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CLIMATOLOGICAL REPORT 2009
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 to 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, evapo-transpiration, and solar radiation for 2009 obtained at the Range Cattle Research and Education Center (REC), Ona, Florida, and is compared to a 68-year summary of rainfall data and a 67-year summary of temperature data collected from this location. The center is located 81^{o} 56.406' W and 27^{o} 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 2009 totaled 46.18 inches (Table 1), which was 7.45 inches (13.9%) less than the 68-year average of 53.63 inches (Table 1). 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.

Monthly rainfall totals were below the 68-year average for all months in 2009 except May, August, and December (Figure 1; Table 1). Rainfall deficits exceeding two inches were recorded in February through April, June, September, October, and

December. Above normal rainfall in May provided some growth of forages for hay, resulting in a fairly good hay crop.

Daily rainfall equaled or exceeded 1 inch on 12 separate occasions in 2009. Three of these rain events exceeded 2 inches (Table 2). The single greatest daily rain event was 31 August when 5.24 inches were recorded.

Table 1. Summary of rainfall by months. Range Cattle REC, 2009.

	1942 to 2009			2009	
Month	Maximum / month	Minimum / month	68-year average†	Total	Difference from 68-year average
	----------	----------	inches*	----------	----------
January	8.45	0.03	2.13	1.20	-0.93
February	9.59	0.02	2.58	0.39	-2.19
March	12.34	0.13	3.08	1.08	-2.00
April	11.91	0.00	2.47	0.50	-1.97
May	10.58	0.00	3.76	6.68	2.92
June	18.99	2.79	8.68	6.19	-2.49
July	19.74	1.87	8.36	7.90	-0.46
August	16.10	3.13	8.34	12.46	4.12
September	20.11	1.14	7.28	3.44	-3.84
October	11.25	0.04	3.01	0.30	-2.71
November	11.22	0.07	1.90	1.17	-0.73
December	8.61	0.16	2.04	4.87	2.83
Year total			53.63	46.18	-7.45

*Inches x 2.54 = cm.

† Since rainfall records began in July 1942, means for January to June are 67-year means.

Evapo-transpiration

Evapo-transpiration is the total amount of water transferred from the earth to the atmosphere. Evapo-transpiration exceeded rainfall in January, February, March, May, and from October-December during 2009 (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 12.84 inches for the entire year.

Table 2. Daily maximum and minimum temperature, precipitation, and solar radiation for 2009, Range Cattle REC.

