

## Adaptive Resources, Inc.

To: Western Water Use Management Modeling Joint Board  
From: Thad Kuntz, P.G., and Heath Kuntz  
Date: April 2016  
Re: Western Water Use Management Land Use Dataset Update through 2013

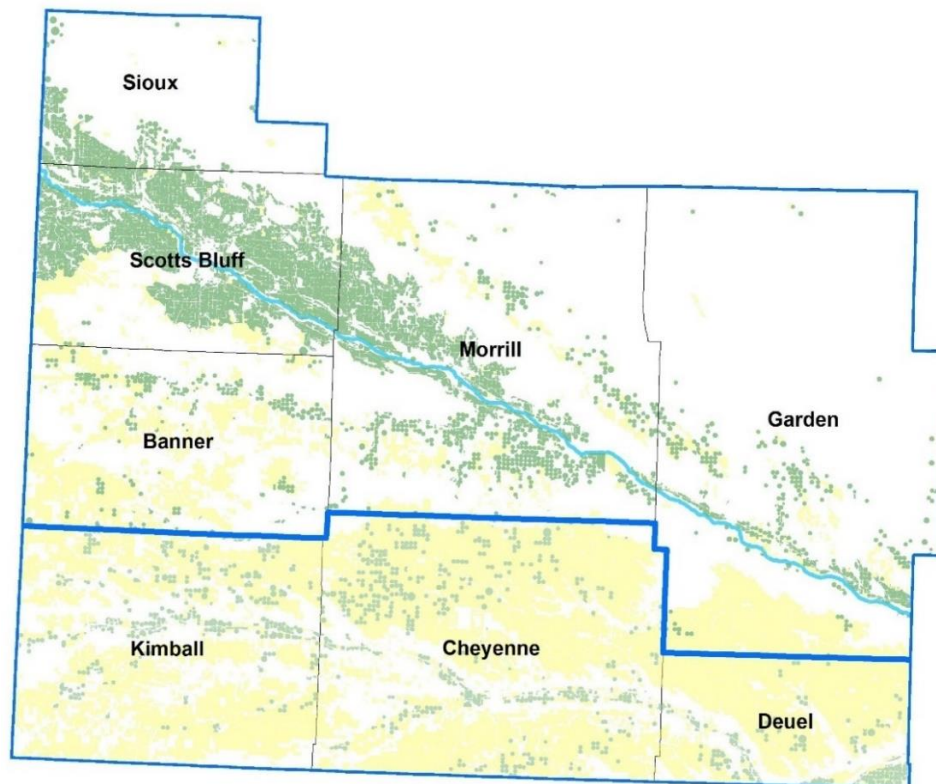
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### INTRODUCTION

The Western Water Use Management Modeling (WWUMM) land use dataset is a comprehensive effort to delineate and attribute all land use within the model area. This document provides details on the extension of the previous land use dataset that is documented in *Western Water Use Management Model Irrigated and Dryland Acreage Assessment* (Leonard Rice Engineers, 2012). This dataset is directly used in several other WWUMM processes and models and includes the surface water operations (SWO) and the Regionalized Soil Water Balance (RSWB) models that are detailed in other documentation. The WWUMM ground water model does not use this dataset directly; however, it does utilize the well and recharge files that are derived, in part, using this information. A list of the documentation for each model and dataset can be found in the *WWUM Modeling Chronological Index of Documentation* (Kuntz, 2016).

The land use dataset encompasses all of the North Platte NRD (NPNRD) and South Platte NRD (SPNRD), collectively referred to as NRDs, in Nebraska and the North Platte River valley from the Whalen diversion dam to the Stateline in Wyoming. The NRDs encompass eight counties (Figure 1); Scotts Bluff, Banner, Morrill, Garden, the lower portion of Sioux county in NPNRD and Kimball, Cheyenne, and Deuel counties in SPNRD. The Wyoming lands are generally located in Goshen County in the southeastern portion of Wyoming.

Figure 1: North Platte and South Platte Natural Resource District Study Area



## EXTENSION STUDY PERIOD

As described in the Leonard Rice Engineers (2012) report, the earliest available aerial imagery throughout the NRDs is 1953 and the most recent imagery in this extension is 2014. This dataset extension focuses on available data from 2011 through 2014 within the NRDs. Lands in Wyoming, Upper Niobrara White NRD, the COHYST model area, and Colorado were not updated, and the 2010 land use for these regions were repeated forward through the time period.

## AERIAL IMAGERY

Several sources of historical aerial imagery have been utilized in this effort to develop the spatial information for the Nebraska portion of the study area. For the extended study period, the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Color NAIP imagery was utilized. **Table 1** provides the list of the imagery and the locales they were used for development of the land use dataset.

