest yields. More recent studies indicate that nitrogen applications would at least double such yields. Indeed, with reed canary grass, moderate nitrogen rates increased annual dry matter yields to 6 - 7 tons per acre.

Simple combinations with alfalfa were particularily interesting; the meadow fescue + alfalfa yielded the highest every year and may now be useful for silage.

Complex mixtures generally provided reduced yields and lower legume contents.

Comparison of Red and Ladino Clovers in Hay-Pasture Mixes

Red and ladino clovers are frequently grown in alfalfa and grass mixtures. They are more adapted to variable drainage than alfalfa, and ladino is useful where aftermaths are pastured. Some of the data of the mixture combinations reported in the 1955-57 reports are presented here.

Table 2. Red-ladino clover mixture comparisons, D.M./lbs/ac, 2 year mean

Mixture	June hay				Aftermaths (2)				Total	Alf plants/ sq.ft.[1]	
	DM	% alf	% red	% lad	DM	% alf	% red	% lad	DM	May	Oct.
Red + tim	5240	—	32	—	1200	—	53	—	6440	—	—
Red + alf + tim	5480	19	26	—	2260	63	21	—	7740	—	—
Red + alf + tim + orch	4740	20	30	—	2360	42	15	—	7100	—	—
Red + alf + tim + brome	5560	19	30	—	2380	62	20	—	7940	3.8	3.2
Lad + alf + tim + orch	4800	6	—	22	2700	18	—	31	7500	—	—
Lad + alf + tim + brome	5320	7	—	24	2380	29	—	40	7700	1.6	1.4
Red + alf + lad + tim + orch	5180	9	13	14	2600	25	6	22	7780	—	—
Red + alf + lad + tim + brome	5520	7	9	14	2280	41	6	27	7800	2.7	2.0
Red + alf + lad + tim + orch + brome	5020	13	8	14	2540	27	6	21	7560	2.1	1.7

1 - in second production year

Red clover suppressed the alfalfa and conbributed more to the first cut yield than alfalfa; however, ladino suppressed alfalfa more than red clover including the aftermaths. Ladino also suppressed alfalfa stands more than red clover.

Growth Curve of Some Forage Species

Two varieties each of four species were grown in three separate studies to determine the effect of advancing maturity on the yield and quality of the forage. The data for only one variety of each species is presented. The information obtained from these rather extensive experiments have been the basis for much of the forage harvest management and quality recommendations in Ontario.

Table 3. The effect of advancing maturity on the DM yield (kg/ha) and quality of four species averaged over three years

Cut date	Vernal alfalfa			Climax timothy			Frode orchardgrass			Saratoga bromegrass		
±1	DM	% IVD	% CP	DM	% IVD	% CP	DM	% IVD	% CP	DM	% IVD	% CP
A. Date basis												
May 7	195	74.5	32.3	543	81.1	26.2	535	76.4	28.0	970	79.4	27.4
May 14	739	74.0	32.0	1035	79.7	23.0	1099	75.0	23.2	1605	79.6	22.4
May 22	1653	77.4	27.1	2177	79.7	17.1	2016	76.4	16.0	2961	77.9	17.1
May 28	2384	78.0	24.1	2975	79.1	14.6	2849	76.0	13.0	3759	78.4	14.2
June 4	3399	74.3	22.3	4190	74.9	12.5	4008	72.0	10.8	5146	73.8	11.6
June 11	4442	68.7	20.3	5315	70.9	10.3	4627	65.0	9.2	5948	67.2	9.3
June 18	5146	67.5	18.8	6057	67.2	9.5	4997	61.9	8.4	6940	64.0	8.5
June 25	5911	64.8	17.4	7031	62.0	8.6	5473	56.9	7.5	7589	60.6	7.1
July 3	6499	63.1	16.1	7541	57.5	7.5	5570	53.5	6.9	7882	60.7	6.5
July 9	7113	61.8	15.8	8363	56.0	6.7	5760	52.4	6.6	8618	60.6	5.9
July 11	7220	58.5	14.4	8437	54.2	5.9	5707	49.7	6.1	9014	59.8	5.4
July 23	6815	57.6	14.4	8563	51.4	5.7	5185	46.3	6.2	8626	58.3	5.0
LSD's 0.05 for dates x varieties x species - DM yield, 599 kg/ha; crude protein, 1.2; IVD content, 1.8.												
B. Stage growth basis*												
Boot	4124	70.6	20.8	5181	70.9	10.6	2874	74.7	13.3	4225	75.1	13.4
Heading	5788	65.9	17.7	6593	64.1	8.9	3911	71.2	11.0	5861	69.1	10.0
Flower	6159	63.0	16.7	8212	56.9	6.9	5115	61.3	8.2	8164	59.4	6.7
Early seed	7135	60.1	15.6	8602	53.1	5.7	5958	51.8	6.6	8307	59.7	5.8
LSD's 0.05 for stages x varieties x species - DM yield, 526 kg/ha; crude protein content, 1.0; IVD content, 1.7												

* Alfalfa - medium bud, very first flower, full flower, early seed

61, 62, 63.

Forage quality generally declined after May 20 at .5% per day in digestibility and .25% per day in crude protein.

Varieties of a species at the same stage of development are similar in feeding value.

Grasses harvested at the heads emerging stage and legumes at the very first sign of a flower, combine optimum yield with optimum quality. The animal intake of such hays is also high.

Table 4. Advancing maturity effects on the yield (kg/ha) and quality of the leaf-stem portions of four species averaged over three years

	Whole Plant		Leaf			Stem		
Date ±1	DM	% leaf	DM	% IVD	% CP	DM	% IVD	% CP
Vernal alfalfa								
May 22	1745	66.9	1139	78.6	—	606	76.4	—
May 28	2735	60.5	1625	79.3	—	1110	72.7	—
June 4	3402	50.4	1668	79.0	31.8	1734	66.6	14.0
June 11	4446	45.6	2016	77.0	30.3	2430	58.4	11.9
June 18	5151	43.7	2218	77.4	29.1	2933	55.8	10.6
June 25 +	5904	42.3	2444	77.6	27.2	3461	54.0	9.8
July 3	6378	39.2	2487	76.3	26.0	3891	50.4	9.3
July 9	7119	38.1	2717	76.6	24.5	4402	50.5	9.1
July 16	7233	32.7	2365	74.8	24.0	4867	49.9	9.2
July 23	6821	31.4	2142	73.6	23.1	4679	48.3	9.6
Climax timothy								
May 22	2136	—	—	—	—	—	—	—
May 28	2863	82.8	2345	76.6	—	518	80.8	—
June 4	4156	59.5	2457	74.4	14.4	1985	76.2	9.1
June 11	5108	53.6	2715	70.5	13.2	2658	69.4	6.7
June 18	6112	44.7	2731	68.7	12.4	3382	64.7	6.1
June 25 +	7034	37.2	2611	64.6	11.9	4423	60.4	5.8
July 3	7566	33.9	2560	62.3	9.9	5167	54.5	5.6
July 9	8502	31.7	2685	60.7	8.8	5818	53.2	5.1
July 16	8414	30.7	2585	56.3	8.0	5829	51.8	4.8
July 23	8451	27.0	2285	51.3	6.8	6167	51.6	4.9
Frode orchardgrass								
May 22	1966	—	—	—	—	—	—	—
May 28	2837	76.9	2081	73.4	—	757	78.8	—
June 4 +	4012	58.7	2279	70.0	13.2	1733	71.5	7.2
June 11	4631	51.5	2388	66.8	11.6	2244	62.3	6.3
June 18	5002	53.1	2639	63.9	10.7	2363	54.7	5.3
June 25	5440	46.8	2504	61.5	9.4	2937	50.3	4.9
July 3	5575	47.3	2581	58.6	8.5	2995	43.1	4.6
July 9	5858	51.3	3070	57.9	8.1	2789	41.1	4.3
July 16	5713	49.2	2907	55.3	7.8	2806	38.3	3.8
July 23	5190	55.8	2878	53.2	8.2	2313	35.0	3.1
Saratoga brome								
May 22	2964	—	—	—	—	—	—	—
May 28	3889	62.9	2649	78.2	—	1240	78.7	—
June 4	5238	44.1	2341	74.3	15.0	2612	72.5	7.6
June 11 +	5954	36.0	2216	70.7	13.4	3473	65.8	6.5
June 18	6947	31.8	2377	69.6	12.8	4570	61.0	5.8
June 25	7596	25.4	1972	67.8	11.9	5624	57.9	4.8
July 3	7769	26.6	2074	65.7	11.8	5531	57.7	4.1
July 9	8626	23.7	2058	66.3	10.5	6568	58.7	4.0
July 16	9022	24.4	2266	62.8	9.8	6757	58.9	3.9
July 23	8634	23.5	2091	62.2	9.4	6542	58.7	3.5

+ Approximate date of 50% emergence of heads in grasses or early flower stage in alfalfa.

Table 5. First crop harvest data effects on the D.M. yield (kg/ha) and distribution of aftermaths of four species averaged over three years

First Cut		Aftermaths						Total
Date +1	DM	1		2		3		DM
Vernal alfalfa								
May 7	163	4797	(6-28)+	2980	(8- 9)	1662	(9-24)	9602
May 14	747	3847	(7- 2)	2735	(8-14)	1374	(9-26)	8703
May 22	1745	3302	(7- 9)	2683	(8-23)	910	(9-28)**	8640
May 28	2735	3320	(7-11)	2611	(8-27)	695	(9-28)**	9361
June 4	3402	2744	(7-16)	2345	(9- 1)	254	(10- 7)*	8745
June 11	4446	2985	(7-28)	1998	(9-13)	—	—	9429
June 18	5151	2896	(7-28)	1970	(9-13)	—	—	10017
June 25	5904	2771	(7-31)	1792	(9-22)	—	—	10467
July 3	6378	2913	(8- 9)	1510	(9-26)	—	—	10801
July 9	7119	3051	(8-16)	1121	(9-30)	—	—	11291
July 16	7233	3040	(8-30)	713	(9-30)	—	—	10986
July 23	6821	2717	(9- 4)	473	(9-28)**	—	—	10011
Climax timothy								
May 7	451	6417	(6-25)	1767	(8-20)	2306	(10- 2)*	10941
May 14	1020	5627	(6-28)	1832	(8-23)	2115	(10- 2)*	10594
May 22	2136	3494	(6-28)	1615	(9- 2)	2157	(10- 2)*	9402
May 28	2863	2940	(7- 5)	1476	(9- 4)	1855	(10- 2)*	9134
June 4	4156	1837	(7-19)	1268	(9- 9)	—	—	7261
June 11	5108	2008	(8- 2)	981	(9-25)	—	—	8097
June 18	6112	2065	(8-11)	1201	(9-21)**	—	—	9378
June 25	7034	2026	(8-18)	883	(10- 2)**	—	—	9943
July 3	7566	1964	(8-23)	173	(10- 2)*	—	—	9703
July 9	8502	2104	(8-28)	92	(10- 2)*	—	—	10698
July 16	8414	1888	(9- 4)	83	(10- 2)*	—	—	10385
July 23	8451	1869	(9- 7)	85	(10- 2)*	—	—	10405
Frode orchardgrass								
May 7	456	3630	(6-14)	1517	(7-28)	1660	(9- 5)**	7263
May 14	1122	3054	(6-20)	1685	(8- 7)	1121	(9-21)**	6982
May 22	1966	2093	(6-23)	1781	(8-23)	1051	(9-21)**	6891
May 28	2837	2151	(7- 5)	1455	(8-25)	1081	(9-24)**	7524
June 4	4012	1909	(7- 9)	1444	(8-27)	1071	(9-28)**	8436
June 11	4631	1894	(7-26)	1362	(9- 8)	131	(10- 7)*	8018
June 18	5002	1992	(7-31)	1088	(9-14)	136	(10- 7)*	8218
June 25	5440	1981	(8-11)	942	(9-18)	—	—	8363
July 3	5575	1762	(8-13)	928	(9-27)	—	—	8265
July 9	5858	1832	(8-15)	887	(9-30)	—	—	8577
July 16	5713	1856	(8-25)	673	(9-30)	—	—	8242
July 23	5190	1874	(8-30)	210	(10- 5)**	—	—	7274

cont'd....

Table 5. continued

First Cut Date +1		Aftermaths 1		2		3		Total DM
Saratoga bromegrass								
May 7	858	4496	(6-14)	2039	(8-22)	2026	(9-25)*	9419
May 14	1645	3069	(6-18)	1656	(8-27)	1805	(9-25)*	8175
May 22	2964	1718	(6-28)	1587	(8-27)	1581	(9-25)*	7850
May 28	3889	2279	(7-11)	1212	(9- 3)	980	(9-25)*	8360
June 4	5238	2157	(7-21)	933	(9-20)	—	—	8328
June 11	5954	2313	(8- 5)	1039	(9-29)**	—	—	9306
June 18	6947	2048	(8- 9)	999	(9-29)**	—	—	9994
June 25	7596	2175	(8-18)	845	(9-29)**	—	—	10616
July 3	7769	1970	(8-18)	830	(9-29)**	—	—	10569
July 9	8626	1809	(8-20)	1003	(9-29)**	—	—	11438
July 16	9022	1787	(9- 2)	1434	(9-25)*	—	—	12243
July 23	8634	1527	(9- 7)	—	—	—	—	10161

\+ month and day of harvest
* one year's data
** two years data

Aftermaths were harvested as pasture at about five week intervals. The best production was obtained from alfalfa; orchardgrass provided quite uniform production. Bromegrass was the best early spring producer (May 7); timothy produced very well in the fall.

Hay Harvest Date Effects on Yield and Quality of Alfalfa Mixtures

The idea of spreading the hay harvest dates, using forage species and varieties with a range of maturity dates, is not new. The study reported here was conducted in the early 1960's to obtain yield and quality data on such mixtures. Simple mixtures with both Vernal (medium) and Du Puits (early) alfalfa varieties, which had yielded well in other tests were studied. Because Du Puits alfalfa is no longer available, and its performance was very similar to that reported here for Vernal, its data has not been included (see 1964-70 progress report).