	January				February				March				April			
Day	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	74.25	47.57	0	14.1	72.48	34.11	0	9.7	70.81	52.02	0.03	10.9	87.73	62.67	0	21.5
2	78.82	50.20	0	13.4	68.20	50.09	0	3.6	63.77	32.45	0	24.4	86.11	62.82	0	19.7
3	78.73	49.06	0	13.4	62.42	36.10	0	13.9	66.78	28.11	0	25.4	79.34	62.10	0.04	9.3
4	82.49	53.85	0	13.8	59.50	33.10	0	18.6	75.02	36.11	0	22.9	87.91	51.08	0	27.1
5	84.83	54.57	0	13.7	54.75	23.82	0	20.6	76.89	42.89	0	23.3	87.93	58.23	0	22.7
6	83.48	53.96	0	16.1	68.97	28.40	0	19.0	80.56	44.60	0	23.0	82.72	53.35	0.01	14.0
7	79.39	46.08	0.02	6.9	69.85	37.92	0	12.6	81.75	42.61	0	22.6	65.62	41.46	0	23.4
8	72.79	39.19	0	17.5	76.12	40.13	0	16.5	84.65	43.95	0	23.4	72.81	38.89	0	30.1
9	75.18	43.72	0	17.2	76.71	38.95	0	16.6	86.66	47.34	0	23.5	83.48	36.56	0	29.2
10	79.57	43.98	0	17.2	81.19	46.51	0	14.3	88.25	45.68	0	25.1	85.93	49.92	0	23.5
11	80.60	47.80	0	17.1	85.84	52.63	0	16.1	86.27	46.99	0.01	225	87.66	58.82	0	23.6
12	69.98	54.37	0	5.5	82.31	55.29	0	11.3	87.39	50.68	0	22.9	90.55	60.93	0	25.5
13	78.89	51.57	0.30	7.7	86.97	53.49	0	15.5	86.67	57.47	0	19.9	90.75	62.56	0	23.7
14	69.10	39.84	0	16.6	83.16	50.09	0	16.6	86.67	57.06	0	20.9	79.59	63.95	0.45	5.0
15	60.49	36.81	0	8.1	82.18	56.37	0	11.6	88.32	58.59	0	21.7	79.9	48.65	0	13.0
16	63.88	39.75	0	17.0	76.46	46.89	0	17.1	91.53	58.66	0	22.5	87.17	41.87	0	29.7
17	67.66	34.87	0	18.5	75.24	40.37	0	17.6	80.85	57.31	0.41	11.3	80.60	58.12	0	19.3
18	73.53	39.48	0	17.2	76.95	43.37	0	16.1	81.73	59.04	0.02	17.5	82.56	52.20	0	27.1
19	72.48	53.58	0.10	14.5	75.25	51.53	0	7.3	83.71	55.17	0	22.0	86.85	50.83	0	27.9
20	66.56	39.61	0.17	14.4	66.65	35.17	0	15.8	83.82	51.96	0	.	83.21	59.38	0	13.2
21	53.29	29.09	0	19.1	75.42	28.20	0	15.8	81.27	54.16	0	22.0	81.73	49.32	0	29.2
22	64.18	22.21	0	17.6	77.29	43.44	0	18.9	77.07	49.33	0	23.9	85.64	47.17	0	29.7
23	74.01	29.27	0	16.1	75.56	49.55	0	21.6	74.80	50.45	0.08	11.8	90.99	46.44	0	29.4
24	75.06	35.23	0	15.4	77.79	42.16	0	22.3	80.80	46.65	0	25.1	89.62	53.46	0	28.8
25	79.45	40.15	0	16.4	76.01	47.91	0	18.0	82.85	49.89	0	25.0	85.53	54.93	0	24.8
26	80.24	43.46	0	14.9	77.88	44.33	0	20.4	86.29	52.34	0	26.1	86.41	57.51	0	30.3
27	81.61	53.20	0	11.9	82.81	47.01	0	22.9	85.51	60.73	0	20.7	87.51	55.35	0	27.9
28	83.10	58.19	0.01	12.9	83.44	49.08	0	22.7	88.38	68.05	0	21.6	86.99	56.48	0	23.1
29	83.86	59.99	0	11.9					76.28	48.52	0.53	8.4	87.48	59.14	0	25.3
30	68.97	43.17	0.60	6.9					85.50	43.46	0	28.1	89.55	56.53	0	25.5
31	62.58	33.71	0	11.2					88.75	60.62	0	22.0				
Avg	74.16	44.11	0.04	14.0	75.26	43.07	0.01	16.2	81.93	50.09	0.03	21.3	84.64	53.59	0.02	23.4
Max	84.83	59.99	0.60	19.1	86.97	56.37	0.39	22.9	91.53	68.05	0.53	28.1	90.99	63.95	0.45	30.3
Min	53.29	22.21	0.00	5.5	54.75	23.82	0.00	3.6	63.77	28.14	0.00	8.4	65.62	35.56	0.00	5.0
Total			1.20	434			0.39	453			1.08	640			0.50	703

Table 2. Continued.