*Table 1: WWUM Model Aerial Imagery*

Year	Source	Format <sup>1</sup>	Area of Shapefile Acquired
1953	USGS	B&W Images	North Platte and South Platte NRD
1975 <sup>2</sup>	USDA	B&W Images	North Platte NRD
1977 <sup>3</sup>	USDA	B&W Images	South Platte NRD
1984	USDA	IR DOQQ	North Platte and South Platte NRD
1993	DNR	B&W DOQQ	North Platte and South Platte NRD
1994	WYGISC	IR DOQQ	Goshen and Platte Counties, WY
1999	DNR	B&W DOQQ	North Platte and South Platte NRD
2003	NRCS	Color NAIP	North Platte and South Platte NRD
2005	NRCS	Color NAIP	North Platte and South Platte NRD
2010	NRCS	Color NAIP	North Platte and South Platte NRD
2012	NRCS	Color NAIP	North Platte and South Platte NRD
2014	NRCS	Color NAIP	North Platte and South Platte NRD

Format Types: Digital Orthophoto Quarter Quadrangles (DOQQ), Color Infra-red DOQQ (IR DOQQ). National Agricultural Inventory Program (NAIP), Black and White (B&W), Individual Aerial Images (Images)

<sup>1</sup> North Platte NRD Imagery for 1975 is a compilation of images from 1975, 1974, and 1973

<sup>2</sup> South Platte NRD Imagery for 1977 is a compilation of images from 1977, and 1973

## NEBRASKA IRRIGATED ACREAGE EXTENSION

The extension of the existing Nebraska irrigated acreage dataset previously developed (Leonard Rice Engineers, 2012) utilized the most recent certified acreage information provided by the NRDs. These irrigated lands are referred to as “certified parcels,” “certified acres,” or “certificates,” and represent the lands that can be served by one or more wells. These certificates are assigned a unique number to track changes or usage of wells associated with it through time. Certified acres can be served by only ground water or can be commingled, meaning either ground water, surface water, or both can be applied to the land. Changes to irrigated lands served by surface water were based on visual inspection of historic aerial imagery.

### Certified Acreage

The NRDs certified acreage datasets were originally compiled from shapefiles or geodatabases containing certified parcels, however, during this extension, only the attributes of the dataset were extended to reflect each additional year of pumping and cropping records collected. If a certification was retired or transferred, the NRDs provided us a list and shapefile of these changes. Figure 2 provides the ground water only and commingled certified acreage within NPNRD.