Table 6. Harvest date and mixture effects on the total yearly yield and cut/composition, DM/lbs/ac

Harvest-Mixture		1962	1963	1964	Total	Mean
Early harvest						
Yield -	Vernal + Lincoln	9097	9046	9488	27631	9210
	Vernal + Climax	9213	8741	9706	27660	9220
	Vernal + Frode	9197	8720	10060	27977	9326
	Mean	9168	8836	9751	27755	9252
% Alfalfa-	Vernal + Lincoln	88.8	74.4	69.7		
	Vernal + Climax	96.3	94.6	93.2		
	Vernal + Frode	82.4	72.1	64.9		
	Mean	89.2	80.3	75.9		
Medium harvest						
Yield -	Vernal + Lincoln	9193	10417	10827	30437	10146
	Vernal + Climax	9276	8734	10244	28254	9418
	Vernal + Frode	9384	10089	10830	30303	10101
	Mean	9285	9747	10633	29665	9888
% Alfalfa-	Vernal + Lincoln	86.6	54.2	79.7		
	Vernal + Climax	98.3	88.0	91.4		
	Vernal + Frode	86.9	73.1	80.2		
	Mean	90.6	71.8	83.8		
Late harvest						
Yield -	Vernal + Lincoln	9729	10479	12296	32504	10835
	Vernal + Climax	8756	10278	11734	30768	10256
	Vernal + Frode	9432	9734	11934	31100	10367
	Mean	9306	10164	11988	31458	10486
% Alfalfa-	Vernal + Lincoln	88.8	55.0	64.0		
	Vernal + Climax	96.5	75.6	83.1		
	Vernal + Frode	90.2	71.4	66.6		
	Mean	91.8	67.3	71.2		

Table 7. Harvest date and mixture effects on the percent and yield (lbs/acre) of in vitro digestible dry matter

Harvest-Mixture	Cut 1				Cut 2				Cut 3			
	1962	1963	1964	Mean	1962	1963	1964	Mean	1962	1963	1964	Mean
Early harvest												
Vernal + Lincoln	67.7	67.5	66.8	67.3	72.4	70.4	67.8	70.2	69.7	69.6	72.7	70.7
Vernal + Climax	69.4	69.7	69.6	69.6	71.3	70.2	67.0	69.5	67.3	69.5	74.3	70.4
Vernal + Frode	67.4	68.7	66.5	67.5	70.9	68.4	65.4	68.2	66.8	68.4	73.4	69.5
Mean	68.2	68.6	67.6	—	71.5	69.7	66.7	—	67.9	69.2	73.5	—
Medium harvest												
Vernal + Lincoln	63.7	60.9	62.6	62.4	72.4	66.7	66.9	68.7	71.8	72.0	70.8	71.5
Vernal + Climax	64.9	65.4	65.0	65.1	71.1	67.6	67.0	68.6	70.6	71.2	71.6	71.1
Vernal + Frode	62.6	63.3	62.5	62.8	72.4	68.1	67.3	69.3	70.2	70.4	71.6	70.7
Mean	63.7	63.2	63.4	—	72.0	67.5	67.1	—	70.9	71.2	71.3	—
Late harvest												
Vernal + Lincoln	61.1	57.1	63.8	60.7	76.0	70.4	64.4	70.3	74.6	73.4	73.2	73.7
Vernal + Climax	61.0	59.4	65.3	61.9	74.6	71.8	63.2	69.9	74.2	74.3	72.0	73.5
Vernal + Frode	59.5	58.6	61.7	59.9	75.6	71.5	63.7	70.3	74.2	71.9	72.4	72.8
Mean	60.5	58.4	63.6	—	75.4	71.2	63.8	—	74.3	73.2	72.5	—
Early harvest												
Vernal + Lincoln	2989	3714	3400	3368	1290	1079	1743	1371	1587	1383	1314	1428
Vernal + Climax	2778	3356	3533	3222	1291	1236	1830	1452	1630	1494	1425	1516
Vernal + Frode	2563	3500	3515	3193	1245	1029	1778	1351	1672	1449	1505	1542
Mean	2777	3523	3483	—	1275	1115	1784	—	1630	1442	1415	—
Medium harvest												
Vernal + Lincoln	3526	3994	3680	3733	1171	1382	1911	1488	1372	1287	1470	1376
Vernal + Climax	2940	3424	3623	3329	1132	1313	1862	1436	1449	1103	1353	1302
Vernal + Frode	3455	3940	3774	3723	1119	1432	1928	1493	1267	1236	1407	1303
Mean	3307	3786	3692	—	1141	1376	1900	—	1363	1209	1410	—
Late harvest												
Vernal + Lincoln	3508	3976	3888	3791	1095	1237	2218	1517	1557	1297	1965	1606
Vernal + Climax	3223	3915	3924	3687	1143	1276	2212	1544	1546	1405	1611	1521
Vernal + Frode	3232	3599	3740	3524	972	1286	2306	1521	1408	1528	1631	1522
Mean	3321	3830	3851	—	1070	1266	2245	—	1504	1410	1736	—

Yields were higher in the later harvested hay (Table 6) but the quality was considerably lower (Table 7).

At the early harvest date, all mixtures produced a similar yield but the alfalfa content was considerably higher in the alfalfa-timothy mixture every year.

The IVD content of the second and third cuts was somewhat higher in the early harvested mixtures but considerably higher on the later harvest dates.

The IVD yield was surprisingly similar at the early harvest for all mixtures.

Growth and Development of Some Grasses

In 1963, two varieties each of timothy, orchard and bromegrass differing in maturity, were examined morphologically at weekly intervals. The objective was to study how and when the shoots, leaves and growing point developed. The data from the two timothy varieties only are presented here; the other species can be found in the 1963 report. The study was conducted for one year only due to the excessive amount of time and work required.

From the data, it is very evident that climax, the earlier maturing variety, grew faster than Essex. Leaf blades and sheaths of the first 4 leaves grew throughout the sampling period, doubling in length; sheaths and blades of upper leaves were fully grown when they appeared.

The growing point of both varieties appeared at the same date May 27. The earlier maturing variety climax grew and developed at a faster rate than the late maturing variety Essex. Similar development occurred with the early and late maturing orchardgrasses but the bromegrass varieties developed similarily and headed at the same time.

Table 8. Shoot growth of timothy varieties differing in date of maturity

Sample Date	Shoot Length (cm)	Height Growing Point	No. Leaves Exposed	Leaf 1* SL	Leaf 1* BW	Leaf 1* BL	Leaf 2 SL	Leaf 2 BW	Leaf 2 BL	Leaf 3 SL	Leaf 3 BW	Leaf 3 BL	Leaf 4 SL	Leaf 4 BW	Leaf 4 BL	Leaf 5 SL	Leaf 5 BW	Leaf 5 BL	Leaf 6 SL	Leaf 6 BW	Leaf 6 BL
Climax																					
May 6	16	B**	5.1	3	-	7	3	-	8	4	-	10	5	-	12						
May 13	22	B	4.3	4	6	9	5	7	11	6	7	14	8	9	15						
May 21	31	B	4.7	4	6	10	6	7	13	10	7	17	13	8	21						
May 27	38	2	4.8	4	6	10	7	7	13	12	7	19	14	8	24						
June 3	55	13	5.5	7	7	13	10	8	17	12	8	21	15	8	26	15	9	32			
June 10	78	37	5.7	10	8	16	12	8	20	14	8	27	14	8	29	14	9	27	16	10	24
June 17	87	51	5.6	12	7	20	15	8	27	14	8	30	12	8	27	12	8	19	11	7	12
June 24	82	49	5.4		Brown		12	7	26	11	7	25	11	8	23	11	7	13	13	5	6
Essex																					
May 6	15	B	4.3	3	-	7	4	-	7	4	-	9	5	-	10						
May 13	18	B	4.1	3	6	9	4	6	9	5	7	11	6	7	13						
May 21	27	B	3.9	5	5	10	8	6	14	9	6	17									
May 27	35	1	4.4	4	6	10	7	7	14	11	7	19	11	7	19						
June 3	43	6	4.8	5	7	11	8	7	15	12	7	20	13	7	26	11	7	21			
June 10	60	22	5.1	9	7	15	12	7	20	13	8	24	16	9	26	13	8	26	14	9	12
June 17	77	36	4.9	12	6	22	14	7	28	13	8	30	14	9	29	11	8	20			
June 24	67	36	5.1		Brown		11	6	22	13	7	23	11	7	21	12	7	17	12	6	8

* SL - Sheath length cms; BW - Blade width mms; BL - Blade length cms.
** B - Below soil surface; height in cms.

Yield and Composition of Recommended Forage Mixtures from Publ. 296.

Alfalfa is a component of most of the forage mixtures recommended in Ontario. With the emphasis on protein production from forages, some farmers and extension agronomists are concerned about the high grass content of some current (1982) recommendations. This study was undertaken to obtain data on the yield, composition and persistence of alfalfa in recommended mixtures, a few of which were modified slightly here to keep alfalfa seeding rates uniform. The mixtures were seeded on three sites where alfalfa had given excellent, good and very good production in previous studies, locations 1, 2 and 3, respectively.

Mixtures and seeding rate, lbs/ac

1 - Saranac 10
2 - Saranac 10 + Climax 6
3 - Saranac 10 + Frode 6
4 - Saranac 10 + Saratoga 8
5 - Saranac 10 + Ladino 2
6 - Saranac 10 + Ladino 2 + Frode 6
7 - Saranac 10 + Ladino 2 + Frode 6 + Saratoga 8
8 - Saranac 10 + Ladino 2 + Climax 4 + Saratoga 8

Table 9. Yield and composition of recommended mixtures from 296, three year mean, DM/lbs/ac

	Location 1[1]		Location 2[1]		Location 3[1]		Mean	
Mixture	Cut 1	Total	Cut 1	Total	Cut 1	Total	Cut 1	Total
DM Yield								
1	4631	10544	3821	8806	4282	8260	4245	9203
2	4668	10886	4294	8895	5538	9187	4833	9656
3	4991	10424	4103	8219	6018	9533	5037	9392
4	4910	10922	4554	9092	5421	9206	4962	9740
5	4235	10415	3597	8070	3995	7222	3942	8569
6	5169	10651	4035	7611	5857	9001	5020	9088
7	5166	10845	4442	8574	5894	9059	5167	9493
8	4818	10866	4495	8450	5662	8996	4992	9437

Composition-	Location 1			Location 2			Location 3			Mean		
% grass cut 1	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
1	0	0	10	0	4	5	0	0	13	0	1	9
2	5	0	2	51	18	31	75	53	40	44	24	24
3	5	40	66	37	49	56	79	73	58	40	54	60
4	5	11	22	49	36	51	61	63	23	38	37	32
5	0	0	5	0	6	12	0	0	11	5	2	9
6	5	44	57	53	55	61	79	69	74	46	56	64
7	5	44	55	55	63	73	62	75	68	41	61	65
8	5	31	11	61	46	56	55	60	53	40	40	40

1 - Classified as excellent, good and very good alfalfa sites, locations 1, 2 and 3, respectively.
2 - 95% or more legume in location 1, year 1, cut 1

Table 10. Alfalfa roots in fall of third production year

Mixture	Number/ sq. ft Loc.1	Loc.2	Loc.3	Mean	Loc.3 Root DM lbs/ac
1	11.4	14.1	5.4	10.3	1898
2	12.1	12.3	7.7	10.7	2352
3	10.1	10.4	6.7	9.1	1824
4	10.1	10.6	7.0	9.2	2266
5	10.1	12.0	5.3	9.1	1833
6	8.6	8.1	4.3	7.0	1680
7	11.1	8.0	4.4	7.8	1505
8	11.6	11.0	6.2	9.6	1873

Although the yields varied among the locations, striking contrasts in the grass content of the mixtures occurred among the sites. For example, alfalfa dominated the mixtures in year 1 at location 1 but provided only a modest contribution at location 3. Bromegrass, and particularily orchardgrass, tended to predominate in the mixtures. Both suppressed alfalfa growth more than timothy. Nevertheless, alfalfa stands in all mixtures were still high in the fall of the third year. The root yields were alfalfa roots only from the top 6 inches (15cm) of soil but indicated a substantial root yield for plowdown.

All sites here were well fertilized, tiled, silt-loam land and yet the performance of the mixtures varied considerably among the locations. Consequently, from this and other studies, the researcher strongly suggests that:

- grass seeding rates should be reduced considerably in recommended mixtures.
- recommended mixtures will perform differently among farms, and indeed, among field within farms.
- unless grasses such as orchard or brome are desired in stored feed mixtures or for aftermath grazing, timothy is the best species to combine with alfalfa.

Grass Seeding Rate Effects in Mixtures With Alfalfa

Recommended forage mixtures, containing legumes and grasses, provide high yields but generally have a high grass content. Most dairymen believe that 10-15% grass with alfalfa is sufficient grass to provide for high animal intake with a minimum depression in the protein content. In order to look further at this situation, two widely grown recommended mixtures were studied.

Two varieties of alfalfa were each grown with timothy and with bromegrass at low and recommended seeding rates of each grass. These popular mixtures were harvested in a three cut hay system to evaluate yield and grass content.

Table 11. Grass seeding rate effects in mixtures with alfalfa on yield and composition of cut 1, DM/lbs/ac

Variety -		Year 1			Year 2			Year 3			Mean		
seeding rate[1]		Cut 1 DM	Cut 1 %-grass	Total DM	Cut 1 DM	Cut 1 %-grass	Total DM	Cut 1 DM	Cut 1 %-grass	Total DM	Cut 1 DM	Cut 1 %-grass	Total DM
Saranac+													
Itasca	2	7462	82	10547	5306	62	9762	4386	52	7890	5718	65	9400
	4	7565	85	10899	5281	69	9679	4305	43	7980	5717	66	9519
	6	7233	84	10358	5313	51	10074	4394	43	8229	5647	59	9554
Saratoga	2	6866	78	10678	5299	68	9957	4229	44	7970	5465	63	9535
	5	7512	80	11297	5287	70	9702	4025	30	7701	5608	60	9567
	8	7989	87	11746	5418	60	9991	4323	48	8186	5910	65	9974
Saranac	10	4613	0	8931	3942	0	8828	4292	3	8366	4282	1	8708
Mean		7034	71	10637	5121	54	9713	4279	38	8046	5478	54	9465
Iroquois+													
Itasca	2	8363	67	11940	5003	16	10067	4320	19	8472	5895	34	10160
	4	8373	74	12117	5243	14	10494	4431	7	8952	6016	32	10521
	6	8197	70	11552	4631	28	9844	4333	28	8522	5720	42	9973
Saratoga	2	7500	67	11415	5401	40	10198	4160	21	8438	5687	43	10017
	5	7669	81	11672	5661	57	10361	4632	16	8903	5987	51	10312
	8	7637	83	11376	5713	53	10618	4419	27	8648	5923	54	10214
Iroquois	10	5116	0	9474	4563	0	9875	4100	1	8528	4593	0	9292
Mean		7551	63	11364	5174	30	10208	4342	17	8638	5689	37	10070

1-10 lbs alfalfa with each grass seeding rate.

Table 12. Aftermath composition - % grass, DM/lbs/ac

Variety - seeding rate[1]		Year 1		Year 2		Year 3		Mean		Mean DM	
		Cut 2	Cut 3	Cut 2	Cut 3	Cut 2	Cut 3	Cut 2	Cut 3	Cut 2	Cut 3
Saranac +											
Itasca	2	12	6	8	4	1	1	7	4	2002	1680
	4	14	8	10	6	2	3	9	6	2054	1748
	6	11	6	3	5	2	2	5	4	2157	1750
Saratoga	2	20	10	25	10	8	6	18	9	2325	1746
	5	24	15	21	15	6	2	17	11	2187	1771
	8	26	17	26	9	9	5	20	10	2220	1844
Mean		18	10	16	8	5	3	13	7	2158	1757
Iroquois +											
Itasca	2	16	3	1	5	-	-	6	3	2435	1829
	4	9	5	1	1	-	-	3	2	2526	1979
	6	9	3	3	1	1	-	4	1	2419	1833
Saratoga	2	17	7	18	7	2	1	12	5	2491	1839
	5	19	11	12	7	5	1	12	6	2399	1925
	8	22	14	17	6	5	2	15	7	2410	1881
Mean		15	7	9	5	2	1	9	4	2447	1881

1-10 lbs alfalfa with each grass seeding rate.