	May				June				July				August			
Day	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	92.14	54.66	0	27.7	91.36	60.24	0	26.7	84.04	73.31	1.96	7.1	92.66	74.48	0	5.1
2	92.28	55.29	0	23.8	92.23	63.84	0	24.5	88.12	73.71	0.36	13.9	92.62	74.16	0	3.6
3	92.75	62.35	0	28.6	91.80	94.02	0.94	21.9	89.37	73.27	0.02	26.0	92.88	73.78	0	3.1
4	91.33	59.99	0	25.1	89.11	67.32	0.01	20.2	91.78	74.12	0	21.9	94.88	73.20	0.10	2.3
5	94.84	57.70	0	23.8	87.53	69.69	0.05	22.6	91.24	73.44	0	27.7	94.53	72.52	0	2.5
6	94.69	64.24	0	30.0	86.40	68.83	0.06	21.5	89.96	73.85	0	24.6	90.63	71.64	0	1.5
7	94.39	60.53	0	25.9	87.78	65.80	1.16	15.1	90.16	75.24	0.20	27.0	92.65	71.38	0.33	1.6
8	93.61	59.68	0	25.6	87.94	68.82	0.21	20.2	90.55	72.32	0	26.8	93.02	71.83	0.28	2.0
9	96.98	57.69	0	29.0	92.66	68.43	0	28.9	87.44	71.15	1.11	11.8	95.92	72.55	0	2.2
10	96.85	58.71	0	30.9	95.23	69.85	0	28.8	92.64	72.34	0	20.8	94.78	72.81	0.02	1.9
11	95.14	59.61	0	29.4	92.43	69.15	0	25.7	.	.	0	.	94.37	73.06	1.63	2.3
12	96.73	58.42	1.04	25.2	93.63	67.21	0	30.0	.	.	0	.	91.00	72.91	0	2.0
13	93.00	64.44	1.74	24.7	94.23	63.03	0	31.4	90.19	74.77	0.02	7.3	90.91	73.22	0.31	1.5
14	90.66	67.75	0.05	22.1	94.35	64.60	0.30	28.2	90.59	72.41	0	17.2	91.85	73.76	0.06	1.7
15	88.21	66.96	0.15	18.8	94.26	69.51	0	23.5	92.08	72.32	0.10	16.7	89.91	73.42	0.23	1.9
16	91.36	66.58	0	27.6	93.78	69.15	0.39	21.2	94.46	72.91	0	19.5	91.29	72.10	0.14	1.9
17	88.23	66.18	0	22.8	94.87	66.06	0	28.7	91.54	73.35	0	20.7	90.91	74.41	0	1.6
