

Range Cattle Research and Education Center

April 2012

Research Report RC-2012-1

CLIMATOLOGICAL REPORT 2011
Range Cattle Research and Education Center

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Weather conditions strongly influence agricultural operations from planting through harvesting. Knowledge of annual rainfall and temperature cycles, along with their extremes, help producers determine optimum times to prepare and plant seedbeds, fertilize pastures, apply herbicides, control water, and supplement cattle on pasture or range. Weather conditions influence seed germination, forage growth, palatability, and nutritive value.

This research report presents a summary of rainfall, air temperature, evapotranspiration, and solar radiation for 2011 obtained at the Range Cattle Research and Education Center (REC), Ona, Florida, and is compared to a 70-year summary of rainfall data and a 69-year summary of temperature data collected from this location. The center is located $81^{\circ} 56.406'$ W and $27^{\circ} 23.733'$ N in south central Florida approximately 45 miles (72 km) east of the Gulf of Mexico and 100 miles (160 km) west of the Atlantic Ocean.

Weather observations were collected with a Weather Watch 2000 (Campbell Scientific, Inc) from 1997 until 2005. Beginning in 2006, observations were collected using the Florida Automated Weather Network (FAWN). Accuracy of rainfall as measured by the Weather Watch 2000 or FAWN and was verified by comparing with rainfall measured using US Weather Service standard gauge. Measurements reported prior to 2006 were recorded at 0900 h; thus, data on a given day represented the previous 24-hour period. Beginning in 2006, measurements were recorded for an entire 24-h period beginning at midnight.

Rainfall

Annual rainfall for 2011 totaled 51.49 inches (Table 1), which was 2.18 inches (4.06%) less than the 70-year average of 53.67 inches (Table 1). Eight months of 2011 saw rainfall that fell below the 70-year average. Rainfall deficits exceeding two inches were recorded in February, May, and June. Rainfall surpluses in excess of two inches were observed in March, August, and September. Daily rainfall equaled or exceeded 1 inch on 18 separate occasions in 2011. Three of these rain events exceeded 2 inches (Table 2). The single greatest daily rain event was 19 September when 3.55 inches were recorded. The lowest annual total was observed in 2000 when 32.02 inches were

measured, and the greatest annual rainfall total on record was in 1959 when 78.82 inches were recorded.

Table 1. Summary of rainfall by months. Range Cattle REC, 2011.

Month	1942 to 2011		70-year average†	2011	Difference from 70-year average
	Maximum / month	Minimum / month		Total	
	-----inches-----				
January	8.45	0.03	2.13	2.55	0.42
February	9.59	0.02	2.55	0.37	-2.18
March	12.34	0.13	3.16	5.93	2.77
April	11.91	0.00	2.45	0.79	-1.66
May	10.58	0.00	3.76	1.35	-2.41
June	18.99	2.79	8.57	5.10	-3.47
July	19.74	1.87	8.31	7.46	-0.85
August	16.10	3.13	8.44	11.45	3.01
September	20.11	1.14	7.30	12.18	4.88
October	11.23	0.00	2.98	4.03	1.05
November	11.22	0.07	1.91	0.17	-1.74
December	8.61	0.11	2.00	0.11	-1.89
Year total			53.67	51.49	-2.18

*Inches x 2.54 = cm.

† Since rainfall records began in July 1942, means for January to June are 69-year means.

Evapo-transpiration

Evapo-transpiration is the total amount of water transferred from the earth to the atmosphere. Evapo-transpiration exceeded rainfall in February, April, May, June, November, and December during 2011 (Figure 2). Evapo-transpiration generally exceeds rainfall in January to May and October to December, which are months with limited rainfall. Rainfall exceeded evapo-transpiration by 6.18 inches for the entire year.

Table 2. Daily maximum and minimum temperature, precipitation, and solar radiation for 2011, Range Cattle REC.