High yields were obtained with all mixtures every year. Iroquois formulations outyielded those of Saranac. Iroquois also had a greater depressing effect on the grass content than Saranac. Timothy and brome, at all seeding rates with Saranac, produced similar grass contents in the cut 1 hay; with Iroquois following the very favourable first year, brome contributed more to the yield than timothy. It also provided more grass in cuts 2 and 3.

Those mixtures containing one third or less of the normal grass seeding rate produced hay of a similar grass content to the recommended rate. In all cases, the grass content was much higher than most farmers, certainly dairymen, would prefer. The data suggests here, as in other studies, that the seeding rate of the grass fraction should be markedly reduced when seeded with alfalfa.

Yield and Composition of Early-Late Timothy Varieties in Alfalfa Mixtures

Timothy varieties provide a wide range of maturities in Ontario differing as much as two weeks in heading date. Yet, such varieties are generally seeded with alfalfa that varies only 5 days, at the most, in maturity. Farmers cut their hay meadows when the alfalfa is at its proper stage paying little attention, if any, to the grass association. Many timothy varieties have not persisted well under such managements on farms.

In the study reported here, six timothy varieties, ranging in maturity from early to late, were grown in a split arrangement with an early and a medium alfalfa, harvested at the first sign of alfalfa flowers, and analysed for yield and timothy composition, an index of the timothy persistence.

Table 13. Yield and composition of early-late timothy varieties in cut 1 alfalfa mixtures, DM/lbs/ac

	Year 1			Year 2			Year 3			Mean		
Variety-mixture	Cut 1 DM	Cut 1 % grass	Total DM	Cut 1 DM	Cut 1 % grass	Total DM	Cut 1 DM	Cut 1 % grass	Total DM	Cut 1 DM	Cut 1 % grass	Total DM
Saranac +												
Salvo (6-16)[1]	6349	41	9596	5017	35	9746	4756	29	8963	5374	35	9435
Toro (6-20)	6289	36	9468	5681	48	10434	4566	31	8976	5512	38	9626
Champ (6-23)	6066	16	9344	5829	19	11273	4645	18	9000	5513	18	9872
Itasca(6-25)	6212	15	9648	6135	10	10734	4014	3	8377	5454	9	9586
Timfor(6-28)	5880	12	9413	5520	17	10091	3742	5	7933	5047	11	9146
Pronto(7-1)	6358	10	9679	5084	10	10237	4401	5	8593	5281	8	9503
Mean	6192	22	9525	5544	23	10419	4354	15	8640	5364	20	9528
Weevlchek +												
Salvo	6408	57	9076	5625	61	11068	5152	54	8641	5728	57	9595
Toro	6972	44	9626	5291	58	9962	5219	51	8992	5827	51	9527
Champ	6967	29	9548	5267	41	10255	4462	44	8093	5565	38	9299
Itasca	6453	25	9544	5196	46	9965	4322	31	7708	5324	34	9072
Timfor	6475	30	9309	5066	35	9933	4261	32	7772	5267	32	9005
Pronto	6014	17	8851	5369	29	10178	4372	25	8073	5252	24	9034
Mean	6548	34	9326	5302	45	10227	4631	40	8213	5494	39	9255

1 - Heading date, June 16 at Elora Station.

Every year, Saranac alfalfa was more competive than Weevlchek on the timothy varieties. Saranac mixtures also yielded more due to its higher yielding aftermaths. The early maturing timothy varieties made substantial grass contributions to the yield with both alfalfas; however, the late varieties with Saranac were basically killed by the third year and made very little contribution to the yield even in the first year. This indicates that severe legume-grass competition probably occurred in the year of seeding.

From this and other studies, it appears to the writer that alfalfa varieties could be rated for competitiveness. Certainly work at Elora has clearly shown that the old concept of the early types being competitive and the medium ones not, as indicated in this and other studies, is not always the case.

Irrigation Effects on Alfalfa Yield

In cooperation with D.M. Brown of Land Resource Science, Saranac alfalfa was irrigated at weekly intervals throughout the summers of 1978, 79 and 80, Banner alfalfa in 1982. The amount of water applied depended upon the moisture deficiency, based on evapo-transpiration, of the previous week. Thick, vigorous alfalfa stands in their second production year were employed. The crops were grown on well fertilized silt-loam soils.

Responses to irrigation were very modest. No responses were obtained in cut 1 in one year that water was applied, in a second year (1982), irrigation reduced the yield.

Table 14. Irrigation effects on alfalfa yields, DM/lbs/ac

Year	Irrigated			Non-irrigated		
	Cut 2	Cut 3	Total	Cut 2	Cut 3	Total
1978	2764	1923	4687	2068	1799	3867
1979	2594	1810	4404	1737	1584	3321
1980	2788	2405	5193	2607	2382	4989
1982	3722	4169	7891	3314	4527	7841
Mean	2967	2577	5544	2432	2573	5005

Leafhopper Control and Alfalfa Yields

Leafhoppers usually damage new alfalfa seedings, and second and third cuttings of established stands, most years. Studies were undertaken to learn if the more tolerant varieties Weevlchek, Chimo and Iroquois would show a different response to hopper control, using methoxychlor, than the more susceptible varieties Saranac, Thor and Vernal. In later studies, the systemic insecticide Temik was used, hopefully, to control a whole spectrum of feeding insects.

Table 15. Effect of leafhopper control on alfalfa yield, DM/lbs/ac

Crop and	Seeding Year				Production Year		
	1976	1977	1978		3 Test-3 year aftermath mean		
Treatment	Cut 1	Cut 1	Cut 1	Mean	Cut 2	Cut 3	Total
Sprayed							
Saranac	3303	3706	4584	3865	3053	2553	5606
Thor	3191	4003	4656	3950	3161	2633	5794
Vernal	3127	3599	4381	3702	2922	2443	5365
Iroquois	3297	3619	4752	3889	3123	2550	5673
Chimo	3181	3610	4495	3762	3108	2535	5643
Weevlchek	3291	3430	4376	3699	2961	2505	5466
Mean	3231	3661	4541	3811	3054	2536	5591
Unsprayed							
Saranac	3085	3448	4757	3763	3071	2535	5606
Thor	3334	3765	4666	3922	3193	2571	5764
Vernal	3084	3203	4088	3458	2962	2356	5318
Iroquois	3113	3480	4704	3766	3128	2513	5641
Chimo	3012	3662	4518	3731	3127	2531	5658
Weevlchek	3340	3501	4165	3669	2968	2446	5414
Mean	3161	3510	4483	3718	3074	2492	5567

From the data presented, it is evident that timely sprays with methoxychlor did not improve the yield of alfalfa in the seeding year (1977 excepted) or in the succeeding years. Although small but significant variety differences occurred in most of the seeding and production years, these differences appeared to be associated with yield potential and not differences in leafhopper tolerance or control. Where the systemic insecticide Temik was used over a three year period, no significant differences were obtained with either the Saranac or Iroquois varieties within any of the three annual cuts, or in total yield. Nevertheless, Ontario farm sprayings for leafhoppers have given very marked increases in yield and crude protein content in some years.

Alfalfa Yield and Quality Responses to Row Spacing

Saranac and Vernal alfalfa were grown in 7, 14, 21, and 28 inch row widths at 12 lbs seed per acre, and at corresponding reduced rates as the row width increased beyond 7 inches. Thus, uniform plant numbers were established within each row. In the split-plot design, the main plots were thinned vs solid rows, the former being established at the seedling stage by removing all plants except a 5 cm clump every 14 inches apart within the rows. The sub plots were row widths. See the 1963 and 1964 reports for the Vernal data, the 1972 and 1973 reports for Saranac. Only Saranac data is presented, in part, here. However, in summary -

Two types of alfalfa (Medicago sativa L.), represented by the cultivars Vernal and Saranac, were grown for two and three successive years, respectively, to study the effects of intra and inter row spacings upon dry matter yield, yield components and forage quality in the seeding and producing years.

With both cultivars, thinning the stand and increasing the row width decreased the yield, Vernal excepted, where a seven percent first cut production year increase from thinning was obtained. Generally, thinning and increasing the row width decreased stem length and stem number, increased stem diameter and weight, and height of the yellow leaves, and had no effect upon stem content of the shoots. Increasing the row width caused very slight declines in the percent digestibility and crude protein content of Saranac stems.

Table 16. Yield, component and quality data of spaced Saranac alfalfa, two year mean

Variable		D.M. kg/ha	Length cm	Diameter cm	Weight g	Number $35.5 cm^2$	Content	% IVD 1970	% Crude Protein 1970
Cut 1									
Row width cm	17.8	5860a	101a	.32b	35.6b	32a	66a	53.7a	9.3a
	35.6	5529a	101a	.34a	38.4ab	25b	65a	53.6a	9.1ab
	53.3	5068b	98ab	.34a	40.0ab	20c	64a	51.7b	8.5ab
	71.1	4911b	95b	.35a	43.0a	18c	64a	50.9b	8.3b
Spacing mean	solid	5513**	98	.32	35.5	30**	64	53.0	8.8
	thinned	5171	99	.35**	43.1**	19	65	52.0	8.8
Year mean	1970	5654*	98	.37**	39.2	22	61	52.5	8.8
	1971	5030	99	.31	39.5	26**	68**		
C.V.		8.4	5.5	2.9	8.6	11.5	2.9	1.7	5.6
Cut 2									
Row width cm	17.8	2879a	56b	.25b	13.4b	48a	54a	53.1a	10.1a
	35.6	2779a	57ab	.25b	14.2ab	36b	54a	51.4b	10.1a
	53.3	2576ab	57ab	.26a	16.0ab	30c	55a	51.6b	10.0a
	71.1	2452b	59a	.26a	17.3a	26c	56a	50.8b	9.7a
Spacing mean	solid	2835**	57	.25	14.2	44**	55	51.4	9.9
	thinned	2508	58	.26**	16.8*	26	55	52.0	10.3
Year mean	1970	2527	58	.26	14.5	31	53	51.7	10.0
	1971	2816**	57	.25	16.0*	39**	57**		
C.V.		5.0	5.2	3.9	7.9	10.5	3.1	3.2	5.6

cont'd....

Table 16. continued

Variable		D.M. kg/ha	Length cm	Diameter cm	Weight g	Number 35.5cm^2	Content	% IVD 1970	% Crude Protein 1970
Cut 3									
Row width cm	17.8	1854a	34c	.20b	6.4b	60a	46b	58.9a	12.4a
	35.6	1761a	37b	.20b	7.4ab	47b	48ab	57.2b	11.9ab
	53.3	1621ab	38ab	.21a	8.2	39c	48ab	56.9b	11.6ab
	71.1	1508b	39a	.21a	9.1a	32d	50a	55.1c	11.3b
Spacing mean	solid	1818**	37	.20	7.1	57**	48	57.1	11.9
	thinned	1552	38	.21**	8.5*	32	47	57.0	11.8
Year mean	1970	2018**	44**	20	9.9**	43	51	57.0	11.8
	1971	1353	30	20	5.7	46	44		
C.V.		7.3	4.8	4.8	6.6	9.9	8.8	3.0	4.6
Cut mean	1	5344	98	.34	39.2	24	65	52.5	8.8
	2	2671	57	.26	15.6	36	55	51.7	10.1
	3	1685	37	.20	7.8	45	48	57.0	11.2

Means followed by the same letter are not different at the 5% level.
*, ** means significant at the 5 and 1% levels, respectively.

Forage Yield and Quality Responses to Spacing in Sweet Clover

Yukon and Goldtop yellow blossomed sweet clover varieties were grown in row widths of 7, 14, 21, 28 and 36 inches at a seeding rate of 17 lbs/ac in the 7 inch row width. The rate decreasing directly with increasing row width thus providing a uniform within row plant population. The main plots were thinned and unthinned rows with the former being established at an early seedling stage by removing all plants except 5 cm clumps spaced 14 inches apart within the row. The sub plots were row widths. See 1972, 1973 progress reports for data; only the Goldtop data is presented here. In summary -

Yukon and Goldtop varieties of sweet clover (Melilotus officinalis L.) were grown for one and two successive years, respectively, to study the effect of solid and thinned row spacings at row widths within each of 17.8, 35.6, 53.3, 71.1 and 88.9 cm. Data were collected on dry matter yield and several components of yield and quality.

The thinned spacing decreased dry matter yields with Yukon but had no significant effect with Goldtop except at the 17.8 cm row width where it produced an 11% yield increase. Increasing the row width generally decreased yields. Furthermore, thinning and increasing the row width increased the shoot weight, stem length and stem diameter but had no marked influence on stem content. In vitro digestible dry matter and crude protein contents of the stems were similar at all row spacings and widths.

Table 17. Yield, component and quality data of Goldtop sweet clover, two year mean

Variable		Dry matter kg/ha	25 shoot wt/g	Stem data: % stem	length cm	diameter cm	% IVD 1970	% crude protein
Row width cm	17.8	8301a	193e	72.8a	145c	.697d	49.8a	7.0a
	35.6	7772b	220d	72.6a	148b	.717c	49.3a	7.0a
	53.3	7325c	238c	72.8a	148b	.750b	49.0a	7.1a
	71.1	7584bc	265b	72.1ab	151a	.772a	48.8a	6.9a
	88.9	6587d	285a	71.7b	151a	.783a	49.0a	7.0a
Spacing mean	unthinned	7451	217	72.6**	148	.714	48.9	7.0
	thinned	7575	264**	72.0	149	.773**	49.5	7.0
Year mean	1970	8094**	242	69.7	148	.788**	49.2	7.4
	1971	6733	238	74.9**	150	.699	-	6.6
C.V.		8.0	11.4	2.2	3.6	5.2	2.3	5.3

Means with a common letter are not significantly different at the .05 level.
** indicates means significantly higher at the .01 level.

Influence of Age of Stand on Alfalfa Variety Hay Yields

Three alfalfa varieties, in yield studies at the various stations in Ontario, were averaged over station-years (1960-1973) to learn the effect of age of stand on variety performance. Although the number of station years in the variety means is not the same, the data are of interest.

- Variety yields declined with age of stand (compare within varieties only).
- The decline in yield with age of stand was more evident in the aftermaths where environmental stress was likely manifested more than in the first crop.
- Yield decline was more evident in the third production year, particularly with the oldest variety Vernal.