Figure 2: NPNRD Certified Irrigated Acreage

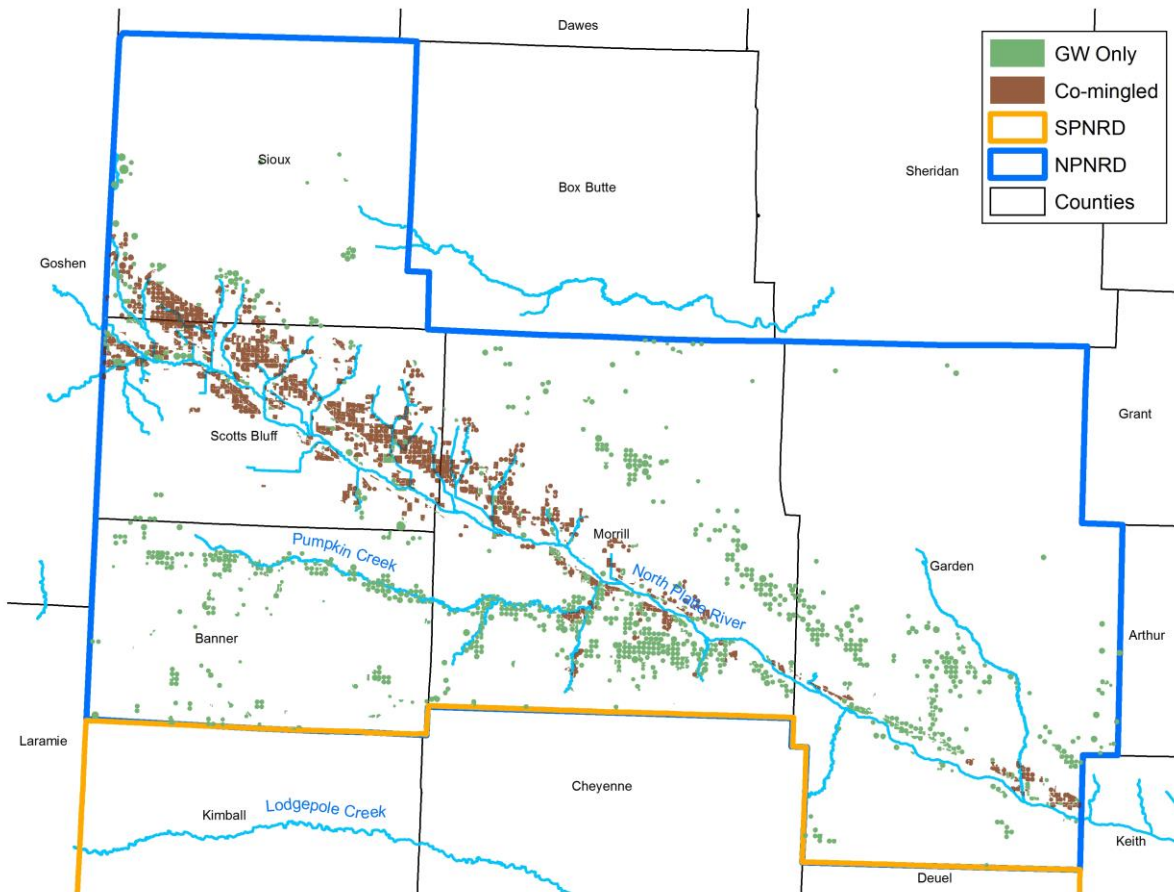
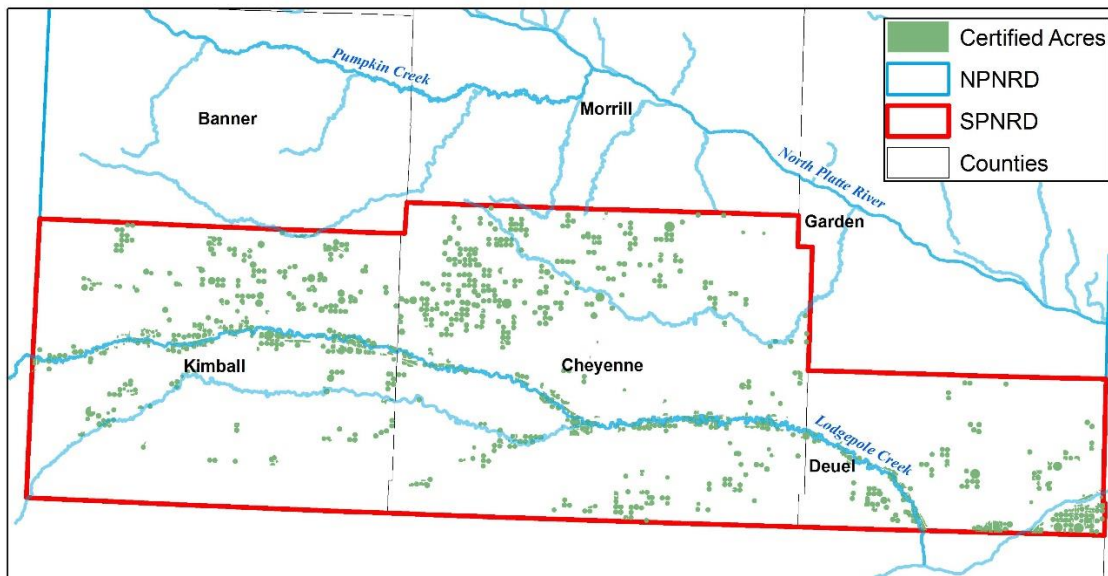


Figure 3 provides the ground water only and commingled certified acreage within SPNRD.

Figure 3: SPNRD Certified Irrigated Acreage



The attributes that were extended through 2013 are consistent with what was previously developed in the original dataset (Leonard Rice Engineers, 2012). Table 2 provides a breakdown of the NRDs irrigated land's attributes.

*Table 2: Irrigated Acreage Attribute Table*

Attribute	Description
Parcel_ID	Unique identifier for each spatial polygon
Cal_Year	Year of Assessment
Acres	Area of parcel in acres (calculated)
IRR_Type	Irrigation method, Sprinkler or Flood
SW	Served by surface water, Y/N
GW	Served by ground water, Y/N
Cert_Num or ID	Certification number or ID from Certified Acres
First_Irr	Year first served/irrigated based on NPNRD/SPNRD
Crop1-4	Crop type of parcel, up to four crops per parcel
Crop1-4_COV	Percent of parcel with 'Crop1-4' grown
SW_FAC	Name of surface water structure serving parcel
GWID01-30	DNR Well ID of well serving parcel, up to 30 wells per parcel
URF_ID	Assignment to URF Zone
COUNTY	County that parcel is located in
SUBAREA	Administration Area (i.e. Pumpkin Creek, North Platte)
CRP_SRC	Flag indicating the source of cropping information
Pivot_C	Indicates if it is a pivot corner

For more background on each attribute, please see the previous documentation (Leonard Rice Engineers, 2012).

### **NEBRASKA DRYLAND ACREAGE EXTENSION**

The previous land use dataset delineated dryland acreage within the NRDs, and consists of either native vegetation or dryland farmed acreage. The dryland acreage was delineated to develop a spatial shapefile of dryland parcels that are used in the RSWB model which estimates the evapotranspiration of vegetation, surface runoff during precipitation events, and precipitation recharge used in the ground water model. Similarly to the original dataset development, this dataset was extended and modified using aerial imagery where dryland parcels were maintained, added, removed, or refined. Dryland parcels were identified on the aerial imagery based on the presence of dryland farmland crop/fallow pattern, terracing, fencing, and the absence of any irrigation supplies. Table 3 summarizes the dryland parcel attributes.