Day	January				February				March				April			
	Max °F	Min °F	Rain inches	MJ/ m ²	Max °F	Min °F	Rain inches	MJ/ m ²	Max °F	Min °F	Rain inches	MJ/ m ²	Max °F	Min °F	Rain inches	MJ/ m ²
1	78.66	54.09	0.00	12.25	82.74	56.12	0.00	13.68	80.67	58.84	0.00	11.37	79.83	55.53	0.01	29.27
2	76.50	56.17	0.01	7.01	83.80	59.85	0.00	16.93	79.65	54.34	0.00	20.73	85.14	48.61	0.00	28.85
3	75.27	55.56	0.00	7.93	79.99	67.19	0.00	8.44	79.36	54.03	0.00	23.07	86.22	54.21	0.00	29.11
4	76.23	49.87	0.00	9.40	82.27	60.30	0.00	13.89	79.63	51.71	0.00	22.04	89.19	61.77	0.00	26.94
5	77.74	52.07	0.00	13.24	81.66	58.51	0.11	12.86	80.69	57.78	0.00	17.51	79.32	54.25	0.62	8.76
6	67.80	45.39	0.50	4.18	68.23	59.77	0.01	5.53	81.37	54.95	0.00	19.59	81.30	46.02	0.00	29.96
7	66.72	38.92	0.00	16.24	82.83	59.31	0.18	14.49	75.47	74.98	0.05	23.55	86.72	58.05	0.00	23.40
8	73.78	46.47	0.00	17.23	61.39	41.78	0.00	21.24	81.86	47.01	0.00	19.94	89.08	64.06	0.00	26.67
9	70.57	37.45	0.00	17.64	77.76	39.23	0.00	19.74	86.20	62.01	0.00	18.53	90.61	63.86	0.00	26.39
10	80.37	50.43	0.00	11.80	73.08	56.14	0.07	4.89	69.24	45.90	1.16	5.81	90.01	64.04	0.00	25.99
11	74.26	47.07	0.00	13.27	60.98	46.90	0.00	7.91	65.23	38.77	0.00	28.22	89.78	63.30	0.00	28.00
12	57.79	38.50	0.00	16.88	64.51	40.43	0.00	22.13	73.63	36.87	0.00	28.64	84.74	64.22	0.00	24.01
13	56.26	30.04	0.00	19.79	68.67	34.01	0.00	23.53	78.57	40.20	0.00	27.85	84.22	55.58	0.00	30.38
14	68.99	37.42	0.00	17.20	72.14	37.23	0.00	23.11	80.22	45.00	0.00	27.07	87.03	56.07	0.00	27.68
15	71.98	41.74	0.00	15.82	75.60	39.87	0.00	21.98	80.10	48.11	0.00	23.70	88.45	61.20	0.00	27.65
16	75.61	46.81	0.00	13.62	77.50	43.77	0.00	18.17	83.07	50.97	0.00	25.16	87.22	60.10	0.00	26.21
17	70.65	56.43	0.00	4.54	81.14	49.50	0.00	16.78	83.89	50.76	0.00	26.93	85.21	60.24	0.00	31.13
18	80.13	59.16	0.00	14.44	81.73	51.75	0.00	17.88	84.96	54.16	0.00	28.00	90.59	57.45	0.00	29.10
19	79.74	50.72	0.08	17.34	82.38	50.34	0.00	22.20	84.87	46.08	0.00	28.21	91.08	59.59	0.11	27.63
20	81.32	50.97	0.00	13.57	81.10	49.73	0.00	19.93	85.80	51.31	0.00	26.38	90.30	64.94	0.00	30.32
21	78.31	62.55	0.24	9.66	81.19	50.07	0.00	20.53	83.59	56.75	0.00	24.73	88.34	60.28	0.00	30.57
22	62.49	32.76	0.00	10.87	82.29	54.81	0.00	14.66	83.88	47.55	0.00	28.42	87.66	58.32	0.00	31.70
23	63.84	30.51	0.00	20.70	83.93	56.61	0.00	17.30	84.25	51.08	0.00	27.69	87.91	56.68	0.00	30.08
24	73.81	41.82	0.00	12.88	82.98	62.13	0.00	17.11	84.20	57.72	0.00	19.43	88.12	62.76	0.00	21.91
25	79.97	59.05	1.55	8.09	81.95	54.72	0.00	16.21	85.77	59.54	0.00	27.34	88.63	63.48	0.00	21.10
26	67.87	42.90	0.17	15.03	84.06	55.08	0.00	21.75	86.27	57.27	0.00	19.97	90.01	65.75	0.00	28.38
27	63.93	36.25	0.00	20.51	85.23	51.48	0.00	21.03	89.15	56.41	0.00	25.81	92.08	66.77	0.00	26.15
28	66.61	41.53	0.00	20.32	84.54	54.81	0.00	21.15	80.83	64.00	2.85	10.40	86.67	69.21	0.00	28.13
29	73.17	39.79	0.00	19.70					85.73	60.28	0.01	22.58	86.81	62.33	0.05	26.34
30	72.88	42.07	0.00	16.40					86.18	65.82	0.45	21.68	87.24	55.47	0.00	28.79
31	76.95	46.49	0.00	14.47					82.72	64.94	1.41	8.24				
Avg	72.26	45.84	0.08	13.94	78.06	51.48	0.01	16.97	81.52	52.68	0.19	22.21	87.32	59.84	0.03	26.92
Max	81.32	62.55	1.55	20.70	85.23	67.19	0.18	23.53	89.15	65.82	2.85	28.64	92.08	46.02	0.62	31.70
Min	56.26	30.04	0.00	4.18	60.98	34.01	0.00	4.89	65.23	36.87	0.00	5.81	79.32	69.21	0.00	8.76
Total			2.55	432.0			0.37	475.1			5.93	688.6			0.79	807.6

Table 2. Continued.