18	80.33	66.78	0.23	8.3	96.37	68.85	0.49	26.3	92.34	73.00	0	19.2	89.60	74.84	0	1.5
19	80.17	66.16	0.62	12.7	92.89	66.94	0.02	27.0	91.85	70.74	0	18.6	91.45	74.66	0.01	2.1
20	83.25	66.16	0.40	12.1	97.90	71.10	0	26.1	88.57	67.69	0.60	8.0	94.60	73.63	1.48	1.5
21	85.21	67.93	1.84	12.4	94.69	73.40	0	25.0	91.09	69.85	0	4.5	94.32	73.81	0.28	2.0
22	83.23	68.07	0.14	15.2	94.91	74.95	0	28.7	93.02	71.92	0.20	5.7	90.77	72.09	0.01	2.4
23	88.59	69.66	0	18.4	92.57	72.81	0.14	19.0	93.83	71.82	0	6.3	91.58	73.45	0	2.4
24	89.44	67.37	0	14.8	92.07	71.49	0	24.9	94.60	72.46	0	5.5	92.03	73.42	1.42	1.4
25	87.93	65.19	0.02	23.0	91.22	69.53	0	26.9	93.36	70.63	0.05	5.2	91.27	71.85	0.21	1.5
26	88.99	62.73	0.44	20.1	83.26	72.55	2.26	11.5	90.64	70.18	0.04	4.0	90.46	73.38	0.01	1.4
27	89.65	63.54	0.01	28.4	87.49	71.87	0	20.5	82.33	70.54	0.52	3.0	91.35	75.02	0.21	1.6
28	88.54	68.81	0	21.2	90.41	71.65	0	26.6	93.11	70.45	0	5.8	88.16	74.28	0.45	1.1
29	87.62	67.30	0	22.5	87.80	74.71	0.16	24.0	92.82	73.58	0	4.6	89.31	74.55	0.04	1.3
30	88.99	68.59	0	28.4	.	.	0	.	93.76	71.04	1.99	3.7	90.75	73.49	0	2.6
31	87.76	62.06	0	30.6					89.24	71.49	0.73	3.6	93.38	71.33	5.24	3.0
Avg	90.19	63.58	0.22	22.9	91.76	68.60	0.21	24.3	90.85	72.20	0.25	13.3	92.07	73.26	0.04	2.1
Max	96.98	69.66	1.84	30.9	97.90	74.95	2.26	31.4	94.60	75.24	1.99	27.7	95.92	75.02	5.24	5.1
Min	80.17	54.66	0.00	8.3	83.26	60.24	0.00	11.5	82.33	67.69	0.00	3.0	88.16	71.33	0.00	1.1
Total			6.68	709			6.19	707			7.90	387			12.46	64