*Table 3: Dryland Acreage Attributes*

Attribute	Description
Parcel_ID	Unique identifier for each spatial polygon
Acres	Area of parcel in acres (calculated)
Crop1-4	Crop type of parcel, up to four crops per parcel
Crop1-4_COV	Percent of parcel with 'Crop1-4' grown
County	Assignment to County
URF_ID	Assignment to URF Zone
CRP_SRC	Flag indicating the source of cropping information
Pivot_C	Indicates if it is a pivot corner

For more information on each attribute, please refer to the original land use documentation (Leonard Rice Engineers, 2012).

### NEBRASKA ACREAGE SUMMARY

To provide land use datasets throughout the modeling, the extension of the land use utilized a similar method to the original dataset. This process applied an approach that carried forward parcel boundaries and attributes for both irrigated and dryland parcels until a change in boundaries or attributes is known. This allowed historical acreage information to be carried forward in subsequent years until additional data becomes available such as an aerial imagery assessment or irrigated acres became active or inactive in a non-assessment year.

Table 4 and 5, respectively, provides a summary of the North Platte NRD and South Platte NRD irrigated land use datasets. The summaries include the new and total commingled, ground water only, and surface water only acreage that became active in each year. The summaries also include the new certificates that become active in each year and total certificates associated with irrigated parcels in each year based on first irrigation dates. In the extension, newly active irrigated parcels may not be related to increased development, rather they actively pumped water after being flagged as inactive by each NRD.

*Table 4: NPNRD Irrigated Acreage Summary*

Year	Add. Commingled Acreage	Total Commingled Acreage	Add. GW Only Acreage	Total GW Only Acreage	Total Add. SW Only Acreage	SW Only Acreage	Total Acreage	Add. Certificates	Total Certificates
1953	1,440	22,538	994	8,189	2,434	299,647	330,374	21	276
1954	5,545	28,083	895	9,084	6,440	294,055	331,222	56	332
1955	2,231	30,315	695	9,779	2,926	291,778	331,872	29	361
1956	2,322	32,637	832	10,611	3,155	289,275	332,523	32	393
1957	1,964	34,601	678	11,289	2,642	287,309	333,198	27	420
1958	246	34,847	672	11,961	919	286,789	333,598	11	431
1959	970	35,817	1,781	13,742	2,751	285,594	335,153	32	463
1960	5,015	40,832	2,281	16,023	7,296	280,689	337,544	63	526
1961	8,404	49,236	1,275	17,298	9,679	272,287	338,821	87	613
1962	430	49,666	1,364	18,662	1,793	271,732	340,060	11	624
1963	224	49,889	730	19,391	953	271,305	340,586	9	633
1964	1,710	51,599	1,240	20,631	2,949	269,643	341,873	28	661
1965	1,216	52,815	2,184	22,815	3,400	268,368	343,998	34	695
1966	76	52,891	1,636	24,451	1,712	268,240	345,581	12	707
1967	557	53,448	1,600	26,050	2,157	267,669	347,168	19	726
1968	492	53,940	3,722	29,772	4,214	267,060	350,772	33	759
1969	609	54,548	3,497	33,270	4,106	266,610	354,429	38	797
1970	1,606	56,155	3,090	36,359	4,696	264,240	356,755	38	835
1971	608	56,763	2,207	38,566	2,814	263,638	358,967	22	857
1972	366	57,128	3,529	42,095	3,894	263,159	362,382	28	885
1973	505	57,634	6,263	48,358	6,768	262,285	368,276	43	928
1974	995	58,628	3,802	52,160	4,797	261,049	371,838	42	970
1975	2,153	60,189	3,619	55,194	5,772	251,976	367,359	53	1026
1976	497	60,686	11,861	67,055	12,358	248,788	376,529	105	1131