Day	May				June				July				August			
	Max °F	Min °F	Rain inches	MJ/m ²	Max °F	Min °F	Rain inches	MJ/m ²	Max °F	Min °F	Rain inches	MJ/m ²	Max °F	Min °F	Rain inches	MJ/m ²
1	89.01	60.82	0.00	31.40	86.47	62.20	0.38	18.53	89.67	70.97	1.12	16.22	92.93	73.67	0.04	28.63
2	90.61	64.99	0.00	28.34	90.90	64.20	0.00	27.74	88.68	70.65	0.35	18.28	90.63	72.27	0.01	18.11
3	90.72	63.03	0.00	30.58	91.71	63.66	0.00	27.71	92.03	71.19	0.05	27.93	91.36	75.31	0.18	21.14
4	91.35	65.14	0.00	26.60	91.89	64.13	0.00	28.72	90.07	71.83	0.00	19.49	91.89	74.95	0.01	22.72
5	83.82	63.16	0.14	21.71	92.70	62.83	0.00	28.59	92.07	71.28	0.00	24.15	93.88	74.68	1.65	21.15
6	80.51	62.53	0.08	12.96	91.80	64.09	0.00	26.17	89.01	71.87	0.32	14.17	95.56	75.13	0.00	28.04
7	86.92	58.78	0.01	31.82	91.26	67.64	0.00	26.58	84.49	74.16	0.53	11.93	92.57	76.51	0.00	23.08
8	88.27	54.00	0.00	33.28	91.67	67.64	0.00	22.90	89.46	71.22	0.81	18.40	89.95	75.56	0.53	21.54
9	91.18	54.61	0.00	30.86	90.28	69.89	0.00	19.95	90.18	72.18	0.03	22.11	85.57	73.78	1.76	6.59
10	91.99	61.57	0.00	27.25	92.12	68.36	0.00	24.99	90.63	72.25	0.01	18.70	82.80	74.32	0.61	8.36
11	92.52	60.67	0.00	28.82	93.18	64.54	0.00	28.41	90.82	74.26	0.03	15.16	93.13	73.78	0.00	24.91
12	94.71	62.53	0.00	29.07	95.20	69.40	0.00	27.56	89.01	71.49	0.00	20.57	93.79	72.05	0.00	19.41
13	90.82	64.17	0.02	24.24	95.50	65.19	0.00	29.61	90.36	73.29	0.00	23.11	93.45	72.12	0.08	18.42
14	87.24	62.10	0.69	17.53	93.83	68.34	0.00	29.94	90.19	73.22	1.54	15.75	90.91	72.27	1.04	16.40
15	83.59	61.45	0.23	27.55	96.35	69.29	0.02	23.24	91.67	74.25	0.02	19.57	91.85	74.52	0.03	22.13
16	80.37	56.17	0.00	24.53	94.42	69.66	0.12	28.13	93.22	71.38	0.01	23.09	89.73	74.98	0.00	18.69
17	81.05	57.88	0.00	27.36	96.30	68.41	0.01	24.30	92.46	72.61	0.00	26.47	90.95	72.48	0.32	15.75
18	83.26	53.78	0.00	28.82	95.68	68.13	0.10	22.05	87.98	72.28	0.00	24.09	93.94	71.35	0.64	22.94
19	88.27	50.81	0.00	32.93	95.52	67.53	0.00	26.46	91.53	68.72	0.00	28.26	93.11	72.14	0.02	24.37
20	93.00	57.42	0.00	29.09	97.36	65.77	0.00	31.03	93.22	68.00	0.00	25.13	92.52	74.07	1.54	17.65
21	93.54	64.29	0.00	24.45	98.89	68.43	0.00	25.14	92.62	71.26	0.00	29.10	92.98	72.59	0.90	20.09
22	93.61	64.81	0.00	30.91	97.48	70.61	0.47	23.67	93.18	72.16	0.78	20.71	92.89	74.53	0.00	20.48
23	88.54	62.60	0.00	23.28	94.66	69.24	0.43	22.77	93.25	71.62	0.01	19.81	94.48	73.33	.055	20.93
24	91.98	62.67	0.00	31.63	93.13	71.28	1.53	22.72	94.84	73.98	0.00	27.00	91.06	73.26	1.40	20.47
25	91.17	59.92	0.00	31.64	87.75	70.74	0.50	15.78	94.24	73.85	0.00	25.19	91.44	74.26	0.03	22.77
26	93.09	61.92	0.02	28.25	88.02	69.12	0.00	25.63	88.50	71.31	0.17	11.58	92.07	74.84	0.00	24.52
27	90.00	66.45	0.16	25.47	90.43	71.69	0.00	15.03	89.38	73.31	0.76	13.50	92.50	75.96	0.00	23.41
28	93.18	62.22	0.00	27.42	89.33	71.13	1.21	12.09	94.33	72.79	0.67	26.00	92.53	75.97	0.00	25.01
29	92.68	63.97	0.00	28.55	88.11	70.74	0.25	12.58	94.10	73.26	0.25	26.07	89.87	76.10	0.00	12.30
30	90.97	64.18	0.00	25.71	87.75	69.75	0.08	15.25	94.46	71.78	0.00	26.22	86.90	75.70	0.06	11.82
31	92.75	66.43	0.00	27.52					93.34	72.61	0.00	28.04	84.27	74.26	0.05	8.55
<u>Avg</u>	89.38	61.13	0.04	27.41	92.66	67.79	0.17	23.78	91.26	72.10	0.24	21.48	91.34	74.15	0.37	19.69
<u>Max</u>	94.71	66.45	0.69	33.28	98.89	71.69	1.53	31.03	94.84	74.26	1.54	29.10	95.56	76.51	1.76	28.63
<u>Min</u>	80.37	50.81	0.00	12.96	86.47	62.20	0.00	12.09	84.49	68.00	0.00	11.58	82.80	71.35	0.00	6.59
<u>Total</u>			1.35	849.6			5.10	713.3			7.46	665.8			11.45	610.4