Table 18. Age of Stand Effects - DM/lbs/ac

Variety-station years	Year 1			Year 2			Year 3[1]		
	cut 1	after-math	total	cut 1	after-math	total	cut 1	after-math	total
Saranac(23)	4099	3550	7520	3689	3151	6905	3920	2667	6587
Iroquois(15)	4363	3459	7543	3850	3221	7071	3863	2264	6127
Vernal(22)	4443	3478	7912	4153	3207	7351	3404	2263	5667
Mean	4302	3496	7658	3897	3193	7109	3729	2398	6127

1-4, 4, and 6 station years for Saranac, Iroquois, Vernal, respectively.

Legume Protein Production

Several forage legumes were evaluated for protein production in pure stands and in mixtures with ladino clover. Harvesting occurred with all species as soon as flower buds were visible on the majority of the shoots.

Protein content averaged over 20 per cent with most species, digestibilities averaged over 70 per cent. Substantial yields were obtained, particularily from the first cutting. The addition of ladino clover in mixtures neither increased the protein content nor increased the yield.

Table 19. Dry matter yield lbs/ac D.D.M. and crude protein content of several forage legumes, two year average

Legume	Cut 1	Cut 2	Cut 3	Cut 4	Cut 5	Cut 6[1]	Average or Total
Pure Stands							
Vernal	3955	1887	1917	784			8543
% D.D.M.	68.6	72.1	70.4	73.0			71.0
% C.P.	21.6	25.6	26.5	25.9			24.9
Saranac	4069	2100	2043	1224			9436
% D.D.M.	68.2	71.4	69.1	73.5			70.6
% C.P.	20.9	25.3	21.4	25.9			23.4
Sweet Clover	5053						5053
% D.D.M.	64.4						64.4
% C.P.	19.2						19.2
Red Clover	3506	876	1136				5518
% D.D.M.	69.7	70.4	64.0				68.0
% C.P.	19.1	21.2	20.0				20.1
Viking Trefoil	2664	1341	1467	1194			6666
% D.D.M	71.7	72.3	72.7	73.1			72.5
% C.P.	21.4	21.0	20.1	23.6			21.5
Ladino Clover	1906	892	1106	559	1048	750	6261
% D.D.M.	80.1	78.4	75.3	74.4	77.8	73.8	76.6
% C.P.	27.5	24.6	25.2	27.4	24.8	28.6	26.4
Mixtures							
Ladino + Vernal	3710	1805	1744	1045			8304
% D.D.M.	70.7	74.5	71.4	74.3			72.7
% C.P.	23.7	22.9	20.8	25.9			23.3
% Ladino	15.7	24.6	30.9	40.6			28.0
Ladino + Saranac	4030	2086	1960	1274			9350
% D.D.M.	68.8	72.1	70.0	74.0			71.2
% C.P.	21.8	22.8	19.7	25.4			22.4
% Ladino	5.4	7.3	16.6	25.3			13.7
Ladino + Red Clover	3234	1323	1370	805			6732
% D.D.M.	72.9	74.6	72.9	71.4			73.0
% C.P.	19.1	19.5	21.9	27.7			22.1
% Ladino	11.6	51.9	57.4	70.8			47.9
Ladino + Viking	2124	811	1071	726	1107	843	6682
% D.D.M.	79.9	78.4	76.0	74.7	77.6	72.1	76.5
% C.P.	26.5	25.5	25.3	22.5	25.6	29.0	25.7
% Ladino	83.3	96.9	98.3	90.3	96.4	99.0	94.0

1 - 1 year only

HAY DRYING AND QUALITY SECTION

Several studies have been conducted on hay drying. They included experiments on conditioning, stubble heights, raking times, windrow widths, weathering, etc. Only a few studies are reported here, the remainder can be found in previous reports.

Table 1. Alfalfa leaf loss through raking, DM/lbs/ac

Variable	Conditioned			Unconditioned		
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
Rain on swath	617	702	---	612	691	---
No rain	459	464	506	439	394	360

- Rain increased leaf shatter.
- Conditioned hay lost more alfalfa leaves when raked than unconditioned.

Table 2. Time and windrow width effects on drying rate (% DM) of hay crops

Hay-width windrow	Drying day - 4 pm				Species mean	Width mean
	1	2	3	4		
Red clover					55.4	
Narrow (30")	28	43	64	66		55.2
Wide (42")	33	48	74	87		59.8
Red + timothy					54.4	
Narrow	33	37	61	75		
Wide	36	40	70	83		
Trefoil					47.1	
Narrow	24	33	43	70		
Wide	29	41	59	78		
Alfalfa					67.1	
Narrow	39	64	74	81		
Wide	45	69	82	83		

- Alfalfa dried the fastest, trefoil the slowest.
- All hays dried faster in wide windrows.

Table 3. Stubble height, swath width and time effects on the rate of drying Saranac alfalfa in windrows, % DM

Variable	Drying Day 1	2	3	4	Mean
Study 1					
High stubble (8")	37	45	70	78	57.5
Low stubble (4")	37	48	68	78	57.7
Swath dried (3")	49	70	79	84	70.5
Study 2					
10' swath windrowed	34	43	65	76	54.5
8' swath windrowed	35	47	67	78	56.8
6' swath windrowed	42	50	75	80	61.8
Swath dried	49	71	78	84	70.5

- Stubble height had no significant effect on drying rate.
- Narrower swaths increased windrow drying rate.
- Swath curing reduced field exposure time by one day.

Table 4. Effect of drying days and windrow width on the % DM, in vitro digestible matter (IVD) and crude protein (CP) of June 18 cut Saranac alfalfa

Drying Day	Rain	% DM Windrow 4 pm		% IVD			% CP		
		Narrow	Wide	Narrow	Wide	Mean	Narrow	Wide	Mean
Cut	0	23	24	66.4	65.5	66.5a	17.9	17.9	17.9ab
1	0	55	57	66.8	66.2	66.5a	18.4	18.0	18.2ab
2	0	70	72	65.6	64.3	65.0b	16.2	16.5	16.4c
3	0	77	77	65.6	64.4	65.1b	17.7	17.3	17.5ab
4	0	74	75	65.8	65.1	65.5b	18.2	18.2	18.2ab
4	.35[1]	64	68	65.2	65.7	65.5b	18.3	19.0	19.0a
4	.74[1]	51	57	65.3	65.2	65.3b	17.8	19.0	19.0a
Mean		59	61	65.9*	65.4		17.8	18.0	
C.V.				1.1			4.2		

1 - applied evening of day 4; * significant p=0.05; values within a column followed by the same letter are not significantly different at p=0.05.

- The crop yielded only 1.7 tons/ac hence the drying speed was similar in the narrow and wide windrows.
- The IVD declined significantly, but only slightly, after day 1 and was slightly higher in the narrow windrows.
- CP content was highest after a rain, probably due to the leaching of some simple sugars, minerals, etc.

Table 5. Effect of drying days, precipitation and windrow widths on the in vitro digestible dry matter (IVD) and crude protein content (CP) of June 21 cut Saranac alfalfa

Drying day		Precipitation-inches				Windrow-width	
		0	.10	.40	.80	30"	42"
IVD data							
1	66.3a	66.3				66.3	66.4
2	61.3b	61.3				60.6	61.9
3	60.1bc	59.1	59.5	61.1	60.5	60.1	60.0
4	59.5c	59.8	58.6	60.0	59.7	59.9	59.1
5	57.6d	58.0	57.6	57.2	57.4	57.6	57.6
6	60.1bc	60.1				60.0	60.3
Mean		60.8a	58.6b	59.5b	59.2b	59.8a	59.7a
C.V. 2.9							
CP data							
1	18.7a	18.7				18.7	18.8
2	16.2b	16.2				16.1	16.2
3	16.1b	15.0	16.0	17.0	16.6	16.2	16.1
4	15.4c	15.0	14.8	15.3	16.5	15.9	14.9
5	14.9d	14.8	14.9	14.8	14.9	14.8	14.9
6	16.3b	16.3				16.3	16.2
Mean		16.0a	15.2b	15.7a	16.0a	15.9a	15.7a
C.V. 4.3							

Values followed by the same letter are not significantly different at P=0.05 within columns for days, between columns for precipitation windrow width.

- IVD and CP contents decreased with field exposure time but at a lower amount when not rained upon.
- the varying amounts of rainfall produced similar decreases in the IVD content but only the light shower decreased the protein content.
- windrow widths had no significant effect on the IVD or CP content.

Table 6. Percent moisture loss per hour during the hay drying period of some forage species

Species	Time Period (Hours)				
	0-25	25-48	48-72	72-92	Mean
Saranac alfalfa	0.92	1.57	0.64	0.37	0.89
Redon red clover	0.86	1.96	0.65	0.38	0.92
Empire trefoil	0.94	1.86	0.48	0.51	0.91
Climax timothy	0.92	1.67	0.50	0.43	0.90
Frode orchard	1.28	1.26	0.40	0.42	0.86
Saratoga brome	1.76	1.05	0.17	0.30	0.84

Table 7. Hours to the reach the haylage and dry hay stage of some forage species

Species	50% DM	80% DM	Varieties	50% DM	80% DM
Saranac alfalfa	31	50	Vernal	26	43
Redon red clover	34	50	Iroquois	30	49
Empire trefoil	32	46	Weevlchek	30	50
Climax timothy	32	49	Saranac	29	49
Frode orchard	23	45	Angus	30	48
Saratoga brome	18	35	Thor	34	54

- Artifically dried, uniform size samples of conditioned species and varieties were weighed at 3-4 hour intervals following a June 12 harvest (1975 report).
- Legumes and timothy lost moisture at a higher rate during the 25-48 hour period, orchard and brome during the first 25 hours.
- Bromegrass reached 80% DM 10-15 hours before the other species.
- Vernal alfalfa was the fastest drying alfalfa variety, Thor the slowest.

FORAGE ESTABLISHMENT

Many studies were conducted in this area during the 1950 era, very few during the past decade or so. Most of the results can be found in old reports. A few are summarized here with brief comments. The statistical analysis was conducted on individual years but not over years.

Table 1. Seeding rate effects on yield of alfalfa, DM/lbs/ac

Seeding rate	Total Year 1	Total Year 2	Total Year 3	Plant data - year No./ sq.ft.	Stems/ plant	Stand/ sq.ft.	Root[1] DM/ac
4	10410	11054	9106	6.8	9.5	64	2913
8	10685	11563	9896	9.6	6.2	61	2535
12	10532	11018	9800	11.9	5.8	69	2570
16	10422	11304	10525	13.1	4.9	64	2429
20	10902	12036	9742	13.9	4.4	61	2126
LSD .05	374	451	547	2.5	1.3		
C.V.	2.7	2.6	5.1	15.0	14.6		

1 - top 6 inches of soil

- The low seedingrate generally produced lowest yields from the lowest number of plants per unit area

- Low plant numbers compensated by producing larger roots and more stems per plant

- It appears that higher seeding rates may prolong stand productivity through increased plant density.

- This might be worthy of a long-term study

Table 2. Methods of seed bed preparation and seed, two year average - plants/sq.ft.

Seeding Method	Disc harrow			Field cultivar			Rotovator			Mean
	Legume	Grass	Total	Legume	Grass	Total	Legume	Grass	Total	
Grain drill, harrow	6.1	7.6	13.7	9.1	4.8	13.9	5.6	6.3	11.9	13.1
Grain drill, pack	9.7	7.7	17.4	11.2	6.8	18.0	10.4	7.5	17.8	17.8
Packer seeder	6.9	3.7	10.6	5.6	2.9	8.5	5.2	3.3	8.4	9.2
Mean	7.6	6.4	13.9	8.6	4.9	13.4	7.0	5.7	12.7	
<u>Hay yield, lbs/ac, cut 1</u>										
Grain drill, harrow			5440			5440			5640	5500
Grain drill, pack			4900			4940			5580	5140
Packer seeder			4480			5020			4980	4820
Mean			4940			5120			5400	

Mixture - alfalfa 6, red 4, timothy 2, orchard 3, brome 5 lbs/per acre; Guelph - loam soil

- In general, the grain drill followed by packing established the thickest stand but produced average hay yields
- The grain drill followed by harrowing provided good stands and uniform hay yields under all preparation methods

Table 3. Effect of oat seeding rate on establishment, plants/sq.ft., three year average

Seeding rate/bu/ac	Alfalfa	Red Clover	Timothy	Orchard	Brome	Succeeding hay- cut 1	
						lbs/ac	% legume*
1	15.1	3.7	2.6	10.9	9.0	4960	61
1-1/2	14.5	3.3	2.3	9.1	8.6	4740	61
2	14.0	2.9	1.9	9.7	9.6	4380	57
2-1/2	12.6	2.7	1.6	9.4	10.8	4280	61
3	12.4	2.2	1.4	9.3	9.3	4160	57
1-1/2 (14" drills)	15.4	5.8	2.7	10.4	8.8	4900	65
No companion	15.1	8.2	2.7	10.6	8.9	4980	67

Mixture - alfalfa 6, red 4, timothy 2, orchard 3, brome 5 lbs. per acre

* - 2nd year

- Increasing the seeding rate of the oats reduced the stand of the legumes and timothy
- Yields were reduced by increasing the oat seeding rate
- Composition of the hay was not affected a great deal by oat seeding rate

Table 4. Oat lodging on establishment and succeeding hay yield, DM/lbs/ac, two year average[1]

Variable	Date	Early moderate	Early severe	Late moderate	Late severe	Not lodged	No companion
Vernal							
plants/sq.ft.*	10/1	19.9	16.4	20.3	14.7	20.0	23.1
height cm	10/1	18.6	19.5	18.2	18.4	19.2	26.1
no tillers	10/1	3.6	3.7	4.0	4.0	3.7	3.7
top dry wt.	10/1	6.7	7.0	6.9	7.7	8.5	10.6
cut 1 hay	6/11	4023	4194	4146	4128	4203	4771
Lincoln							
plants/sq.ft.*	10/1	10.4	9.2	10.6	9.9	12.9	14.9
height cm	10/1	18.4	20.1	17.8	16.9	17.1	23.1
no tillers	10/1	9.1	9.0	9.8	8.8	10.0	9.0
top dry wt.	10/1	7.6	7.2	8.6	7.0	8.6	9.2
cut 1 hay	6/1	1331	1359	2627	1139	2357	2826
Empire							
plants/sq.ft.	10/1	15.8	10.6	17.5	12.1	17.9	16.8

* - Three year average.