Year	Add. Commingled Acreage	Total Comingled Acreage	Add. GW Only Acreage	Total GW Only Acreage	Total Add. SW Only Acreage	SW Only Acreage	Total Acreage	Add. Certificates	Total Certificates
1978	1,039	65,279	2,056	72,855	3,095	243,872	382,007	24	1221
1979	671	65,950	3,903	76,758	4,574	243,195	385,903	43	1264
1980	777	66,726	2,790	79,548	3,567	242,154	388,429	25	1289
1981	827	67,553	6,193	85,742	7,020	240,946	394,241	63	1352
1982	1,382	68,935	1,509	87,250	2,891	239,687	395,872	26	1378
1983	371	69,306	2,043	89,293	2,414	239,327	397,926	19	1397
1984	470	70,302	6,133	120,314	6,603	238,628	429,244	51	1612
1985	548	70,851	805	121,119	1,354	238,173	430,142	12	1624
1986	27	70,877	440	121,558	467	238,146	430,582	4	1628
1987	299	71,176	227	121,786	526	237,724	430,686	3	1631
1988	152	71,328	402	122,187	554	237,445	430,961	5	1636
1989	5,947	77,276	1,088	123,276	7,036	231,530	432,082	60	1696
1990	5,614	82,890	1,582	124,858	7,196	225,860	433,608	57	1753
1991	2,679	85,569	1,169	126,026	3,848	223,076	434,672	29	1782
1992	3,774	89,343	1,151	127,177	4,925	219,611	436,131	34	1816
1993	1,227	92,033	1,064	128,769	2,291	218,055	438,857	21	1835
1994	1,356	93,389	1,318	130,088	2,674	216,754	440,230	26	1861
1995	832	94,221	1,614	131,701	2,446	215,944	441,866	22	1883
1996	1,311	95,532	2,118	133,819	3,429	214,525	443,876	31	1914
1997	1,235	96,325	2,368	136,156	3,603	212,183	444,664	37	1944
1998	657	96,982	1,062	137,218	1,719	211,555	445,754	18	1962
1999	508	97,489	632	137,849	1,139	210,966	446,304	11	1973
2000	1,040	98,529	1,418	139,267	2,458	209,595	447,391	30	2003
2001	1,060	99,348	721	141,124	1,781	208,224	448,696	17	2024
2002	8,752	108,100	2,357	143,481	11,109	199,875	451,456	91	2114
2003	6,192	114,291	0	141,450	6,192	193,753	449,494	69	2131
2004	269	114,560	172	141,622	440	193,485	449,666	3	2137
2005	0	113,915	119	141,698	119	188,605	444,218	1	2130
2006	0	113,692	0	139,658	0	188,301	441,652	0	2118
2007	0	113,692	0	138,855	0	188,301	440,848	0	2110
2008	0	113,630	0	138,995	0	188,048	440,673	0	2113
2009	0	113,587	0	135,608	0	187,861	440,221	0	2052
2010	564	114,151	307	135,235	307	188,817	438,203	3	2047
2011	-142	114009	543	135778	356	189173	438960	23	2070
2012	-3094	110915	-1,693	134085	1,084	190257	435257	-59	2011
2013	4208	115123	438	134523	167	190424	440070	0	2011
2014	353	115476	763	135286	1,799	192223	442985	66	2077

Note: the reduction in GW only acreage 2003-2014 is due to the exclusion of CREP/EQIP lands and certified acreage with inactive pumping records or no meters.

Table 5: SPNRD Irrigated Acreage Summary

Year	Add. Commingled Acreage	Total Commingled Acreage	Add. GW Only Acreage	Total GW Only Acreage	Total Add. Acreage	SW Only Acreage	Total Acreage	Add. Certificates	Total Certificates
1953	72	5,860	835	15,425	21,286	10,875	32,160	13	199
1954	96	5,956	342	15,767	21,723	10,792	32,515	6	205
1955	339	6,295	676	16,442	22,737	10,505	33,242	12	217
1956	276	6,571	607	17,050	23,621	10,262	33,883	11	228
1957	62	6,633	831	17,881	24,514	10,223	34,737	10	238
1958	214	6,847	239	18,119	24,966	10,027	34,994	7	245
1959	154	7,001	93	18,212	25,213	9,873	35,086	3	248
1960	257	7,258	280	18,492	25,750	9,689	35,439	9	257
1961	141	7,399	1,067	19,559	26,958	9,519	36,477	11	268
1962	53	7,451	212	19,772	27,223	9,467	36,690	5	273
1963	319	7,770	131	19,903	27,673	9,150	36,823	6	279
1964	0	7,770	1,848	21,752	29,522	9,102	38,624	19	298
1965	246	8,016	1,642	23,394	31,410	8,992	40,402	13	311
1966	94	8,110	456	23,850	31,960	8,900	40,860	5	316
1967	187	8,297	1,781	25,631	33,929	8,745	42,674	17	333
1968	202	8,500	2,748	28,379	36,879	8,646	45,524	24	357
1969	124	8,624	2,127	30,506	39,130	8,537	47,667	19	376
1970	0	8,624	1,740	32,246	40,870	8,537	49,408	12	388
1971	47	8,671	876	33,122	41,793	8,467	50,261	9	397
1972	55	8,726	3,357	36,479	45,204	8,430	53,635	25	422
1973	57	8,783	2,776	39,255	48,038	8,320	56,358	24	446
1974	277	9,060	7,048	46,303	55,363	8,047	63,410	59	505
1975	0	8,985	10,380	56,683	65,668	7,769	73,437	66	571
1976	570	9,555	7,791	64,474	74,030	7,408	81,437	64	635
1977	158	8,697	1,988	68,779	77,476	6,004	83,480	24	663
1978	0	3,941	6,645	75,424	79,365	370	79,735	15	678
1979	0	3,941	988	76,412	80,353	370	80,723	6	684
1980	0	4,091	1,745	78,157	82,248	220	82,468	13	697
1981	0	4,091	5,001	83,158	87,249	220	87,469	34	731
1982	0	4,091	2,211	85,369	89,460	220	89,680	12	743
1983	0	4,091	933	86,303	90,394	220	90,613	8	751
1984	0	4,098	2,737	93,492	97,590	104	97,694	21	777
1985	0	4,183	532	94,024	98,207	20	98,227	6	783
1986	0	4,183	141	94,166	98,348	20	98,368	2	785
1987	0	4,183	62	94,228	98,411	20	98,430	1	786
1988	0	4,183	673	94,901	99,084	20	99,103	4	790
1989	0	4,183	368	95,269	99,451	20	99,471	3	793
1990	0	4,183	1,899	97,168	101,350	20	101,370	12	805
1991	0	4,183	1,469	98,637	102,820	20	102,839	10	815