Table 2. Continued.

Day	September				October				November				December			
	Max °F	Min °F	Rain inches	MJ/m ²	Max °F	Min °F	Rain inches	MJ/m ²	Max °F	Min °F	Rain inches	MJ/m ²	Max °F	Min °F	Rain inches	MJ/m ²
1	89.62	73.53	2.95	13.04	85.35	63.79	0.00	22.44	77.23	60.76	0.00	15.58	69.82	42.05	0.00	17.49
2	89.47	71.96	0.00	20.67	82.90	57.47	0.00	24.51	80.44	58.44	0.00	18.32	74.64	51.19	0.00	15.10
3	89.94	70.02	1.13	20.16	86.27	58.21	0.00	22.28	79.61	60.33	0.00	13.20	78.26	53.60	0.00	10.63
4	88.36	73.29	0.14	10.48	85.01	64.08	0.00	23.89	72.28	52.23	0.00	14.99	77.56	55.45	0.00	12.00
5	90.90	75.11	0.02	21.56	85.12	64.24	0.00	22.03	74.55	49.53	0.00	17.05	80.91	56.64	0.00	13.35
6	82.85	74.25	1.05	4.95	84.67	65.05	0.01	18.44	80.24	56.82	0.00	13.97	80.53	55.80	0.00	15.05
7	87.75	72.01	0.53	12.79	85.39	66.87	0.00	18.91	78.55	61.79	0.00	13.28	80.22	52.20	0.02	15.59
8	85.73	72.82	0.19	14.83	77.11	67.78	1.88	10.78	81.77	60.76	0.00	14.22	66.15	39.83	0.00	14.94
9	88.43	71.40	0.01	14.71	76.35	69.30	0.94	7.21	81.25	59.09	0.00	17.69	81.01	56.41	0.00	11.71
10	91.33	71.87	1.04	20.77	83.68	67.80	0.05	15.26	79.12	54.84	0.00	18.34	76.62	65.10	0.08	8.64
11	92.98	71.76	0.01	20.98	87.48	70.97	0.01	16.15	68.22	47.23	0.00	20.94	78.84	61.23	0.01	7.42
12	91.83	73.44	0.00	24.75	87.66	70.43	0.10	18.62	76.91	46.85	0.00	19.37	77.52	64.51	0.00	10.35
13	91.54	71.20	0.00	21.94	83.30	70.39	0.01	11.97	80.73	52.21	0.00	18.16	79.14	62.80	0.00	14.20
14	90.90	69.42	0.00	24.31	86.45	67.73	0.00	20.23	84.83	57.72	0.00	17.51	77.99	57.40	0.00	15.08
15	91.58	68.94	0.00	22.46	82.56	67.41	0.00	14.10	85.51	66.83	0.00	10.37	76.05	56.08	0.00	9.69
16	93.65	70.95	0.00	23.29	84.51	68.99	0.00	14.99	86.32	67.60	0.00	13.66	81.12	60.21	0.00	12.35
17	90.97	70.59	0.00	24.51	81.18	70.03	0.00	7.66	84.16	66.07	0.00	11.24	80.31	58.57	0.00	12.68
18	90.63	70.93	0.00	21.28	77.11	72.00	0.15	3.59	77.27	57.79	0.00	9.66	71.08	47.91	0.00	17.24
19	92.12	70.86	3.55	18.74	82.38	59.94	0.02	9.13	83.01	64.76	0.00	14.09	76.41	46.22	0.00	15.96
20	91.44	72.88	0.01	19.90	70.48	54.43	0.00	16.74	84.67	63.90	0.00	14.97	78.55	48.45	0.00	13.90
21	91.35	74.25	0.00	17.74	72.61	51.28	0.00	21.52	85.71	65.91	0.02	13.07	81.73	54.32	0.00	15.04
22	90.00	73.15	0.86	13.35	75.78	50.72	0.00	19.84	83.75	63.50	0.00	13.92	83.59	52.88	0.00	14.34
23	90.07	73.44	0.50	16.24	80.01	56.28	0.00	19.10	82.11	60.80	0.03	12.28	84.67	58.53	0.00	14.01
24	90.48	73.15	0.16	17.74	78.40	56.80	0.00	20.79	79.32	58.01	0.00	16.62	78.80	60.06	0.00	9.64
25	87.57	72.52	0.01	12.27	81.68	55.20	0.02	19.43	78.58	55.06	0.00	14.10	83.80	59.56	0.00	13.19
26	83.84	73.13	0.02	6.86	83.97	60.82	0.01	19.94	79.66	56.59	0.00	13.75	78.67	58.28	0.00	9.74
27	88.72	71.53	0.00	15.72	85.33	61.02	0.00	16.60	81.00	57.25	0.00	16.37	76.33	55.85	0.00	7.98
28	91.96	71.65	0.00	20.38	72.82	68.68	0.68	3.02	80.85	60.78	0.12	10.07	65.77	39.38	0.00	17.35
29	92.14	72.07	0.00	17.73	80.29	65.29	0.06	7.45	71.17	51.37	0.00	15.92	68.20	36.60	0.00	13.79
30	89.47	69.55	0.00	21.81	76.68	59.58	0.07	9.76	65.97	46.62	0.00	15.13	79.65	40.09	0.00	15.82
31					78.40	63.19	0.02	9.25					80.73	51.24	0.00	12.82
<u>Avg</u>	89.92	72.06	0.41	17.87	81.32	63.41	0.13	15.65	79.49	58.05	0.01	14.93	77.57	53.50	0.00	13.13
<u>Max</u>	93.65	75.11	3.55	24.75	87.66	72.00	1.88	24.51	86.32	67.60	0.12	20.94	84.67	65.10	0.08	17.49
<u>Min</u>	82.85	68.94	0.00	4.95	70.48	50.72	0.00	3.02	65.97	46.62	0.00	9.66	65.77	36.60	0.00	7.42
<u>Total</u>			12.18	536.0			4.03	485.1			0.17	447.9			0.11	407.1