Table 2. Continued.

	September				October				November				December			
Day	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	85.51	71.01	0	1.9	85.75	62.13	0	3.3	88.70	68.07	0	3.2	80.85	56.52	0	4.0
2	87.78	72.59	1.60	2.3	86.14	61.45	0	2.9	85.08	66.54	0	2.9	83.98	62.56	0.07	7.7
3	85.24	72.77	0.10	1.7	89.31	64.11	0	2.8	82.58	65.86	0	3.2	75.61	63.23	0.31	5.3
4	89.92	72.46	0.03	3.0	91.67	66.85	0	3.0	85.42	64.22	0	3.5	63.09	56.91	1.42	2.1
5	89.19	71.94	0.01	2.2	90.28	70.38	0	2.2	81.81	59.04	0	4.1	94.08	47.64	2.60	3.7
6	91.94	71.87	0	3.3	92.39	72.43	0	2.5	80.44	55.26	0	3.7	68.00	43.41	0	7.9
7	90.77	72.39	0	3.1	94.10	72.83	0	2.8	81.59	59.76	0	4.1	80.82	60.62	0	4.8
8	91.20	73.11	0	2.9	93.99	71.73	0	2.6	82.72	60.39	0	3.4	80.74	62.22	0	0.6
9	91.02	72.55	0.03	3.7	93.36	73.62	0	3.3	82.67	68.88	0	1.8	84.22	65.16	0	1.9
10	90.75	73.06	0	3.7	93.15	75.16	0.17	3.7	83.05	70.61	0.14	2.0	82.29	59.92	0	3.1
11	90.88	74.39	0.06	3.4	91.33	73.71	0	2.3	79.95	67.01	0.24	2.4	67.15	55.47	0	3.3
12	81.79	73.60	1.06	0.9	92.23	73.17	0	2.6	67.46	51.46	0	1.7	78.08	58.01	0	7.2
13	89.80	73.64	0.27	2.7	91.71	71.11	0	2.9	74.34	47.53	0	4.5	85.32	63.34	0	8.6
14	91.44	74.95	0	3.5	90.37	70.65	0	2.6	79.29	50.43	0	3.8	84.99	63.19	0	8.8
15	89.62	74.71	0	2.8	89.04	70.14	0	2.3	78.08	50.25	0	4.8	84.56	63.18	0	9.1
16	88.97	72.88	0	3.1	83.93	71.44	0.10	1.8	80.17	50.27	0	4.6	80.38	62.85	0	9.6
17	90.75	73.89	0	3.3	74.25	54.01	0	2.3	81.05	54.05	0	4.0	76.32	61.34	0	6.9
18	91.78	72.27	0	3.7	67.77	47.79	0	3.7	82.90	54.81	0	3.8	74.66	63.81	0	3.5
19	92.14	72.57	0	3.6	75.54	46.33	0	3.6	81.79	58.84	0	4.4	66.97	49.57	0	8.3
20	91.81	74.80	0	3.0	82.78	57.43	0	3.5	80.67	56.84	0	3.9	62.53	44.89	0	9.4
21	92.26	74.39	0.11	3.1	85.44	62.92	0	3.5	82.98	59.99	0	2.3	60.49	38.98	0	8.6
22	92.91	73.98	0	3.2	83.55	66.34	0	3.3	79.61	66.18	0	1.3	66.06	42.72	0	7.6
23	90.03	74.17	0	3.0	89.08	67.75	0	3.6	82.98	67.33	0	4.1	73.47	47.66	0	9.1
24	91.74	74.03	0	2.9	88.63	65.12	0	3.8	82.13	68.16	0.02	7.4	78.84	54.88	0	9.8
25	92.14	73.92	0.16	2.8	85.12	60.28	0	4.0	70.95	65.05	0.74	0.6	78.01	54.81	0.08	5.8
26	91.78	74.26	0.01	3.5	89.85	59.11	0.03	3.5	71.42	49.35	0.03	0.9	67.14	50.81	0	9.4
27	89.94	74.53	0	2.7	90.14	71.33	0	2.8	65.86	41.45	0	1.3	64.09	46.89	0	7.3
28	90.79	70.07	0	3.3	91.31	71.06	0	3.5	66.87	39.66	0	2.5	69.84	43.28	0	10.9
29	90.81	67.23	0	3.5	90.86	71.06	0	4.0	77.41	44.78	0	3.2	63.52	35.04	0	11.0
30	83.55	64.08	0	2.9	90.23	69.98	0	4.0	79.16	49.10	0	4.2	74.53	40.89	0	10.6
31					90.05	68.95	0	3.7					77.79	52.66	0	8.8
Avg	89.94	72.75	0.11	3.0	87.85	66.46	0.01	3.1	79.30	57.71	0.04	3.3	74.14	53.95	0.16	6.9
Max	92.91	74.95	1.60	3.8	94.1	75.16	0.17	4.0	88.70	70.61	0.74	7.4	85.32	65.16	2.60	11.0
Min	81.79	64.08	0.00	0.9	67.77	46.33	0.00	1.8	65.86	39.66	0.00	0.6	60.49	35.04	0.00	0.6
Total			3.44	89			0.30	97			1.17	98			4.87	215