1 - Oats seeded 2-1/2 bushels; average yield 63 bushels grain and 4460 lbs straw; early lodging July 7, late lodge July 26, harvest August 12; moderate lodging - 45°, severe - 90°

- Severe lodging depressed stands of alfalfa; all treatments depressed stands of brome
- Lodging had little effect on tiller numbers but reduced fall height and top weight
- All lodging treatments reduced alfalfa yields uniformity
- Yield reduction with brome was greater from both early lodging as well as the late severe treatment

Table 5. Companion crop management, three year average, DM/lbs ac

Management applied	Seeding year Yield	Seeding year Alfalfa sq. ft.	Seeding year Brome sq.ft.	First Cut Hay yield	First Cut % legume	Second Cut Hay yield	Second Cut % legume
Oats cut 10" left	-	17.2	14.0	4700	41	3120	68
Oats cut 24" left	-	17.9	12.6	4940	42	3180	73
Oats cut 24" removed	2050	18.0	14.3	4620	44	3180	73
Oats - hay	4460	20.1	15.4	4760	52	3140	76
Oats - 14" grain	2554	19.6	13.9	4780	51	3110	76
Oats - 7" grain	2793	18.5	12.9	4620	54	3260	72
Barley - grain	2501	19.2	8.9	4520	65	3360	81
Mixed grain[3]	2819	20.1	9.4	4380	70	3360	80
No companion	3220	21.7	13.5	5060	40	3120	71

1 - pounds grain or forage from one cut; stand in October
2 - oats cut when 10 or 24" high to a 6" stubble
3 - 2 year average
4 - first year of production only

OATS
- managements had no marked effects on plant stand
- early removal stimulated grass development

BARLEY AND MIXED GRAIN
- reduced observed seedling height of alfalfa 30 to 50 per cent
- reduced brome stands approximately 50 per cent
- depressed first crop hay yields
- affected the grass composition of the hay

NO COMPANION
- more vigorous fall seedlings followed by a higher bromegrass content in the hay crop

Table 6. Alfalfa establishment, Elora, mean of June 23, etc.

	Mean of June 23, July 5 and July 22 sample dates No stems 3 sq.ft.	 Ave length 40 stems/cm	 Ave dry wt 40 stems/g
Vernal			
Nurse crop			
oats	97	15.5	5.4
barley	80	15.1	2.6
Direct			
7" drills	123	23.6	40.3
broadcast	132	21.7	37.2
Saranac			
Nurse crop			
oats	78	14.7	3.7
barley	72	13.3	2.2
Direct			
7" drills	123	20.0	37.3
broadcast	117	18.2	31.3

- Alfalfa established under a grain companion crop produced 66% as many plants per unit area, whose stems were 63% as long but only 10% as heavy, as direct seeded plants
- Barley depressed stands, and particularily shoot weight more than oats
- The two alfalfa varieties were remarkably similar in the seedling year

Table 8. Fall seedings on winter wheat at Brampton, two year average

Seeding Method	Plants/sq.ft. succeeding fall			
	Vernal alfalfa	Lincoln brome	Viking trefoil	Medon timothy
Banded 7"	16.0	7.7	0.5	7.5
Banded 14"	13.8	4.4	0.3	4.9
Broadcast	11.2	6.0	-	-
Broadcast, harrow	13.4	9.6	0.2	5.8
Broadcast in spring	13.4	3.1	1.0	8.0
Drilled in spring	24.7	9.5	5.0	12.6

- In one year of this three year study, all species failed to establish satisfactory stands
- Brome established good stands seeded in the fall; trefoil did not establish well under wheat

Table 7. Effect of barley varieties on establishment, three year average, DM/lbs /ac

Variety	Plants/sq.ft.		Plant height (cm)		Succeeding June yield	
	Vernal	Lincoln	Vernal	Lincoln	Vernal	Lincoln
York	22.1	12.3	21	22	4340	2970
Herta	22.3	12.6	22	21	4460	2910
Parkland	21.4	12.2	21	21	4340	2720
Mixed grain	21.5	11.6	21	23	4400	3000
Garry oats	24.0	18.1	34	25	4580	2950
No companion	25.1	20.6	37	33	4640	4160

- Barley varieties reduced the stand of Lincoln brome and the vigor of Vernal by October

- Vernal yields were similar in the succeeding year; Lincoln yields were depressed very significantly under all campanion crops

Table 9. Early spring seeded forage species on winter wheat at Brampton, plants/sq.ft.

Species seeding rate	Year 1	Year 2
Alfalfa (12)	20.5	8.0
Red clover (10)	27.0	14.0
Birdsfoot (10)	13.0	1.8
Timothy (8)	14.1	12.0
Orchard (10)	13.0	18.6
Brome (15)	3.0	4.1
Meadow fescue (10)	9.6	7.5

- In one year of this three year study, all species failed to establish a satisfactory stand on a heavy clay

Table 10. Methods of seeding with a grain drill, three year average

Method	Plants/sq.ft. alfalfa	seeding year brome	Cut 1 DM lbs/ac	% Legume
Before disk, shallow*	16.8	6.8	5540	61
After disk, shallow	18.1	8.3	5440	67
After disk, shallow pack	18.7	8.4	5560	65
After disk, shallow harrow	18.9	8.3	5680	70
After disk, normal*	15.5	5.2	5220	66
With oats, shallow	16.5	7.9	5620	69
With oats, normal, harrow	16.5	5.4	5480	68
Band, shallow	16.9	8.2	5640	68

* refer to depth of brome seeding
Vernal 10 + Lincoln 10 seeded on heavy clay

- Seeding methods had no marked effect on stands, succeeding year yield or composition

Table 11. Methods of band seeding, three year average

Method	Plants/sq.ft. alfalfa	seeding year brome	Cut 1 DM lbs/ac	% Legume
Band, uncovered	15.8	6.2	5220	64
Band, harrow	15.6	6.4	5640	69
Band, pack	16.5	5.8	5560	70
Band, 14" drills	16.8	6.8	5540	56
Band, no companion	18.0	8.4	5940	54
Broadcast, harrow	18.1	5.3	5680	66
Broadcast, pack	19.0	4.5	5420	66

Vernal 10 + Lincoln 10 - seeded on heavy clay with oats

- Band seeding did not improve stands or yield over conventional methods; it markedly improved seedling vigor
- Where seeding year competition was reduced the succeeding years grass vigor was improved

Table 12. Seedbed firming and coverage, three year average

Treatment	Plants/sq.ft.		First cut hay	
	alfalfa	brome	DM/lbs/ac	% legume
Pack before	18.6	6.4	5700	64
Pack after	19.7	6.3	5960	64
Pack before and after	24.3	6.7	6100	69
Pack before and harrow after	21.6	6.8	5820	64
Harrow	22.0	7.5	5840	64
Band	18.7	7.0	5760	67
Drill chains	17.7	6.4	5720	66
Check uncovered	17.7	7.0	5520	67

Vernal 10 + Lincoln 10 - seeded on heavy clay with oats

- Packing before and after established more alfalfa plants
- Brome was seeded with the oats and not affected by any treatment
- Yield and content were not affected greatly by coverage

FORAGE PERSISTENCE SECTION

Persistence studies were initiated in the early sixties on alfalfa and later enacted on trefoil and some grasses. Investigations into critical fall harvest dates, snow cover, top insulation, soil fertility, crown temperatures, etc., have been conducted. The overall objective of this research was to reduce the possibility of winterkill and maintain high succeeding yields. Some data which might be of use are presented.

Critical Fall Harvest Period for Alfalfa

Table 1. Plant population, height and cut 1 dry matter yield of alfalfa in year following application of post-harvest cuttings

	Location 1** Mt. Forest			Location 2 Guelph			Location 3 Brantford		
Fall cutting date*	No plants 0.09M	Height cm 5/20	Hay yield kg/ha	No. plants 0.09M	Height cm 5/18	Hay yield kg/ha	No. plants 0.09M	Height cm 5/13	Hay yield kg/ha
3 Sept.	16.0	9.5	6,919	23.8	12.5	4,914	19.7	6.5	5,764
10 Sept.	13.5	9.5	6,584	19.0	11.3	4,317	16.8	5.5	5,406
17 Sept.	15.3	9.5	6,974	6.7	6.0	2,533	10.7	5.7	5.323
24 Sept.	15.7	9.7	7,084	12.2	7.0	2,860	14.2	7.0	5,677
1 Oct.	19.7	10.2	6,946	15.5	8.5	3,523	19.3	7.8	6,516
Uncut	18.2	13.0	7,329	26.8	12.7	4,949	18.8	10.5	6,814
L.S.D. 0.05	3.6	0.7	NS	4.8	1.1	426	4.9	1.0	498
C.V.	18.6	3.2	6.9	23.4	8.4	9.3	24.8	9.5	7.1

* 5 and 10 days later at locations 2 and 3, respectively; ** mean 3 tests at each location

Post-harvest fall cutting of alfalfa reduced late fall root reserves, succeeding stands and cut 1 hay yields. The root reserve levels attained varied among years and locations; however, within a location the most critical post-harvest fall cutting treatment, from which the lowest root reserves were obtained, occurred on the same date each year. The insignificance of the year X fall cutting treatment interaction at the locations made it possible to draw a fall management map for alfalfa by determining the critical post-harvest fall cutting date at 40 selected test-year sites in Ontario.

Critical Fall Harvest Period for Birdsfoot Trefoil

Table 2. Fall cut date effects on the succeeding yield of dry matter (kg/ha) and plant stand (m^2) of three birdsfoot trefoil varieties average over two studies

Fall	Empire		Viking		Leo		Mean		
cut date	cut 1	plants	cut 1	plants	cut 1	plants	cut 1	total	plants
30 Aug.	2708b	67bc	2204bcd	97a	2412bcd	72ab	2443	4971	78
7 Sept.	2310c	50d	1579d	63a	2088d	66bc	1991	4468	59
14 Sept.	2528bc	56cd	1852cd	74bc	2172cd	69bc	2185	4690	67
21 Sept.	2583bc	67bc	1981bcd	98a	2276bcd	78ab	2282	4940	81
28 Sept.	2985b	71bc	2299bc	88ab	2345bcd	85a	2543	5289	80
5 Oct.	3515a	82b	2550ab	96a	2772ab	81ab	2944	5780	86
Uncut	3545a	97a	3012a	98a	3045a	78ab	3202	6700	91

Three varieties of birdsfoot trefoil were examined over two studies and six years to determine the critical fall harvest period for the species. The critical period of all varieties was found to be about September 7 at the Elora Research Station. Succeeding yields and plant stands were improved if the fall harvest occurred before or after that time. This critical period is about 10 days earlier than that determined for alfalfa, and a similar earlier critical period might be expected for all the crop areas in Ontario.

Critical Fall Harvest Period for Timothy, Orchard, Brome

Table 3. Autumn harvest effects on the fall and succeeding year's yield of three grasses, DM/lbs/ac, two test - five year mean

Species	Harvest date	Autumn harvest yield	Autumn harvest Nov 1 ht/cm	Succeeding year cut 1	Succeeding year total	Mean cut dates cut 1	Mean cut dates total
Climax timothy							
	Sept. 1	660	14	5562	7327	4314	6818
	7	944	12	5239	6957	4108	6487
	14	1220	10	5195	6875	3975	6399
	21	1367	10	5115	6847	3812	6191
	28	1547	9	4980	6676	3852	6143
	Oct. 3	1566	8	4943	6694	4088	6217
	Uncut	-	25	5530	7488	4536	7210
	Mean	1217	13	5223	6976	-	-
Frode orchardgrass							
	Sept. 1	870	19	3450	6594		
	7	1122	17	3153	6121		
	14	1507	15	3021	6127		
	21	1637	14	2884	5809		
	28	1762	12	3097	5790		
	Oct. 3	1882	11	3719	5830		
	Uncut	-	44	3510	6792		
	Mean	1463	19	3262	6152		
Saratoga bromegrass							
	Sept. 1	629	17	3930	6358		
	7	906	14	3932	6384		
	14	1096	13	3710	6195		
	21	1195	11	3437	5919		
	28	1296	11	3489	5962		
	Oct. 3	1284	10	3602	6129		
	Uncut	-	32	4569	7349		
	Mean	1068	15	3810	6328		

Successive weekly autumn harvests were superimposed on three species in two studies over five years. The species had previously been harvested for hay and aftermath pasture, last cut Aug. 10.

- Autumn harvests had significant effects on the succeeding year's production with every species (summary in 1977 report).

- Orchardgrass provided higher autumn yields than timothy or brome which were similar.

- Almost every year, the succeeding June hay harvest and total yield was lowest where the species had been cut during late September.

- The early September harvest did not affect yield.

- Averaged over the five year period, the severest autumn harvest produced 89, 77 and 79% of the uncut check in June and 89, 83 and 83% of the uncut check in total dry matter yield for timothy, orchard and brome, respectively.

- In no case was there any visible evidence of winterkilling from the fall harvests.

- The critical date for these grasses is very similar to alfalfa.

Cutting vs Browsing Alfalfa During the Fall

Table 4. Effect of date and severity of autumn harvest on succeeding Saranac alfalfa yield, 5 year mean, DM/lbs/ac

Autumn treatment		Height cm[1] Oct. 23	Height cm[1] May 8	Plants sq/ft[1] May 8	Yield at fall cut	Succeeding yield cut 1	Succeeding yield total
Aug. 25	cut	13.8	23.5	6.5	1775	3699	7528
	browse	21.8	30.5	10.1	-	4434	9018
Sept.17	cut	6.6	23.0	6.3	2330	3120	6753
	browse	18.2	26.5	8.9	-	3985	8747
Oct. 15	cut	5.0	28.0	7.4	1442	3828	7583
	browse	18.8	31.2	10.2	-	4336	9209
Check	uncut	41.2	33.5	10.3	-	4376	9458

1 - 3 year mean

Fall top growth was completely or partially (6 inches browsed off) removed from Saranac alfalfa before, during or following the critical food storage period.

The objective was to investigate the effects on succeeding stand and yield of utilizing excessive fall top growth. The study was conducted over a five year period with a new seeding in its first production year being used each year.

The height of growth in the fall appeared to be closely related to the succeeding spring height (vigor).

Cutting in the fall significantly reduced the succeeding stand, first cut and total yield, every year. It completely killed the stand in one test year.

Browsing at anytime during the autumn had no significant effect on either succeeding stand or yield. Indeed, its stands persisted following the winter where the fall cutting treatments killed.

Fall Top Growth Height Effects on Alfalfa Persistence

Table 5. The effect of November established top growth regimes on the winter crown (3 cm depth) temperature (F) and succeeding yield of Saranac alfalfa, DM/lbs/ac

Established top growth	Winter			
	1970-71	1972-73	1974-75	Mean
Lowest crown temperature recorded				
2" top - snow off	13.0	11.5	6.0	10.1
2" top - snow on	29.0	21.5	20.5	23.7
6" top - snow on	30.0	24.5	25.0	26.5
12" top - snow on	29.0	29.0	26.0	28.0
Succeeding yield				
2" top - snow off	killed	killed	killed	-
2" top - snow on	4500-9030[1]	killed	killed	-
6" top - snow on	4540-9100	killed	3780-7985	4460-8542
12" top - snow on	5050-9790	4885-8907	3720-8133	4552-8943

1 - cut 1 and total yield

For a three year period, the insulation effect of varying amounts of fall top growth and associated snow, on the persistence and succeeding yield of Saranac alfalfa, was studied. First production year stands were used each year. The alfalfa was cut three times prior to September, followed by post-harvest height regimes superimposed on the top growth about mid-November. Snow was periodically blown off certain plots during the winter (about five times).