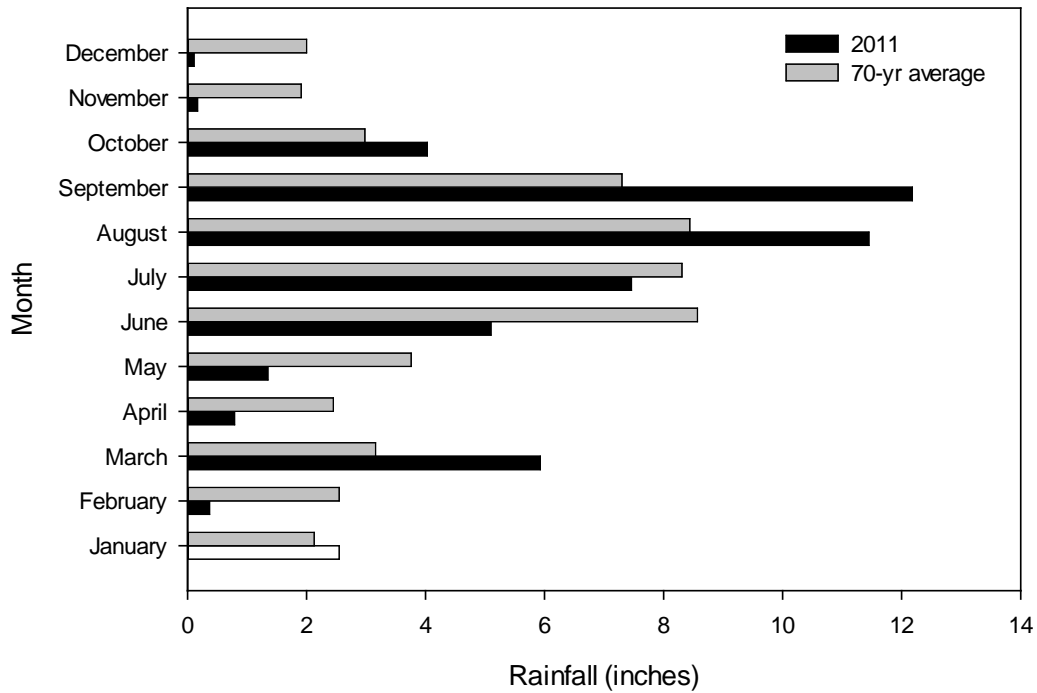


Figure 1. Monthly rainfall in 2011 compared with the 70-year average.