Year	Add. Co-Mingled Acreage	Total Co-Mingled Acreage	Add. GW Only Acreage	Total GW Only Acreage	Total Add. Acreage	SW Only Acreage	Total Acreage	Add. Certificates	Total Certificates
1992	0	4,183	1,318	99,955	104,137	20	104,157	9	824
1993	0	4,145	140	101,342	105,487	14	105,501	2	819
1994	0	4,145	1,577	102,919	107,064	14	107,078	9	828
1995	0	4,145	1,157	104,077	108,222	14	108,235	8	836
1996	0	4,145	1,972	106,048	110,193	14	110,207	11	847
1997	0	3,506	1,188	106,130	109,636	0	109,636	10	833
1998	0	3,506	746	106,876	110,382	0	110,382	5	838
1999	0	3,506	1,030	107,906	111,411	0	111,411	7	845
2000	0	3,506	1,217	109,123	112,629	0	112,629	8	853
2001	0	2,669	1,222	113,927	116,596	0	116,596	7	856
2002	0	2,669	2,503	116,431	119,099	0	119,099	16	872
2003	0	2,669	2,464	118,894	121,563	0	121,563	19	891
2004	0	2,669	3,542	122,436	125,105	0	125,105	19	910
2005	0	2,116	0	123,524	125,640	0	125,640	0	902
2006	0	1,077	0	122,131	123,208	0	123,208	0	862
2007	0	1,078	0	121,515	122,593	0	122,593	0	853
2008	0	1,034	0	120,846	121,880	0	121,880	0	841
2009	0	1,034	0	119,183	120,217	0	120,217	0	817
2010	0	1,116	0	119,276	120,392	0	120,392	0	814
2011	14	1130	1,426	120702		40	121872	12	826
2012	-52	1078	1,208	121910		40	123028	7	833
2013	0	1078	463	122373		40	123491	6	839
2014	-99	979	13	122360		40	123379	7	832

Note: The reduction in GW only acreage 2006-2014 is due to the exclusion certified acreage with inactive pumping records.

#### Irrigated Acreage by Water Supply

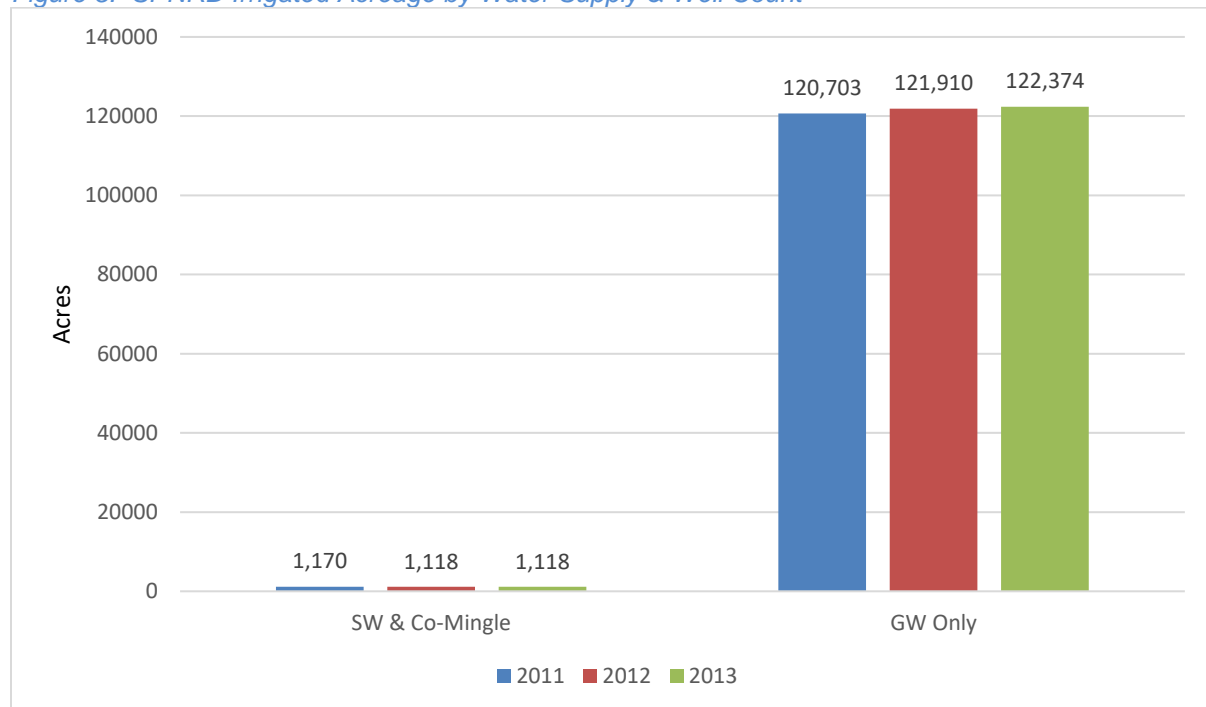
Figure 4 and 5, respectively, provide a graphic of the North Platte NRD and South Platte NRD water development per water source and well count throughout land use dataset extension.



