RANGE AND HAY PRODUCTION IN RELATION
TO EFFECTIVE PRECIPITATION

Annual range yields obtained from clippings at the Dickinson Station have been summarized for the period 1946-1970 (25 years). Hay yields from clipped crested wheatgrass plots have also been summarized, but data were available for this summary only for the period from 1951-1969 (19 years). In addition, yields obtained from crested wheatgrass plots fertilized with nitrogen have been assembled for the period 1953-1969. The data that have been used here involve plots that were fertilized annually with 50 lbs. N per acre for the period 1953-1957 and plots that were fertilized with 67 lbs. N per acre in the years 1958-1969.

The yields obtained from these various clipped plots have been related to the effective rainfall obtained for the year of production in order to derive an expression for lbs. of forage produced per inch of effective precipitation. Recent interest in the possibilities of augmenting growing-season precipitation in western North Dakota by weather modification procedures has raised the question of just how much additional forage might be obtained from an additional 1 to 2 inches of rainfall during the growing season. The data from the various Dickinson clippings should provide at least a rough estimate of potential increases in range forage and tame hay from additional increments of rainfall.

Precipitation data have been obtained from the long time records at the Dickinson Station. Both the range and tame grass hay plots were located within ¾-mile of the weather station, so the precipitation data can be assumed to reflect quite accurately the precipitation situation at the site of the various plots. For purpose of this analysis effective precipitation was considered to be the rainfall occurring in September and October of the previous year plus that occurring in April, May, June, and July of the year in which the clipping was made.

August precipitation would thus be considered as not being effective in forage production in either the current season or the following season. Likewise it was assumed that significant amounts of precipitation occurring in September and October would be stored in the soil for use the following spring. In addition, it is assumed that precipitation occurring in the months of November, December, January, February, and March, immediately preceding the growing season, would not make an appreciable contribution to the moisture available for grass growth. It is obvious that in some seasons these assumptions may not be correct, but in general it seems that precipitation occurring in the so-called effective period is the precipitation that is most likely to contribute to grass production.

Table 1 gives the potentially effective precipitation at the Dickinson Station by month for each of the years from 1948-1970. The amounts vary from a low of 6.29 inches in 1949 to a high of 17.44 inches in 1965. As might be expected, the years with higher amounts of potentially effective precipitation do not necessarily correspond to the years of higher range forage or tame hay production. It is apparent that conditions of temperature and specific distribution of rainfall are of great importance in determining actual productions of forage in any given year.

Table 1.   Total Effective Precipitation 1948-1970 -   Inches

Year	Previous Year		Current Year				Total
	Sept.	Oct.	April	May	June	July	
1948	.62	.30	1.45	3.20	2.87	3.18	11.62
1949	.22	.55	.14	1.33	1.21	2.84	6.29
1950	.42	1.75	1.37	2.13	2.87	.68	9.22
1951	1.77	.87	.63	1.58	2.68	2.39	9.92
1952	1.73	2.39	T	.42	3.80	1.85	10.19
1953	.63	.04	3.50	3.47	3.99	2.48	14.11
1954	.22	1.93	.49	1.67	2.84	.59	7.74
1955	.66	.39	1.91	2.45	4.70	1.08	10.19
1956	1.53	.18	.22	2.90	1.17	3.01	9.01
1957	.76	.43	2.59	2.10	6.61	3.46	15.95
1958	1.98	1.94	.57	.45	3.26	3.86	12.06
1959	.06	.65	.16	1.94	3.08	.97	6.86
1960	4.54	.33	.35	2.23	3.06	.58	11.09
1961	.14	.02	1.89	1.44	2.82	1.66	7.97
1962	3.05	.11	1.12	6.18	2.07	3.22	15.75
1963	.75	.55	3.79	3.69	4.24	1.86	14.88
1964	1.35	.20	1.38	1.86	6.12	4.42	15.33
1965	.62	.01	3.41	6.07	4.25	3.08	17.44
1966	1.63	T	.82	2.16	4.94	2.19	11.74
1967	.93	.48	3.87	2.79	1.63	.72	10.42
1968	2.48	.61	1.02	1.25	3.38	2.83	11.57
1969	.43	.91	.72	1.32	6.13	4.40	13.91
1970	.31	.86	3.53	6.35	1.98	3.86	16.89

Table 2 gives the yields of range vegetation from the clipped plots. In general these clippings have been made from not less than 10 plots nor more than 20 plots from grazed native range with the plots protected for the year of clipping by means of steel mesh cages. The plots were located on an upland sandy site (Flasher-Vebar complex) of moderate productivity with a condition rating of low good. All yields are oven-dry weights.

The data of Table 2 show that for the 25-year period, 1946-1970, range forage production from the clipped plots has averaged 1009 lbs. / acre, while the average effective rainfall has been 11.83 inches. The production per inch of effective rainfall has thus been 85 lbs. / acre. The production per inch of effective rainfall was quite variable over the period, with the lowest production being 44 lbs. / acre in 1956 and the highest being 125 lbs. / acre in 1953. Comparing the yield data with the monthly precipitation data given in Table 1, it is apparent that the April, May, and June precipitation totals have a strong influence on range production.