The lowest crown temperature was recorded each year under the 2 inch canopy and was particularily low where the snow was occasionally removed. Crown temperatures were highest under the 12 inch fall top growth.

Alfalfa killed every year where the snow was periodically removed, and killed in two of the three years where the stubble was only 2 inches high.

Heavy ice accumulation from rains in January - February 1973, killed the alfalfa under the 2 and 6 inch canopies but the crop survived where the top growth perforated above the ice and crusted snow of the 12 inch top. The latter also produced a high succeeding yield.

Effect of Fall Top and Timothy Association on Alfalfa Persistence

Table 6. Influence of fall top growth regimes and timothy associations on winter crown temperature (F) and succeeding yield of Saranac alfalfa, DM/lbs/ac

Fall established top growth-mixture		Lowest temperature 1974-75	1975-76	1976-77	Cut 1 DM 1975	1976	1977	Total DM 3 yr mean
2" top	alfalfa	24.5	12.8	1.0	4644	killed	killed	-
snow off	alf + tim	24.6	13.6	0.0	6303	killed	killed	-
2" top	alfalfa	28.4	28.2	23.3	5457	3211	5332	8972
snow on	alf + tim	28.1	28.2	22.0	6671	4188	5147	9463
6" top	alfalfa	29.5	30.8	27.0	5615	3621	5287	9516
snow on	alf + tim	29.3	30.4	27.0	7248	4791	5395	10402
12" top	alfalfa	30.6	30.8	28.7	7390	3469	5090	10021
snow on	alf + tim	30.6	31.1	29.0	6787	4876	5153	10304
Mean[1]	alfalfa	28.3	25.7	20.0	6154	3435	5236	9504
	alf + tim	28.1	25.8	19.5	6902	4618	5231	10056

1 - snow off treatment omitted from yield mean

The winter insulation effects of timothy, on Saranac alfalfa crowns, in an alfalfa-timothy mixture, were monitored twice daily during the winter over a three year period. First production year stands, cut three times prior to September, were used each year and upon which mid-November stubble height regimes were established. Snow was occasionally removed from some plots during the winter.

Lowest crown temperatures were obtained where the snow was occasionally removed. This resulted in the alfalfa winterkilling in two of the three winters.

Crowns were warmer where the top growth was high.

Timothy did not provide a higher temperature at the 2 cm crown depth in any association or in any year.

The mixture generally produced higher hay yields than pure alfalfa but its yields were similar to pure alfalfa where a foot of top growth remained over winter.

Effect of Fall Top and Grass Species Association on Alfalfa Persistance

Table 7. Fall top growth regimes and grass association effects on succeeding yield and compostion of Saranac alfalfa mixtures, DM/lbs/ac

Established top growth -	alfalfa mixture	1980 cut 1 DM	1980 cut 1 % grass	1980 total DM	1981 cut 1 DM	1981 cut 1 % grass	1981 total DM
2" top	Itasca	3409	33	6719	4130	60	9254
snow off	Saratoga	3056	65	6813	4982	57	9685
	Hallmark	2270	11	6386	4034	37	9257
	Mean	2792	36	6339	4373	51	9400
2" top	Itasca	4872	27	10196	4787	35	10329
snow on	Saratoga	5231	51	10532	5437	37	11734
	Hallmark	5514	42	10661	5016	36	10817
	Mean	5205	40	10463	5080	36	10960
6" top	Itasca	4553	30	9555	5230	25	11378
snow on	Saratoga	6055	70	11183	5266	50	11228
	Hallmark	5683	55	10801	5535	43	11757
	Mean	5430	52	10513	5344	39	11454
12" top	Itasca	4805	11	10230	5350	27	11327
snow on	Saratoga	5436	35	10812	5256	57	11077
	Hallmark	4886	32	10341	5675	50	12121
	Mean	5042	26	10461	5427	45	11508
Mixture	Itasca	4593	31	9873	8.2[1]	3.92[2]	3.45
mean	Saratoga	5090	53	10276	6.6	3.24	3.24
1980-81	Hallmark	4826	38	10267	5.9	3.16	3.32

1 - roots/sq.ft; 2 - root wt. g; 3 - etiolated growth g for 1981 alfalfa data only

Winter insulation effects of timothy, brome and orchardgrass on Saranac alfalfa crowns were monitored over a two year period following the establishment of mid-November stubble height regimes. Snow was occasionally removed from one treatment.

Snow removal significantly reduced succeeding yield and alfalfa persistence both years. It also affected the persistence of orchard grass; however, brome responded well to this treatment and provided the highest grass content in the first cut hay. Yields were similar from other fall top growth and mixture associations.

The bromegrass-alfalfa mixture yielded very well but generally contained the highest grass content. Brome significantly reduced the alfalfa stand, as well as alfalfa root weight and carbohydrate reserves, measured by etiolated growth, below timothy. These measurements indicate the competitive ability of bromegrass.

Grass species had no significant effect on alfalfa crown temperatures.

Time and Rate of Application of Potassium on Persistence and Yield of Saranac Alfalfa

Table 8. Time of application of potassium on Saranac persistence and yield, no fall cutting treatment summary over years, DM/lbs/ac

Time application K_2O/ac	Experiment and year						Mean yield subs
	1626-1978	1626-1979	1627-1979	1627-1980	1628-1980	1628-1981	
Cut 1 yield							
100 lbs after each cut	3788	4263	4750	4244	5084	3870	4348
300 lbs after third cut	4095	4340	5184	4901	5169	3784	4578
300 lbs on Sept. 27*	4555	4238	4829	4547	5156	3544	4477
No fertilizer	3423	4111	4994	4433	5092	3257	4218
Mean - main	3965	4238	4938	4531	5125	3614	
Total yield							
100 lbs after each cut	8326	8727	10276	9414	9825	9886	9408
300 lbs after third cut	8662	8987	10799	10164	10242	9714	9762
300 lbs on Sept. 27*	9050	8675	10434	9889	10282	9660	9666
No fertilizer	7588	7926	10325	9298	10281	9099	9085
Mean - main	8406	8579	10459	9691	10157	9589	
LSD (0.05)	Cut 1	Total					
Mains (years)	435	544					
subs (time)	206	252					
M x S	505	618					
C.V. %	8.0	4.6					

* 10 days after critical fall harvest date

Saranac alfalfa was seeded in three studies, each harvested over two years on a three cut system where the main plots consisted of an additional fall cut on the critical date vs no fall cut. The sub plots were 100 lbs K_2O per acre applied after each cut, 300 lbs after the third cut, 300 lbs 10 days after the critical date, and an unfertilized check. Each study was run on a silt-loam soil testing high or high plus in potassium.

Fall cutting reduced succeeding yields and stands significantly, and provided considerable variability among years. Potash applied after the third cut often produced higher succeeding yields but was not always significant; see the 1978, 1979 and 1980 reports for data.

In the summary table presented of the no fall cutting split, with years as the main plots and time of application as the subs, the 300 lb rate applied at one time in the fall significantly outyielded the 100 lb rate applied after each cut and the unfertilized check treatment.

Table 9. Rate of application of potassium on Saranac persistence and yield, no fall cutting treatment summary over years, DM/lbs/ac

Rate K_2O/ac	1776		1777		1778		mean
	1978	1979	1979	1980	1980	1981	subs
Cut 1 yield							
100 lbs	4725	4247	4792	4233	5299	4315	4602
200 lbs	4708	4683	5364	4334	4844	4156	4665
300 lbs	4618	4431	4996	3777	5071	4093	4498
no fertilizer	4531	4167	5444	4280	5284	4394	4683
Mean (main)	4646	4382	5149	4131	5124	4240	
Total yield							
100 lbs	9876	8196	10266	9510	9977	10177	9667
200 lbs	10104	9041	10817	9663	7398	10184	9625
300 lbs	9934	9078	10694	9248	10096	8128	9530
no fertilizer	9286	7946	10858	9451	9644	10535	9620
mean (main)	9800	8565	10659	9468	9413	9756	
L.S.D. (.05)	Cut 1	Total					
mains (years)	214	107					
subs (rates)	N.S.	N.S.					
M x S	N.S.	N.S.					
C.V. %	7.6	5.3					

Saranac alfalfa was seeded in three studies, each harvested over two years on a three cut system where the main plots consisted of an additional fall cut on the critical date or not cut. The sub plots were 100, 200 or 300 lbs per acre of K_2O applied annually after the third cut and an unfertilized check. Each study was run on a silt-loam soil testing high or high plus in potassium.

Fall critical date harvests reduced succeeding yield by 67% and stands by 48% below that of no fall cutting. The fertilizer rates did not significantly affect these variables.

In the summary table presented, the analysis was run on the uncut fall split with years as mains and rates as sub plots. No significant differences among fertilizer rates were obtained in cut 1 or total yield.

Crown and Root Temperature Effects on the Survival and Succeeding Growth of Freezer Exposed Field Excavated Alfalfa Roots During the Winter

Table 10. Effect of freezer temperatures (F) on the survival and growth of early January excavated Saranac alfalfa roots

Degree F	% Survival - year						Harvest data - 5 yr mean			
	1977	1978	1979	1980	1982	Mean	Stage[1]	Ht/cm	Stems[2] plant	Wt[2] /plant(g)
30	100	97	93	96	93	96	3.9	34	4.9	11.0
25	90	90	91	56	90	83	3.8	35	5.2	8.7
20	65	77	75	46	87	70	2.6	33	4.0	7.6
15	71	-	55	20	37	46	1.7	32	3.8	6.3
10	55	40	26	40	-	40	1.5	29	2.9	3.4

1 - full flower 5, vegetative 1; 2 - per live plant

January field excavated, two year old Saranac alfalfa roots were exposed for a 24 hour period to low freezer temperatures in each of five winters. Following exposure, the roots were emersed in saw dust and dehardened over a period of five days at 34F. Roots were then trimmed to 6 inches, planted in vermiculite and grown to early flower to study the effect of such temperatures on survival and growth.

Lowering the temperatures, particularly below 20F, reduced alfalfa survival. Lowering the root temperature delayed maturity, shortened the plant height, reduced the number of stems per plant and had a marked effect upon the yield of the surviving plants.

These and other findings indicate that June hay yields may be strongly affected by the crown temperature of the alfalfa during the preceeding winter.

Table 11. Effect of hours of freezer exposure at 20 F on the survival and succeeding growth of Saranac alfalfa roots

Hours at 20F	% survival	Ht cm	Stage[1] maturity	Stems/ plant	Plant wt/g
Test 1					
0	90	29	2.5	3.4	6.0
8	93	26	2.5	3.7	6.0
16	68	24	2.0	3.1	5.0
24	26	24	1.5	2.4	4.0
48	17	22	1.7	1.5	3.0
72	13	25	1.7	1.8	5.0

1 - vegetative-1, full flower-5

Test 2 - Field exposed, mean December 1977 and 1979					
0 day	91	36	-	5.2	6.5
4 days	75	32	-	4.5	5.6

Saranac alfalfa roots were field excavated, exposed for various time periods in a freezer at 20F, and handled in a similar manner as reported in Table 10.

The hours of exposure at 20F markedly affected persistence and the development of the surviving plants (see 1982 report). Prolonged exposure at this temperature reduced the stand, delayed maturity, shortened the growth, reduced the stems per plant and the yield.

In the field exposed studies, roots were obtained the day prior to freeze-up in each of two years. This was followed by an extreme drop in air temperature to about 5F. Roots were again collected within 3-5 days. The survival and performance of these field exposed roots were very similar in the growth room to those exposed in the freezer.

Table 12. January vs March survival and succeeding growth of high and low reserve roots of Saranac alfalfa subjected to 20F freezer exposure for 24 hours

Reserves-year	% Survival		Stems/plant		Height cm		Weight/g	
	Jan.	March	Jan.	March	Jan.	March	Jan.	March
Low Reserves								
1976	83	30	5.3	4.0	27	26	5.9	3.0
1977	70	16	2.8	0.5	30	45	4.4	1.1
Mean	76	23	4.0	2.2	28	36	5.1	2.0
High Reserves								
1976	74	43	4.5	4.7	34	28	7.3	4.2
1977	80	70	2.9	2.7	30	48	5.4	6.5
Mean	77	56	3.7	3.7	32	38	6.3	5.3

1 - per live plant

Saranac alfalfa was harvested four vs three times during the crop year to establish low vs high root reserve regimes on productive alfalfa stands in each of two years. Roots were excavated from the field in early January and March, subjected to a freezer temperature of 20F for 24 hours, then handled similarily to that reported under Table 10.

Low and high reserve plants produced similar survival numbers following exposure at 20F in January, but by March survival was reduced at both levels, especially at the low regime. Plant weight and stems per plant were also less on the surviving low reserve plants than on the high reserves, particularily in March.

The decline in survival and other plant characteristics by March is an indication of respiration and possibly root growth uses overwinter. It further indicates that alfalfa plants are killed more easily as winter progresses, especially where root reserves are low, and as indicated in the 1977 and 1979 reports, at higher root temperatures.

ANNUAL PASTURE AND STORED FEED SECTION

Annual forage crops were very important on Ontario farms at one time, however, with more consistent performance and high yields from perennial forages, they are now used only in those years of feed shortages. In recent years, some sorghum family hybrids have provided exceptionally good yields. It appears that they may deserve more detailed studies to learn if they have a place on some livestock farms.

Table 1. Fodder beet varieties, DM/lbs/ac

Variety	Roots			Tops			Total	
	1981			1981				
	DM	%IVD	1982	DM	%IVD	1982	1981	1982
Monobamba	7091	87.5	13271	5156	81.3	3344	12661	16605
Triumf	7668	90.0	13684	4446	81.4	2433	12465	16117
Monoblanc	7021	86.1	14844	5006	77.9	3869	12567	18713
Brigadier	6150	87.6	12548	3554	80.5	2618	9703	15166
Barres	10343	88.9	13087	3695	77.7	2905	13520	15992

1981 seeded 28 inch rows; 1982 - 21 inch rows; seeded May 15

The recent mechanization of fodder beets, and their blending with corn silage in Western Europe, initiated these studies on yield performance of a few varieties at Elora.

Dry matter yields were higher in 1982 than in 1981 which may have been due to the narrower row width employed. This narrow spacing also produced a lower yield of top and a higher root:top ratio. The IVD content would indicate that fodder beets may be a very useful energy source.