Figure 4: NPNRD Irrigated Acreage by Water Supply & Well Count



Figure 5: SPNRD Irrigated Acreage by Water Supply & Well Count



### Crop Assignments

Crops for the 2011 through 2013 extension were assigned to irrigated lands using cropping data provided by each NRD and CropScope information when NRD data was not available. Figure 6 and 7, respectively, provide a graphic of the North Platte NRD and South Platte NRD irrigated land cropping patterns for the dataset extension.

Figure 6: Annual NPNRD Crop Information for 2011 through 2013

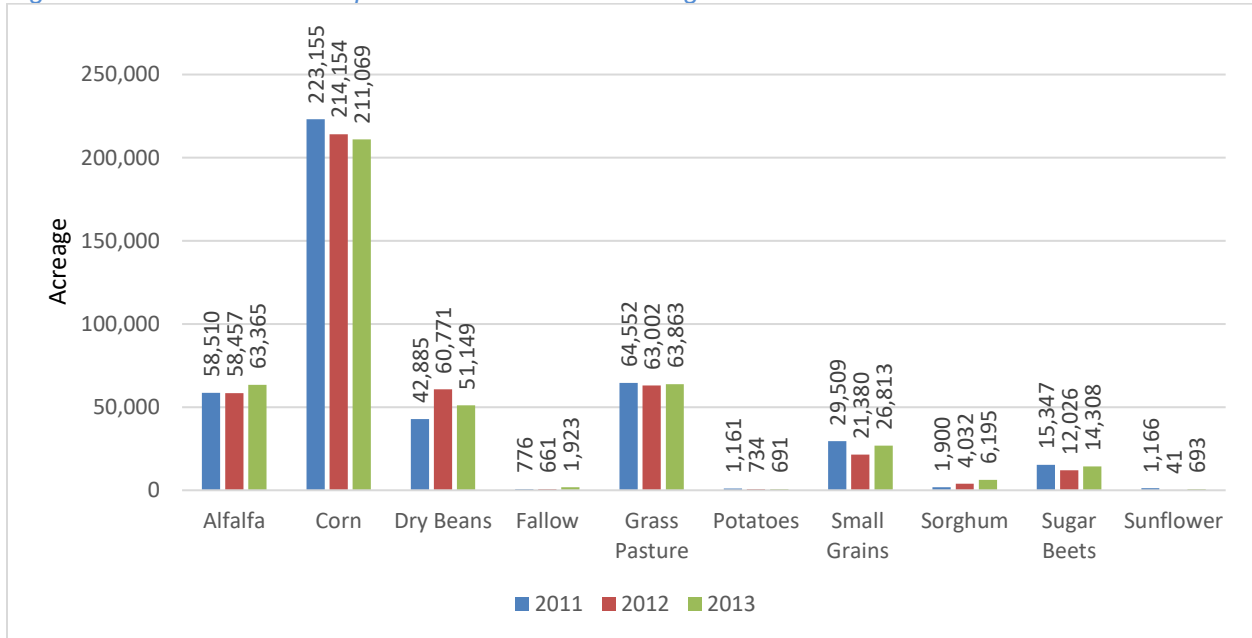
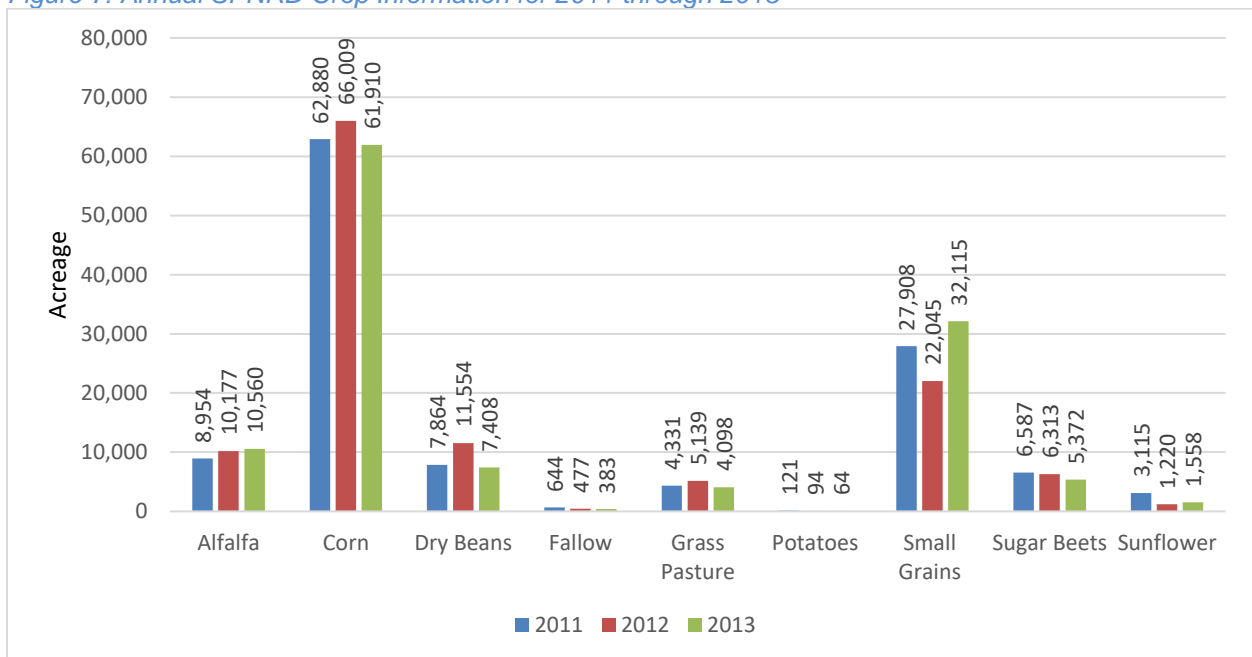