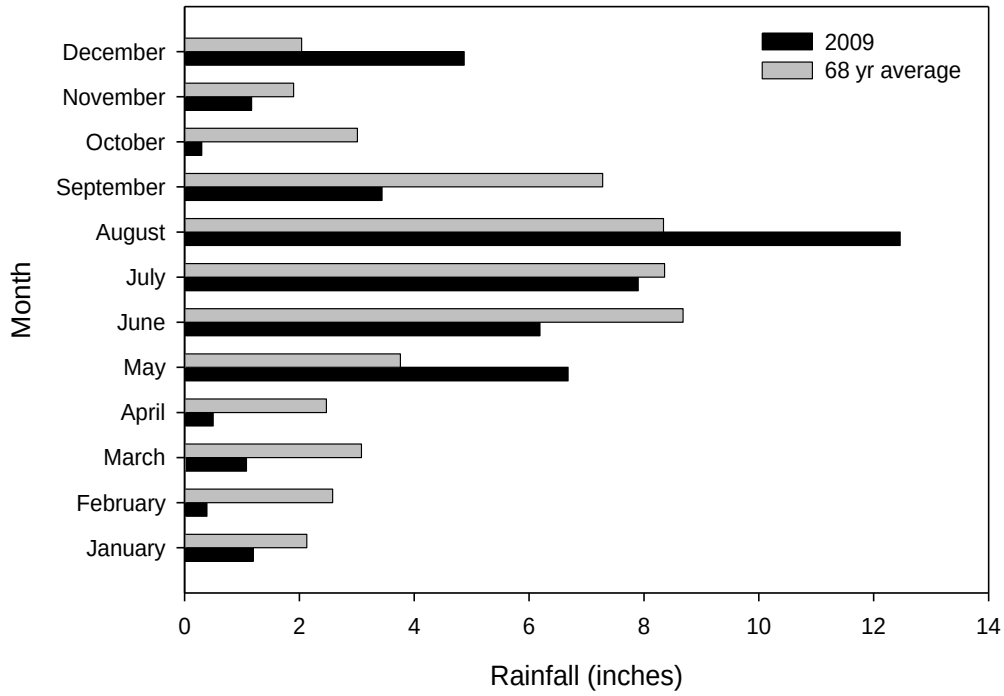

Figure 1. Monthly rainfall in 2009 compared with the 68-year average.

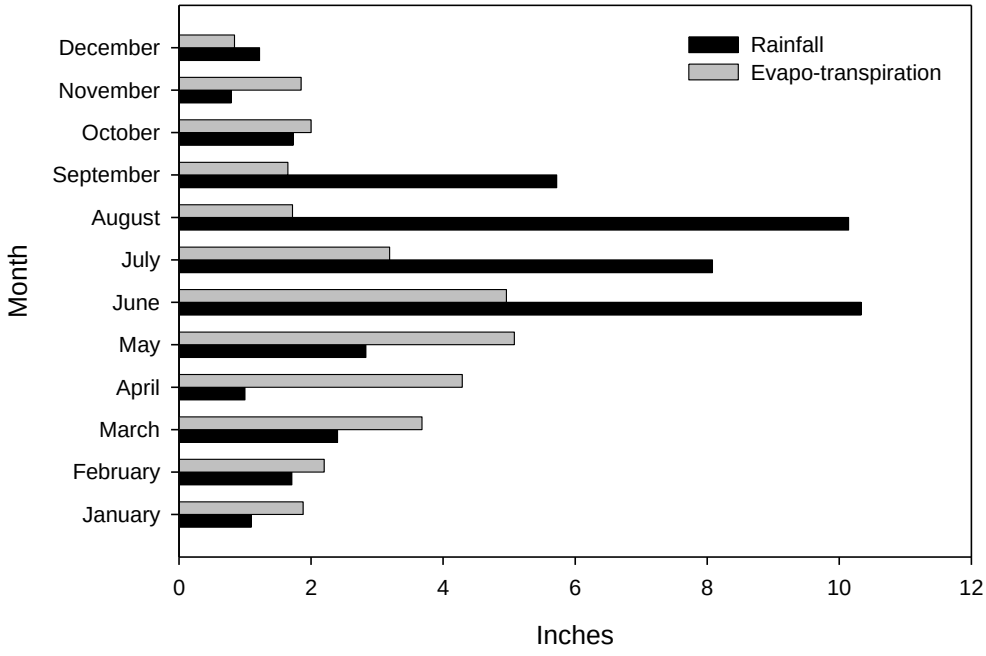

Figure 2. Monthly rainfall compared with evapo-transpiration during 2009. Cumulative rainfall = 50.05” and cumulative evapo-transpiration = 40.79”.

Solar Radiation:

Daily solar radiation is shown in Table 2, and 2009 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 2009 (705 MJ) to produce 10,052 lb/A of plant dry matter. Total solar radiation for 2009 was 4,595 MJ.