Table 2. Annual pasture and stored feed crop yields, DM/lbs/ac

Crop harvest	First cut date	Cut 1 DM	Total DM	No cuts	%IVD 1981
Pasture - 2 year average					
Tetra ryegrass[1]	July 18	2093	5860	4	
Oats	July 18	5358	-	1	
Hybrid sorghum	July 30	6112	8075	2	
H. sorghum x sudan	July 30	6940	8356	2	
H. sudan	July 30	4081	7325	2	
Corn 7" rows	July 30	6727	-	1	
Fodder rape	Oct. 30	6370	-	1	86.6
Marrowstem Kale	Oct. 30	9064	-	1	78.3
Stored Feed - 4 year average					
Tetra ryegrass[1]	Aug. 14	4014	6183	3	
Oats	July 31	6053	-	1	
Oats + peas	July 31	6512	-	1	
Millet	July 30	4873	-	1	
Corn 30" rows	Sept 15	11768	-	1	77.0
Hybrid sorghum	Sept 15	13708	-	1	60.7
H. sorghum - sudan	Sept 15	12805	-	1	61.3
H. sudan	Aug. 5	7819	-	2	71.0
Common peas[1]	July 30	4118	-	1	
Forage peas[2]	July 30	3111	-	1	

1 - 1 year's data; 2 - mean 3 varieties; seeded May 10

The hybrid sorghums and their crosses yielded well as green chop or stored feed, the latter being taken about heading. Generally, in similar studies over the years, oats have always looked very good; new European fodder peas and the tetraploid ryegrasses and ryegrass hybrids tested, have not been very impressive.

Table 3. Seeding rate and distribution of Westerwolth DM/lbs/ac

Seeding rate	Hay		Pasture		
	Cut 1 July 12	Total 3 cuts	Cut 1 June 20	Total 6 cuts	Mean per cut
10	2067	6076	692	4250	802- cut 1, June 20
15	2084	6215	726	4666	898- cut 2, July 12
20	2200	6330	632	4498	1401- cut 3, July 8
25	2113	6290	962	4837	521- cut 4, Sept 15
30	2276	6377	996	4828	415- cut 5, Oct. 2
Mean	2148	6256	802	4616	579- cut 6, Nov. 5

Table 4. Yield of Westerworlth vs Italian ryegrass, DM/lbs/ac

Species harvest	Harvest cut 1	cut 2	cut 3	total
Pasture				
Westerwolth	872	1179	1512	5314 (6 cuts)
Italian	941	1123	1232	5037 (6 cuts)
Hay				
Westerwolth	2403	2676	1631	6710
Italian	2964	2562	1492	7018

Westerwolth and Italian ryegrass were seeded in several studies (see 1962 report), only a few results are presented in Tables 3 and 4. They were harvested at a vegetative pasture stage or for hay and aftermath pasture.

Table 5. Effect of seeding methods, rates and dates on the yield of Garton's Early Giant fodder rape, DM/kg/ha, 3 year mean

Seeding method - rate kg/ha	Study 1 DM Oct 28	Study 2 Seeding date	DM Oct 28
Rows - 71 cm			
0.56	8824 a[1]	May 23	11815 a
1.12	7679 b	June 6	10403 b
1.68	7526 b	June 19	8363 c
2.24	7501 b	July 3	6973 d
Mean	7882	July 13	7623 cd
Broadcast		July 29	4932 e
2.24	6633 c	Aug. 7	3341 f
4.48	6537 c		
6.73	6760 c		
Mean	6612		

1 - means with a common letter are not significantly different at .05 level

Summary of some studies

Production practices that included two seeding methods and seven seeding rates in one study, and a combination of seven seeding and five harvest dates in another, were compared in field studies over a five-year period. Data were collected on dry matter yield and several plant characteristics. The lowest seeding rate in the row plantings produced the highest yield of dry matter every year. Seeding rates had no effect on yield within the broadcast method. Plant weight, stem diameter and leaf content were greater under the row seeding method than under the broadcast system, but none was affected strongly by seeding rate under either method. Plant height and dry matter content at harvest were not affected either by the methods or by the rates of seeding used. On the other hand, date of seeding had a marked effect on the final dry matter content and yield. Early seeding dates produced the highest yields. Dry matter yield increased several fold throughout the autumn harvest period where mid to late season seedings were employed.

Table 6. Effect of seeding and harvest date on yeild DM/kg/ha of Dunn's marrowstem kale, 2 year mean

Seed date	Harvest date Sept. 1	Oct. 1	Oct. 30	Mean
May 25	9966	12297	14349	12190
June 5	6636	10840	12959	10002
June 20	5807	8419	10694	8356
July 4	2130	5267	7959	5418
July 17	1065	4136	7343	4228
July 30	336	2770	4664	2751
Aug. 12	22	1043	2646	1460
Mean	3709	6396	8659	
Mean DM(%)	9.8	10.8	13.8	
Mean height (cm)	53	77	80	

Table 7. Method and rates of seeding effects on the yield DM/kg/ha, leaf content and plant height of Dunn's marrowstem kale on 30 August and 30 October, 3 year mean

Seeding rate kg/ha	DM kg/ha	% leaf	Height cm	DM kg/ha	% leaf	Height cm
Rows						
1.12	4997 d*	55 a	78 a	16723 a	25 a	126 a
2.24	5223 c	52 bc	78 a	17125 a	26 a	119 ab
3.36	5424 bc	53 abc	75 ab	15794 b	25 a	118 b
4.48	5599 ab	52 ab	72 b	15166 b	24 a	118 b
5.60	5700 a	51 c	71 bc	13509 c	23 a	114 bc
Mean	5398	52	75	15617	24	119
Broadcast						
2.24	4645 e	54 ab	67 cd	12580 d	25 a	110 cd
4.48	5323 c	54 ab	64 de	12782 d	23 a	115 bc
6.72	5549 ab	53 abc	64 de	12778 d	23 a	112 bcd
8.96	5725 a	55 a	61 e	12605 d	24 a	106 d
Mean	5323	54	64	12677	24	111

* Means with a common letter within a column are not significantly different at .05 level

Agronomic studies on marrowstem kale (Brassica oleracea L.), consisting of seven seeding and five harvest dates in one trial, two seeding methods and nine seeding rates in another, and five silages in another, were conducted for up to 3 years. Data were collected on dry matter yield and several yield and quality components. Delaying the date of seeding reduced yields in the autumn but the converse held for delaying the date of autumn harvest. Similar results were obtained with dry matter content and plant height. Medium to high seeding rates in broadcast stands produced the highest yields for early pasture; light seeding rates in rows yielded the highest for later pasture. Leaves constituted 55% of the pasture herbage in the early harvest and 25% in the late harvest. Height, stem diameter, and plant weights were higher in the row compared with the broadcast method, and at the lighter seeding rates.

Table 8. Quality assessment of kale-corn stover silages blended for different moisture contents

Blended moisture content	Ratio† kale to corn stover	% IVD		% CP	
		1975	1977	1975	1977
50	1:8	62.9	45.9	6.9	5.1
55	1:4	63.9	50.2	7.8	6.5
60	3:8	64.0	53.9	7.2	7.1
65	1:2	66.1	58.9	8.8	7.9
70	5:8	68.4	64.0	10.2	8.7
75	3:4	69.3	66.7	10.4	9.3
Corn stover		62.2	45.6	6.8	4.9
Kale		83.6	78.5	18.3	16.1
LSD (0.05)		2.1	1.8	0.7	0.6
CV (%)		1.8	2.2	4.6	6.8

† Mean moisture content of kale was 85, corn stover 45

Midas marrowstem kale was grown in different row width associations with United 106 corn in two studies and ensiled in different moisture blends with corn stover in another. Highest dry matter yields were obtained where a single row of kale was grown at 30 cm to the side of a corn row. This combination also provided the lowest moisture content feed and the highest in vitro digestibility and crude protein content. Changing the corn row width had no significant effect upon yield, plant height, in vitro digestibility, kale leaf or corn ear content. Blending kale with corn stover to provide a silage of about 70% moisture increased the digestibility and protein content of the feed and provided a silage that kept well in storage.

LEGUME PLOWDOWN SECTION

Ontario farm crops and practices have changed dramatically during the past 25 years. The wide use of selective herbicides has had marked effects particularly on the increased production of grain crops. Indeed, corn production has doubled in the past decade or so. But the energy requirement to produce these crops, plus the soil structure and erosion problems frequently associated with them, has recently caused concern among farmers and researchers alike.

Continuous corn growing, on many farms, is presently producing lower or stable corn yields in spite of the yield improvement in new hybrids. Consequently, cash crop farmers are again becoming interested in forage crops, particularly legumes. The thought is that they might supply the nitrogen for succeeding grain crops while improving the structure and active organic matter content of the soil.

The studies reported in this section provide some information on the dry matter and nitrogen yields of legume forages. Most of the information is on red clover seeded in early May as a seeding year "break crop." No attempt has been made to measure succeeding corn yield responses beyond the first year following plowdown. All reported root yields are from the top 6 inches (15 cm) of the soil only.

See past reports for analysis of variance, etc.

A few adapted legume species were evaluated as plowdown crops including a few varieties of red clover. The crops were direct seeded at normal rates, harvested at the bloom stage in July, except sweet clover which was not cut, and the aftermaths plowed in mid-October of the seeding year. Succeeding corn yields were taken.

Table 1. Species-variety effects on seeding year October 15 plowdown, 4 year mean, DM/lbs/ac

Species-variety	Top	Root	Total N	Succeeding corn/bu/ac
Saranac alfalfa	2171	3186	140	105
Yukon sweet clover	4388	2740	183	88
Ottawa red clover[1]	1882	1712	104	105
Norlac red clover[2]	435	2091	79	99
Common red clover[3]	2200	1522	107	97

1 - double cut; 2 - single cut; 3 mean 6 double cut lots.

Sweet clover produced the highest yield of plowdown material and nitrogen but the lowest yield of corn. The plowed material of sweet clover was coarse and lignified and probably took longer to break down and liberate nitrogen.

The common double cut lots performed similarily, Ottawa and one common double cut lot excepted (see Table 7).

Single cut red produced less fall top growth but good root growth following the late July harvest. Although it had a low nitrogen yield, its corn yields were similar to the other types (see 1978-83 annual reports for detail).

Ottawa double-cut red clover and Saranac alfalfa were direct seeded or seeded under oats, in the early spring, for three successive years. The direct seedings were harvested for hay in late July, the companion crops were removed at maturity cut to a low 2 1/2 inch stubble height. Yields of top growth and roots to a depth of 6 inches (15 cm) were taken at plow down on 15 October. Top and root material were analyzed for nitrogen content. The purpose of the study was to obtain some information on these legumes as seeding year plowdown crops.

Table 2. Seeding method effects on red clover and alfalfa at October 15 seeding year plowdown, DM/lbs/ac

Crop-seeding method	1977	1978	1979	Mean	Total DM	Total Calculated N
Top DM						
Red clover direct	2304	793	2169	1755	4218	123
Red clover + oats	2514	910	867	1430	3116	91
Red clover mean	2409	851	1518	1593		
Alfalfa direct	2038	1024	2297	1786	4231	112
Alfalfa + oats	1720	1119	932	1257	2613	69
Alfalfa mean	1879	1071	1614	1521		
Root DM						
Red clover direct	2384	3613	1392	2463		
Red clover + oats	1859	2351	847	1686		
Red clover mean	2124	2982	1119	2024		
Alfalfa direct	2692	1756	2888	2445		
Alfalfa + oats	1707	1040	1323	1356		
Alfalfa mean	2200	1402	2105	1900		

In each of the three years, establishment was quite satisfactory. The direct seedings of alfalfa and red clover produced very similar amounts of top growth and root material at plowdown following the July harvest. The results were also somewhat similar when the two legumes were seeded under oats; however, red clover root production was generally better than alfalfa under the oat competition, 1979 excepted. The results obtained during the dry autumn of 1978 are of interest. In that year, top growth production was low but root production was very high, a normal finding during dry fall periods.

Table 3. Companion crop effects on October 15 plowdon of seed year Ottawa red clover, DM/lbs/ac

Crop-Management	Top 1980	Top 1981	Top 1982	Top Mean	Root 1980	Root 1981	Root 1982	Root Mean
Wheat-short[1]-fall[2]	trace	439	625	532	419	trace	101	260
wheat-long-spring	2329	1400	3129	2286	1579	138	1384	1034
Wheat-short-spring	1810	491	2320	1540	2225	166	1676	1356
Barley-long-spring	1819	2249	3019	2362	1257	3018	1081	1785
Barley-short-spring	1514	2012	2611	2046	1828	2277	1521	1875
Oats-long-spring	1199	1651	2655	1835	1423	3668	1220	2104
Oats-short-spring	954	1735	1714	1468	1786	3325	1582	2231
Direct-spring	2275	2033	2172	2160	2554	3834	1828	2739

Crop-Management	Total N 1980	Total N 1981	Total N 1982	Total N Mean	Succeeding corn bu/ac 1981	Succeeding corn bu/ac 1982	Succeeding corn bu/ac Mean
Wheat-short[1]-fall[2]	-	-	-	-	93	120	106
Wheat-long-spring	142	45	140	109	101	134	117
Wheat-short-spring	150	19	123	97	101	132	116
Barley-long-spring	116	134	128	126	107	150	128
Barley-short-spring	128	136	128	130	113	157	135
Oats-long-spring	103	154	120	125	112	154	133
Oats-short-spring	106	147	101	118	115	161	138
Direct-spring	161	170	193	175	120	166	143
Check	-	-	-	-	91	126	109

1 - short 2-1/2" vs long 12" stubble; 2 - fall seeded with wheat vs spring seeded

Red clover seeded directly or with winter wheat in the fall, failed to survive the winter in each of the three years. Indeed, red clover also gave the lowest production under wheat even when spring seeded. Long stubble produced more red clover top but less root with each companion crop. Top growth was very good seeded under barley, root growth was superior under oats, both were inferior to the direct seeding. The latter produced more nitrogen in the plowdown material and also the highest succeeding corn yields, followed rather closely by oats and barley. All red clover plowdowns were superior to the high yielding check treatment.

Single and double cut red clover are used for plowdown, the former does not bloom in the seeding year or in the aftermath of succeeding years. The single cut usually retails at a lower price than the double cut. This study was conducted to examine the performance and usefulness of the two types.

Table 4. Single vs double cut red clover type effects on seeding year October 15 plowdown, 5 test - 4 year mean, DM/lb/ac

Type-Method	Top	Root	Total N
Norlac-single-direct[2]	382	2282	80
Ottawa-double-direct[2]	1970	2302	129
Norlac-single + oats[1]	1139	2821	115
Ottawa-double + oats[1]	1735	3325	147

1 - 1981 data only, oat companion crop; 2 - harvested for hay in July.

Following a late July hay harvest, the direct seeded single cut produced a low top and nitrogen yield but a similar root yield as the double cut. In 1981, under oats, the root and top yield of the single cut was improved over direct seeding (2386 and 320, respectively) but was markedly inferior to the double cut type.

Direct seeded Ottawa red clover was planted at various seeding rates, over a period of three years, in early May and in mid-summer. The objective was to determine the best seeding rate and to obtain an evaluation of such seedings for plowdown and on succeeding corn yields.