Crested wheatgrass hay yields per inch of effective precipitation are given in Table 3. All yields are oven-dry weights. The crested wheatgrass yields per inch of effective precipitation are also quite variable ranging from 59 lbs. / inch of effective precipitation in 1964 to a maximum value of 242 lbs. The average value for the 19-year period is 135 lbs. / inch. As would be expected, this value is appreciably higher than the yield of range forage per inch of effective precipitation, averaging 58.8% greater for the period of the clipping trial. The comparison of the production data for crested wheatgrass with the precipitation data given in Table 1 shows again the strong influence of April, May, and June precipitation. July precipitation seems to have had little effect on crested wheatgrass production.

Table 2. Total Annual Precipitation, Effective Precipitation[1] and Range Yields at the Dickinson Experiment Station, 1946-1970

Year	Total Precip. Inches	Effective Precip. Inches	Total Forage Yield Lbs. / Acre	Lbs. of Forage per Inch of Effective Precip.
1946	14.50	8.77	924	105
1947	18.86	16.78	1432	85
1948	16.11	11.62	776	67
1949	10.77	6.29	434	69
1950	15.13	9.22	710	77
1951	16.70	9.92	512	52
1952	11.97	10.19	593	58
1953	19.39	14.11	1768	125
1954	16.33	7.74	929	120
1955	14.65	10.19	903	89
1956	12.70	9.01	392	44
1957	22.15	15.95	1020	64
1958	12.18	12.06	752	62
1959	13.45	6.86	656	96
1960	10.23	11.09	880	79
1961	13.90	7.97	378	47
1962	18.34	15.75	1460	93
1963	18.94	14.88	1653	111
1964	18.74	15.33	1283	84
1965	21.63	17.44	1640	94
1966	16.69	11.74	1296	110
1967	14.24	10.42	839	81
1968	15.73	11.57	975	84
1969	16.37	13.91	1332	96
1970	20.16	16.89	1689	100
AVERAGE	15.99	11.83	1009	85

[1]   Effective precipitation is defined here as the precipitation for Sept. and Oct. of previous year plus that of April, May, June and July of the current season.

Table 3. Total Annual Precipitation, Effective Precipitation[1], and Crested Wheatgrass Yields at the Dickinson Experiment Station, 1951-1969

Year	Total Precip. Inches	Effective Precip. Inches	Total Forage Yield Lbs. / Acre	Lbs. of Forage per Inch of Effective Precip.
1951	16.70	9.92	1627	164
1952	11.97	10.19	961	94
1953	19.39	14.11	2761	196
1954	16.33	7.74	1243	161
1955	14.65	10.19	1276	125
1956	12.70	9.01	612	68
1957	22.15	15.95	1356	85
1958	12.18	12.06	1809	150
1959	13.45	6.86	1416	206
1960	10.23	11.09	2134	192
1961	13.90	7.97	1036	130
1962	18.34	15.75	1859	118
1963	18.94	14.88	3075	207
1964	18.74	15.33	905	59
1965	21.63	17.44	1786	102
1966	16.69	11.74	946	81
1967	14.24	10.42	2524	242
1968	15.73	11.57	1096	95
1969	16.37	13.91	1177	85
AVERAGE	16.02	11.90	1558	135

[1]   Effective precipitation is defined here as the precipitation for Sept. and Oct. of previous year plus that of April, May, June and July of the current season.

Data on the production of fertilized crested wheatgrass per inch of effective precipitation are given in Table 4. Again, the data are variable ranging from a low value of 85 lbs. of forage per inch of effective rainfall in 1956 to a high value of 405 lbs. per inch in 1963. The average for the 17-year period, 1953-1969, was 209 lbs. oven-dry forage per inch of effective precipitation.

The figures for production per inch of effective rainfall, as derived from the long-time clipping studies at Dickinson, indicate that considerable variability can be expected, but that reasonable and perhaps potentially profitable increases in range forage and in tame grass hay production can be obtained from added growing-season rainfall in amounts of 1 to 2 inches.

Table 4. Total Annual Precipitation, Effective Precipitation[1], and Yields of Crested Wheatgrass Fertilized with 67 lbs. N / Acre, 1953-1969

Year	Total Precip. Inches	Effective Precip. Inches	Total Forage Yield Lbs. / Acre	Lbs. of Forage per Inch of Effective Precip.
1953	19.39	14.11	4348[2]	308
1954	16.33	7.74	1953[2]	252
1955	14.65	10.19	2121[2]	208
1956	12.70	9.01	763[2]	85
1957	22.15	15.95	2064[2]	129
1958	12.18	12.06	2491	207
1959	13.45	6.86	1737	253
1960	10.23	11.09	2713	245
1961	13.90	7.97	1120	141
1962	18.34	15.75	3242	206
1963	18.94	14.88	6030	405
1964	18.74	15.33	1407	92
1965	21.63	17.44	4281	245
1966	16.69	11.74	1658	141
1967	14.24	10.42	3344	321
1968	15.73	11.57	2094	181
1969	16.37	13.91	1736	125
AVERAGE	16.22	12.12	2535	209

[1]   Effective precipitation is defined here as the precipitation for Sept. and Oct. of previous year plus that of April, May, June and July of the current season.

[2]   Yields from 1953-1957 obtained with 50 lbs. N/acre instead of 67 lbs.