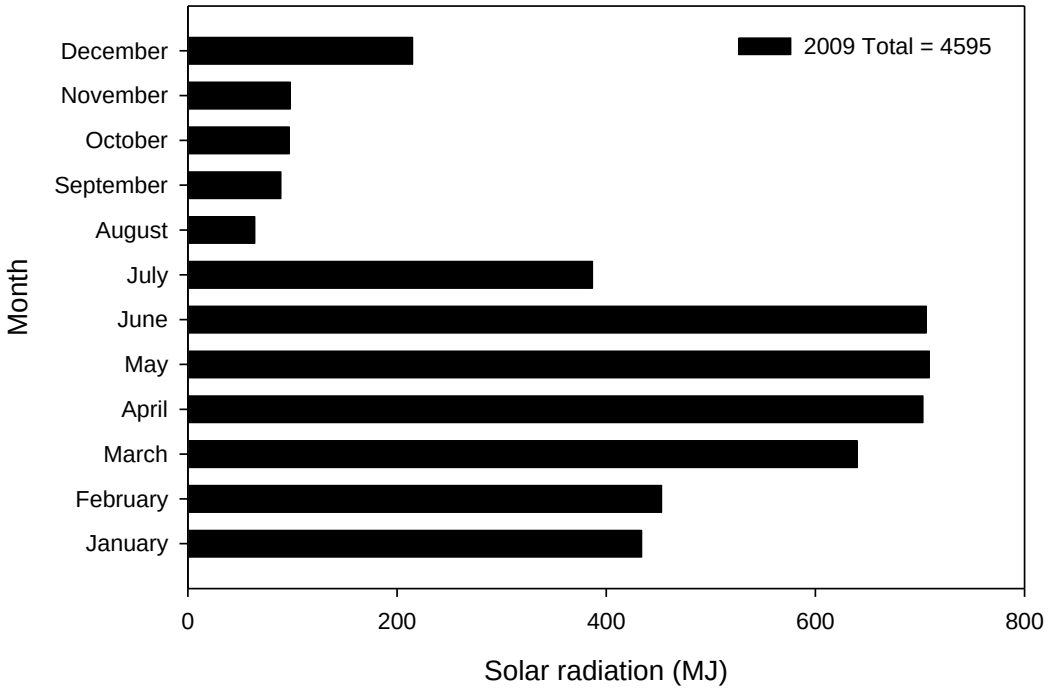

Figure 3. Total monthly solar radiation for 2009. Cumulative solar radiation in 2009 = 4,595. MJ (MJ = Joules x 1,000,000)

Temperature

Daily-low shelter temperatures at or below 32 ^{o}F were observed on eight days(Table 2). The extreme low temperature for 2009 occurred on 22 January when shelter temperature reached 22.2 ^{o}F. Scattered frost begins when air temperature drops to 35 ^{o}F. Air temperatures at or below 35^{o}F were observed on 14 days in 2009, resulting in widespread or scattered frost across the landscape (data not shown). Mean low temperatures were lower than the 67-year means for all months in 2009 (Table 3). Overall, mean low temperature for 2009 was 15.1 ^{o}F lower than the 67-year mean.

Table 3. Summary of minimum temperature* for 2009 by month, Range Cattle REC.

	Shelter†					Ground level‡	
	1944-09	2009	1944-09		2009	2009	
Month	Avg. low	Avg. low	Extreme low	Year	Extreme low	Avg. low	Extreme low
	----------°F----------				----------°F----------		
January	49.3	22.2	18	1981	22	60	51
February	50.5	23.8	24	2009	24	60	50
March	54.4	28.1	26	1980	28	66	58
April	57.9	36.6	34	1971	37	71	64
May	63.2	54.7	43	1945	55	77	73
June	68.9	60.2	52	1984	60	80	75
July	71.2	67.7	62	several	68	81	78
August	71.8	71.3	61	1977	71	81	80
September	71.1	64.1	51	1962	64	81	79
October	64.8	46.3	38	2008	46	77	70
November	56.8	39.7	25	1970	40	71	61
December	51.3	35.0	20	1962	35	65	57
Average	60.9	45.8				73	66

*°C = (°F – 32) x 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 2009, 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.