Table 5. Date and rate of seeding effects on top and root yield of Ottawa red clover at seeding year plowdown on October 15, 2 year mean, DM/lbs/ac

Date-rate	July[1] cut	Top	Root	Total	Nitrogen	Succeeding Corn/bu/ac
May 5[2]						
4	4017	2151	2074	4225	130	98
6	4000	2265	2591	4846	149	95
8	4080	2123	2788	4911	149	104
10	3979	1888	2552	4440	134	97
12	4150	1976	2814	4790	146	96
Mean	-	2080	2564	4642	141	98
July 15						
4	-	1081	1946	3027	99	102
6	-	1271	1799	3070	101	104
8	-	1393	1969	3360	111	103
10	-	1430	2311	3740	123	100
12	-	1440	2339	3779	125	103
Mean	-	1323	2073	3395	112	102

1 - 3 year mean; 2 - cut for hay

The May seeding produced a high yield of clover, blooming about July 25, with seeding rates having no significant effect on yield.

Aftermath growth from the May seeding yielded more top and root at plowdown than the first growth from the July seeding; root yields were also higher. Seeding rates had no significant effect on top yields but reduced root yield at the low rate. Both root and top yields were reduced at low seeding rates in the July seeding.

Nitrogen yield was higher in the May seeding but surprisingly good for the summer seeding. Corn yields were not affected by seeding rate but were significantly higher both years from the July seeding probably due to its less lignified material breaking down and liberating nitrogen and other nutrients faster than the May seeded material. The check plots, where no red clover was seeded, averaged 89 bu corn over the two years.

May 5 direct seeded Arlington red clover was cut at three dates during July in three successive seeding years. The objective was to learn what effect such clipping would have on future flowering, seed production (see seed production section) and top and root plowdown material.

Table 6. Some effects of seeding year cutting date and herbage management on October 22 plowdown of Arlington double cut red clover, 3 year mean, DM/lbs/ac

Cut date	Herbage treatment	Cut date DM	Yield Top	Yield Root	Yield Nitrogen	Succeeding[1] Corn/bu/ac
July 3	left	-	2548	1183	110	105
	removed	732	2196	1324	107	109
	mean		2312	1253	108	107
July 15	left	-	1720	1805	107	109
	removed	2846	1821	1944	113	109
	mean		1770	1874	110	109
July 29	left	-	1115	2028	93	114
	removed	3724	1102	2087	94	114
	mean		1108	2057	93	114
Uncut check			2306	1008	101	112

1 - 2 year mean.

Seeding year first crop yields increased dramatically in July every year. The crop height was about 6, 18 and 28 inches high at the progressive cut dates.

The red clover grew through the clipped material left on the plots following all cut dates.

Early cutting produced the most top in October but smaller roots. The uncut plots produced the smallest roots. This type of root growth occurred every year.

Removing the herbage following cutting decreased the top growth at the early cut date but increased the root growth every year at other cut dates.

The uncut plots and the early cut date produced flowers; the amount of bloom on the early cut date plots was lower some years than on the uncut plots.

Nitrogen yields were lower every year following the late cutting but corn yields were higher there, probably due to less lignified plowdown material.

Eight common double cut lots of red clover, plus the Ottawa variety, were direct seeded, harvested for hay in July, and sampled for top and root yield at the mid-October seeding year plowdown. The objective was to learn if there was variability among lots in top and root yield and in nitrogen production.

Table 7. Seeding year, double cut, red clover seed lot comparisons at October 15 plowdown, 2 year mean, DM/lbs/ac

Seed	Top		Root		N
lot	DM	% N	DM	% N	Yield
1	2824	3.08	1764	2.44	129
2	2834	3.08	1580	2.50	126
3	2872	3.06	1800	2.33	129
4	2988	2.98	1777	2.42	132
5	2807	3.02	1588	2.45	123
6	2845	3.04	1584	2.40	124
7	2305	3.15	1823	2.43	127
8	3039	3.23	1980	2.29	142
Ottawa	2182	3.12	1517	2.33	103
Norlac (Single)	496	3.83	2451	2.72	78

The yield and nitrogen content of the October top material was relatively consistent averaged over the two years; however, significant differences did occur. For example, lot 7 produced a lower yield of top but it had a high nitrogen content. Similar differences among lots occurred with the root data. Of real significance, however, was the fact that some lots produced a considerably higher yield of nitrogen than others. Ottawa was the lowest nitrogen yielder. It is of consequence that these results have led to an expanded study in this area.

FORAGE SEED PRODUCTION SECTION

Several studies have been conducted over the years on forage seed production, mostly on grass species, but also on some legumes. A few results are included here.

Table 1. Medon timothy seed yield from five row widths, each averaged over four rates of seeding

Year	Row width in inches						L.S.D.	C.V.
	7	14	21	28	35	Mean	0.05	
	Seed yield in pounds per acre							
1955	278	352	383	358	336	341	58	9.1
1956	244	361	336	357	320	324	54	9.4
1957	189	307	296	413	370	315	46	11.5
1958	76	125	196	201	194	158	75	12.7
Mean	197	286	302	332	305	285	50	4.9

Row widths of 14, 21, 28 and 35 inches gave similar seed yields, outyielding the 7-inch row width by 109 pounds per acre over a 4-year period. Row width had only minor effects on seed quality measured by seed weight, percentage of seed that established normal seedlings in soil and early seedling height. Rows 21 inches and wider required weed control measures. Based on seed yield, seed quality and weed control, the 14-inch row spacing was superior.

Seeding rates of 2.5, 5, 7.5 and 10 pounds per acre had no important effects on seed yield or seed quality. Of the three yield components studied-spike number, spike length and seed weight-only the last two were correlated with seed yield.

Table 2. Seeding rate and row width effects on the yield of Oron orchard grass seed, lbs/ac

Rate of seeding lb./acre	7"	14"	21"	28"	35"	3-year av.	1955	1956	1957
2 1/2	161	169	180	239	228	196	128	293	164
5	165	209	209	218	208	202	169	292	144
7 1/2	190	225	207	213	197	206	181	297	141
10	197	223	209	223	196	210	173	299	157
12 1/2	198	200	206	218	191	202	163	302	143
15	195	200	203	204	191	199	146	301	149
Row width mean									
3-year av.	184	204	203	219	202	202			
1955	216	196	140	129	119		160		
1956	273	324	318	301	270			297	
1957	64	93	150	226	217				150

L.S.D. (0.05)	Rates	Row widths	Rates x row widths	C.V.
3-year av.	9	20	19	6.7
1955	28	31	Sig.	27.3
1956	N.S.	40	N.S.	9.8
1957	17	39	N.S.	17.6

Row width had a marked effect on seed yield each year. Rate of seeding affected seed yield to a lesser extent and a row width x seeding rate interaction did occur. Seeding rates and row width caused small relatively unimportant differences in seedling establishment and early seedling vigour only in the third harvest year. Considering seed yield, seed quality and the ease of weed control, the best treatment in combination appeared to be a seeding rate in the area of 7 1/2 lb. per acre in 14-in. rows for stands to produce for 2 or 3 years.

Seed yield was positively and closely correlated with the number of fertile culms in the first and second 2 crop years but a negative relationship was found in the third crop year. Seed weight was negatively correlated with seed yield.

Table 3. Seed yield responses to April 1 date of nitrogen application, lbs/ac

Nitrogen	3 Test - 7 year mean		
rate	Oron orchard	Medon timothy	Mean
33	342	326	334
66	398	425	411
100	421	419	420
133	433	392	412
166	426	362	394
no N	305	276	290

Analysis run on individual years indicated 66 lbs. N/ac was sufficient for seed production, hence recommendations are still about 75 lbs. N/ac for grass seed production.

Table 4. Date effect of applying 75 lbs. N on the yield of seed, lbs/ac

Date applied	Timothy-2 tests 5 year mean	Orchard-1 test 4 year mean	Brome-2 tests 3 year mean
Aug 15	265	316	333
Sept 1	268	323	346
Sept 15	292	327	342
Oct 1	318	365	367
April 1	317	356	389
Oct+April 1	296	373	320

Climax timothy, Rideau orchard, Saratoga brome

- Analysis not run on tests over years, however, all species responded best from late fall or a very early spring application.
- There was no yield advantage from a split, spring-fall, application.
- Very early spring application, while the soil is still frozen, is recommended.

Table 5. Year, row width, and spacing effects on the seed yield of Rideau orchard grass in kg/ha

Variable	1965	1966	1967	1968	1969	Mean
Row width: 35.5 cm	473	497	282	476	237	393
71.0 cm	746**	599**	366**	519**	244**	495**
Spacing: solid	614	489	313	493	224	430
thinned	605	606**	336	503	257	461**
Year mean	610a*	548 b	324 d	498 c	241 e	

*a-e Means with the same letters are not significantly different at the 0.05% level.

** Means within a pair significantly different at the 0.01% level.

Table 6. Year, row width, and spacing effects on the seed yield of Climax timothy in kg/ha.

Variable	1965	1966	1967	1968	1969	Mean
Row width: 35.5 cm	622	411	423	193	307**	391
71.0 cm	632	470**	413	200	281	399
Spacing: solid	604	417	363	178	288	370
thinned	651	464	473	214	300	420**
Year mean	627 a	441 b	418 b	196 d	294 c	

*a-d Means with the same letters are not significantly different at the 0.05% level.

** Means within a pair significantly different at the 0.01% level.

Table 7. Year, row width, and spacing effects on the seed yield of Redpatch bromegrass in kg/ha

Variable	1965	1966	1967	Mean
Row width: 35.5 cm	553	103	121	259
71.0cm	671**	117	135	308**
Spacing: solid	567	105	134	269
thinned	657**	115	122	298
Year mean	612a*	110 b	128 b	

*a-b Means with the same letters are not significantly different at the 0.05% level.

** Means within a pair significantly different at the 0.01% level.

Orchard grass, timothy, and bromegrass were grown for seed production in 35.5 and 71.0 cm row widths, containing plants in a solid or in a 35.5 cm thinned row arrangement. Seed yield, head numbers, head length, seed per head, and seed weight data were collected for 3-5 crop years. Orchard grass produced its highest yield of seed from the 71.0 cm thinned rows. Yield differences were present for the first 3 years only. Yield components were affected to a larger extent by row width than by thinning. However, with timothy, row widths did not influence yield and components some years. The production methods affected the bromegrass seed crop in the 1st crop year but had no influence by the 3rd year.

Table 8. Seed yield responses of species to post-harvest stubble removal kg/ha

Stubble removal date	Timothy	Orchard	Brome
15 Aug.	291	473	223
15 Sept.	317	443	227
15 Oct.	290	442	254
15 Aug. + 15 Sept.	272	454	210
10 Apr.	287	417	205
Not removed	310	381	134
Seed year 2	500	551	279
3	360	368	286
4	105	252	161
5	212	568	112
LSD (0.05) dates	NS	34	17
years	56	35	21
CV (%)	19.4	15.5	16.1

The effect of post-harvest stubble removal dates upon the succeeding year's seed yield of timothy (Phleum pratense L. 'Climax'), orchardgrass (Dactylis glomerata L. 'Frode"), and smooth bromegrass (Bromus inermis Leyss. 'Saratoga') was investigated over four harvest years. The stubble was removed each year on 15 Aug., 15 Sept., 15 Oct., 15 Aug. and 15 Sept., 10 Apr., or left uncut. The experiments were conducted under conditions of adequate soil fertility. No stubble removal treatments increased the seed production of timothy. Orchardgrass seed yields were increased by all fall removal treatments but responded best to the 15 Aug. removal. Bromegrass responded to all stubble removal treatments but produced its highest seed yield from the 15 Oct. treatment. Seed yields declined with successive years until year 5 when timothy, and particularly orchardgrass, produced a yield increase. The interaction for years x stubble removal dates was significant only for bromegrass seed yield. Seed yield was highly correlated with panicle number in all species, with weight of seed in 25 panicles in timothy and bromegrass, and with 200-seed weight in timothy.

Table 9. Effect of harvest methods on the yield and quality of medon timothy seed, lbs/ac

Variable	Yield		% Hulled		% Germination
	Year 1	Year 2	Year 1	Year 2	Year 2
Harvesting method					
Binder-combine	--	287	--	29	90
Swath-combine	552	308	16	49	81
Direct combine	404	287	21	48	84
Cylinder speed					
1100 rpm			6	27	97 (unhulled)
1300 rpm			19	38	79 (hulled)
1450 rpm			33	50	
1675 rpm			38	71	

- Swath drying followed by combining recovered a high seed yield.
- Increasing the cylinder speed of the combine increased timothy seed hulling which had a lower percent germination than unhulled seed.

Table 10. Methods of harvesting birdsfoot trefoil seed, lbs/ac

Method	Yield	% hard seeds
Direct combine	195	75
Coiled-combine 5 days	226	61
Windrowed-combine same day	162	70
Windrowed-combine 24 hours	174	67
Windrowed-combine 48 hours	141	67

- Harvesting methods appear to have had an effect upon seed recovery and quality of trefoil in this replicated trial.

Table 11. Seed yield and maturity date of some Canadian and European forage varieties, lbs/ac, 14 inch rows

Species-variety	Year 1	Year 2	Harvest date
Timothy			
Climax	379	451	Aug. 13
Toro	400	376	Aug. 4
Bounty	328	446	Aug. 19
Champ	288	285	Aug. 7
S 352 (U.K.)	640	408	Aug. 9
S 48 (U.K.)	82	79	Sept. 4
Bluegrasses			
Golf (Kentucky)	521	229	July 13
Merion (Kentucky)	300	83	July 13
Canon (Canada)	454	344	Aug. 4
Fescues			
Highlight (Chewings)	526	238	July 24
Dawsons (Creeping red)	240	129	July 16
Barenza (Sheeps)	354	610	July 7
Bentgrass			
Highland	213	110	July 26
Emerald	81	78	Aug. 8
Reton red top	387	300	July 30
Perennial ryegrass			
Pennfine	212	killed	July 27
Manhattan	328	killed	Aug. 14
Norlea	564	killed	Aug. 10
Miscellaneous			
Frontier reed canary	248	86	July 9
Grove reed canary	293	58	July 9
Sawki Russian wildrye	358	--	July 21

- Some 79 OECD varieties from 15 countries plus Canadian checks tested for two years, see 1973 and 1974 reports.
- Varieties presented indicate some seed yield differences and maturity dates.

Table 12. Seeding year seed yields of direct combined common double cut red clover, lbs/ac cleaned seed

Field		Yield	Remarks
1979	1 - 16 acres	42	Excessive top growth (2 ton)
	2 - 6 acres	150	Short (1 ton)
	3 - 9 acres	90	Moderate (1 1/2 tons)
	4 - 12 acres	124	Moderate (1 1/2 tons)
1980	1 - 8 acres	160	Moderate (1 1/2 tons)
	2 - 6 acres	175	Moderate (1 1/2 tons)
Mean	9.5 acres	123	--

- Seed can be obtained from direct seeded (May 5), double cut red clover in September of the seeding year; full bloom will occur about July 25.
- The root system from such seed crops will not be as extensive by mid-October as that from new seedings that were cut during July. See plowdown section.