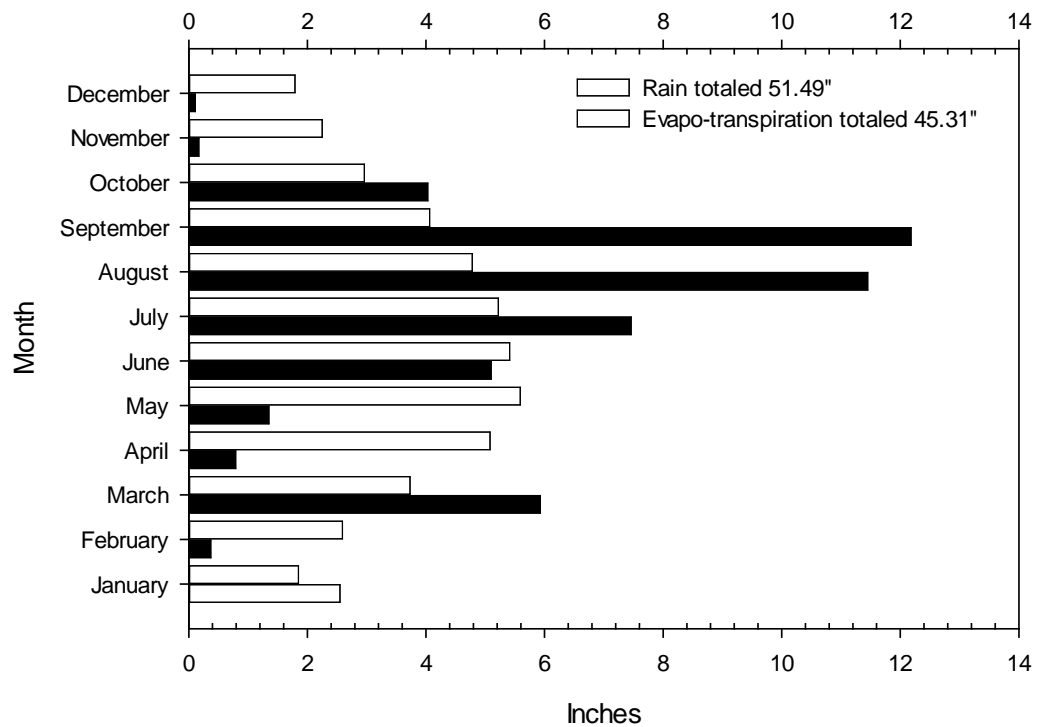


Figure 2. Monthly rainfall compared with evapo-transpiration during 2011. Cumulative rainfall = 51.49" and cumulative evapo-transpiration = 45.31".

Solar Radiation:

Daily solar radiation is shown in Table 2, and 2011 total monthly solar radiation can be seen in Figure 3. For interpretation of solar radiation as it pertains to plant growth, 1 MJ results in about 14.3 lb/A of plant dry matter if soil water, temperature, and fertility are not limiting and vegetative cover is complete. Theoretically, enough solar radiation was received in April 2011 (807.6 MJ) to produce 11,549 lb/A of plant dry matter. Total solar radiation for 2011 was 7,120 MJ.