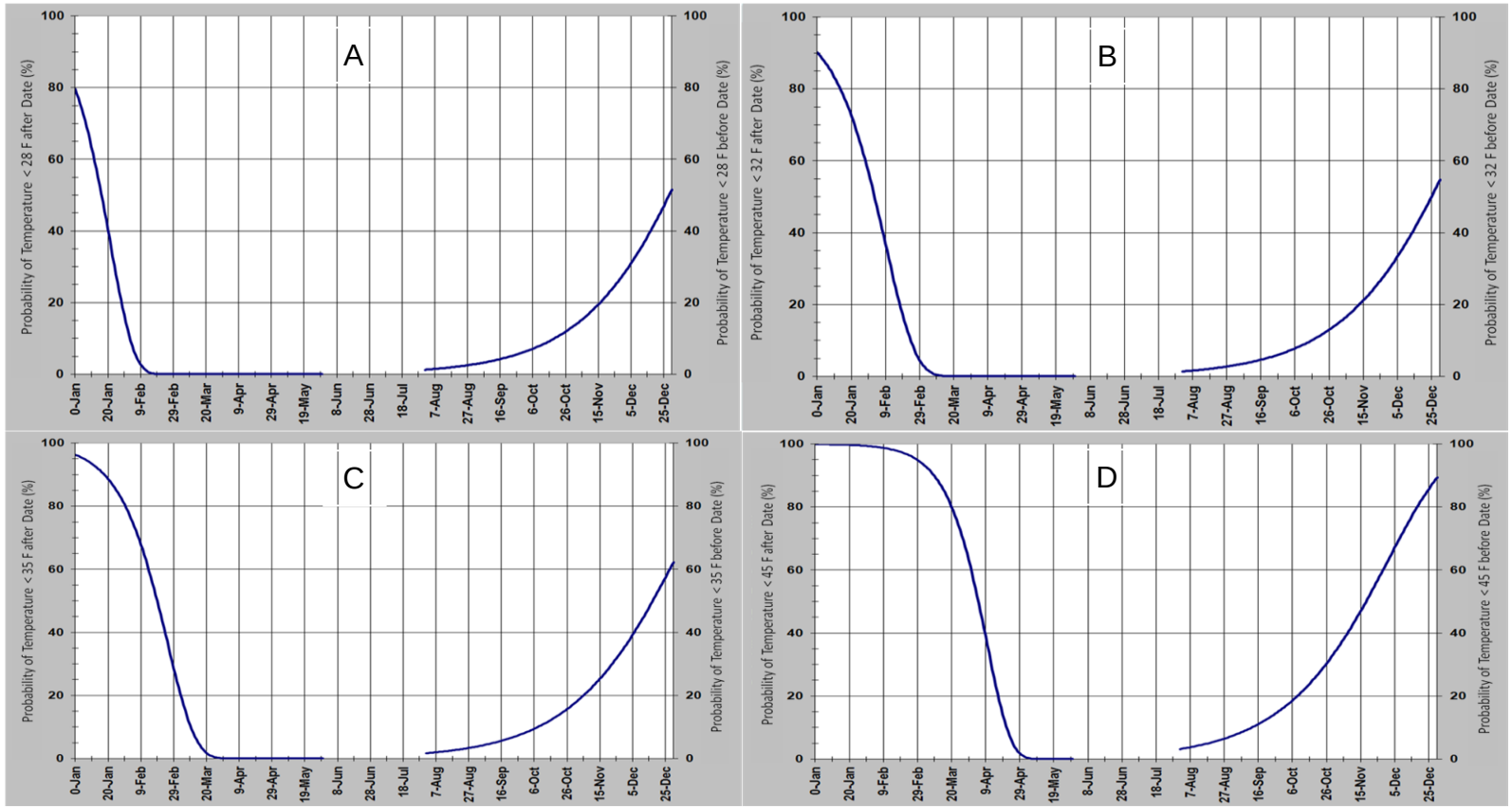

Figure 4. Spring and fall freeze hazard showing temperature probabilities after the spring date and before the fall date. Trend lines for temperature probabilities <28 ^{o}F (A), <32 ^{o}F (B), <35 ^{o}F (C), and <45 ^{o}F (D). Graphs were constructed using minimum temperature data from 1960 – 2009 using FRISKNH as developed by R. Snyder and J. Paulo de Melo-Abreu and can be accessed at http://biomet.ucdavis.edu/frost-protection.html

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