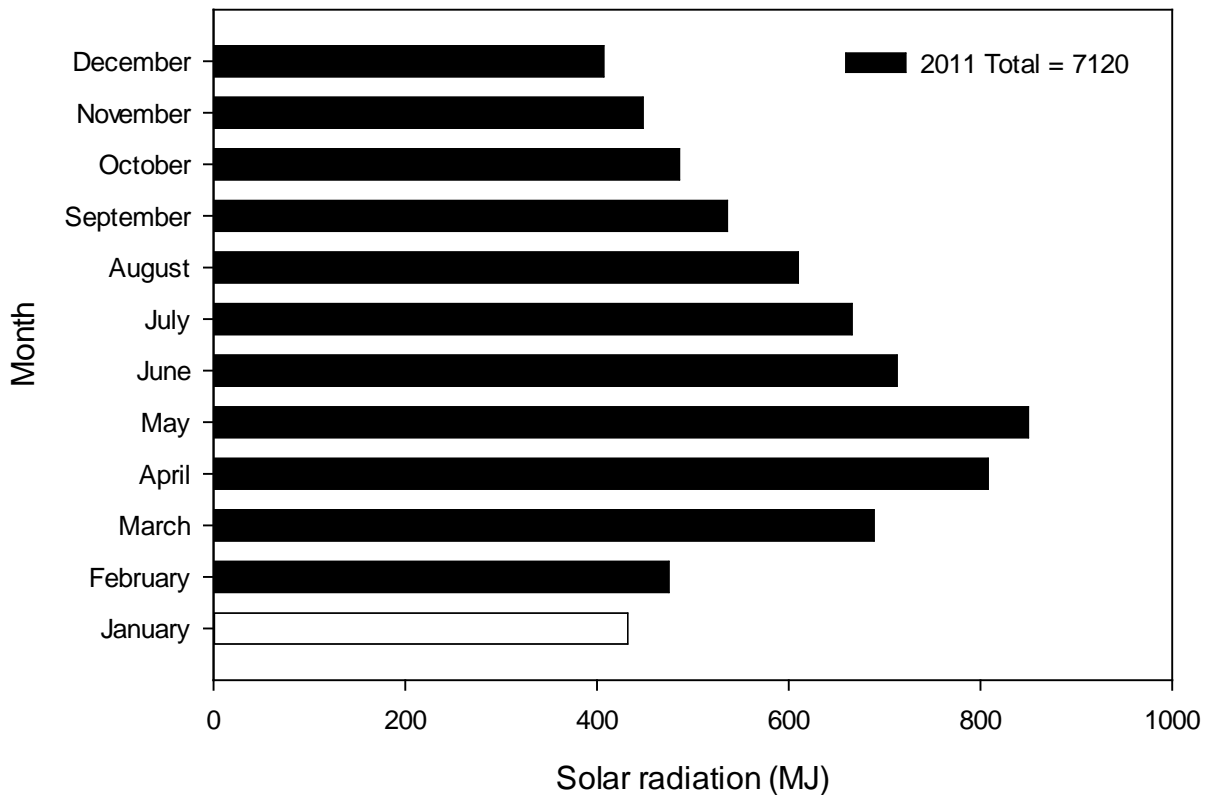


Figure 3. Total monthly solar radiation for 2011. Cumulative solar radiation in 2011 = 7,118 MJ (MJ = Joules x 1,000,000)

Temperature

Daily-low shelter temperatures at or below 32 °F were only observed on two days in 2011, both occurring in January (Table 2). The extreme low temperature for 2011 occurred on 13 January when shelter temperature reached 30.04 °F. Scattered frost begins when air temperature drops to 35 °F. Air temperatures at or below 35°F was observed only one day in

2011, resulting in widespread or scattered frost across the landscape (data not shown). Mean low temperatures were lower than the 69-year means in January, March, May, June, and October in 2011 (Table 3). Overall, mean low temperature for 2009 was 15.1 °F lower than the 69-year mean.

Table 3. Summary of minimum temperature* for 2011 by month, Range Cattle REC.

Month	Shelter†				Ground level‡		
	1944-11 Avg. low	2011 Avg. low	1944-11 Extreme low	Year	2011 Extreme low	2011 Avg. low	2011 Extreme low
	-----°F-----					-----°F-----	
January	49.1	45.8	18.0	1981	30.0	58.8	54
February	50.5	51.5	23.8	2009	34.0	62.4	56
March	54.3	52.7	26.0	1980	36.9	65.9	58
April	58.0	59.8	34.0	1971	46.0	72.2	65
May	63.3	61.1	43.0	1945	50.8	76.3	72
June	69.0	67.8	52.0	1984	62.2	79.4	75
July	71.3	72.1	62.0	several	68.0	80.2	77
August	71.9	74.2	61.0	1977	71.4	81.5	79
September	71.1	72.1	51.0	1962	68.9	79.7	79
October	64.7	63.4	37.5	2008	50.7	73.6	68
November	56.8	58.0	25.0	1970	46.6	66.6	64
December	51.2	53.5	20.0	1962	36.6	60.0	40
Average	60.9	61.0				71.4	66

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 0.555$$

† Air temperature is measured using a thermometer in an instrument shelter designed to protect meteorological equipment from exposure to direct sunlight, precipitation, and condensations, while allowing for adequate ventilation so that the instruments measure environmental parameters accurately.

‡ Ground level temperature is measured with a soil probe, which measures the temperature 4 inches below the soil surface.

Freeze hazard

The fall and spring freeze hazards for the Range Cattle REC are shown in Figure 4. The spring freeze hazard estimates the likelihood of temperatures reaching below the critical temperature after a selected date, while the fall freeze hazard estimates the likelihood of experiencing the first attainment of a critical temperature before a selected date. Based on records from 1960 to 2011, these data will not predict what will occur in a given year, but what can be expected over a period of years. In an example using the spring freeze hazard, one should expect approximately a 50% chance of survival of a frost-susceptible crop (assuming 32 °F) planted before the 1st of February (Figure 4-B). A grower has a significant likelihood of experiencing five crop frosts over ten years by planting before the 1st of February.

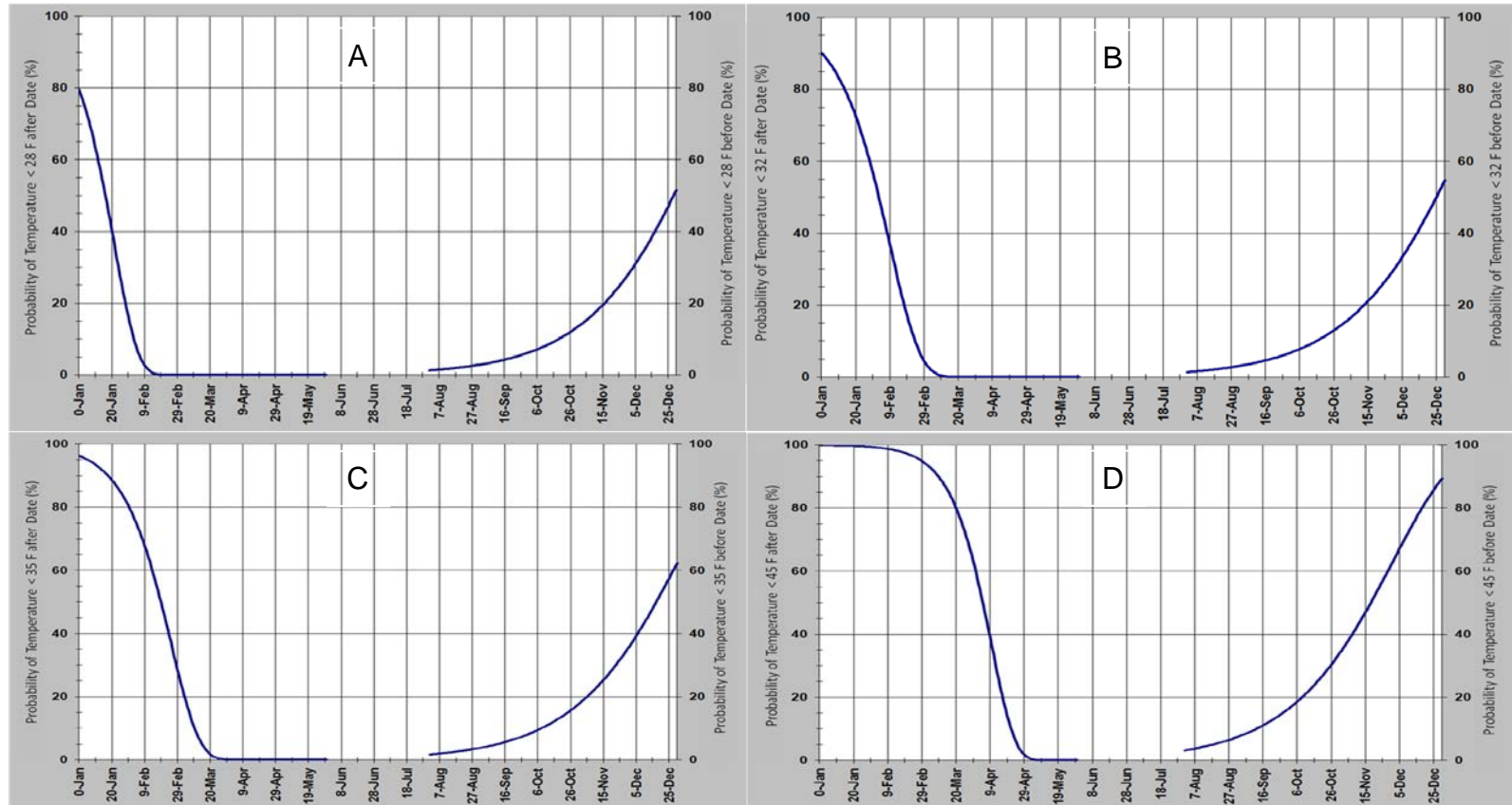


Figure 4. Spring and fall freeze hazard showing temperature probabilities after the spring date and before the fall date. Trend lines for temperature probabilities <28 °F (A), <32 °F (B), <35 °F (C), and <45 °F (D). Graphs were constructed using minimum temperature data from 1960 – 2010 using FRISKNH as developed by R. Snyder and J. Paulo de Melo-Abreu and can be accessed at <http://biomet.ucdavis.edu/frost-protection.html>

Acknowledgements: The authors thank Toni Wood and Joseph Noel for data preparation.