Figure 7: Annual SPNRD Crop Information for 2011 through 2013



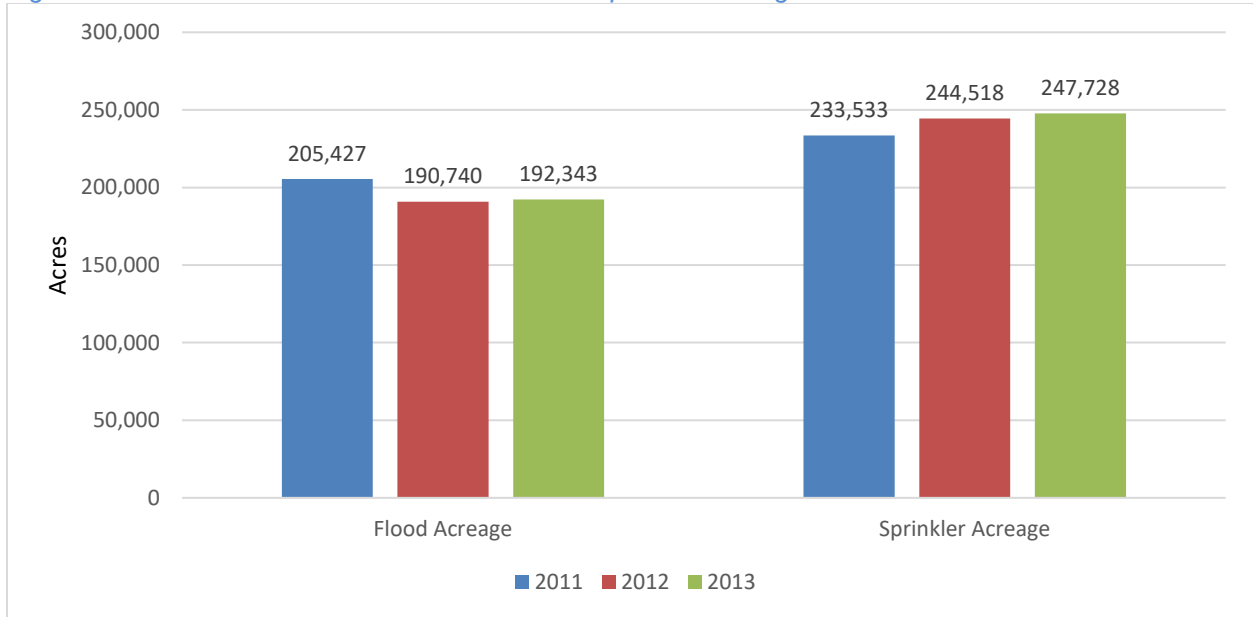
### Well Assignments

The well associations to certificates that were originally developed were carried forward through the extension. Modifications to these well associations were completed based on information provided by the NRDs.

### Irrigated Acreage by Irrigation Type

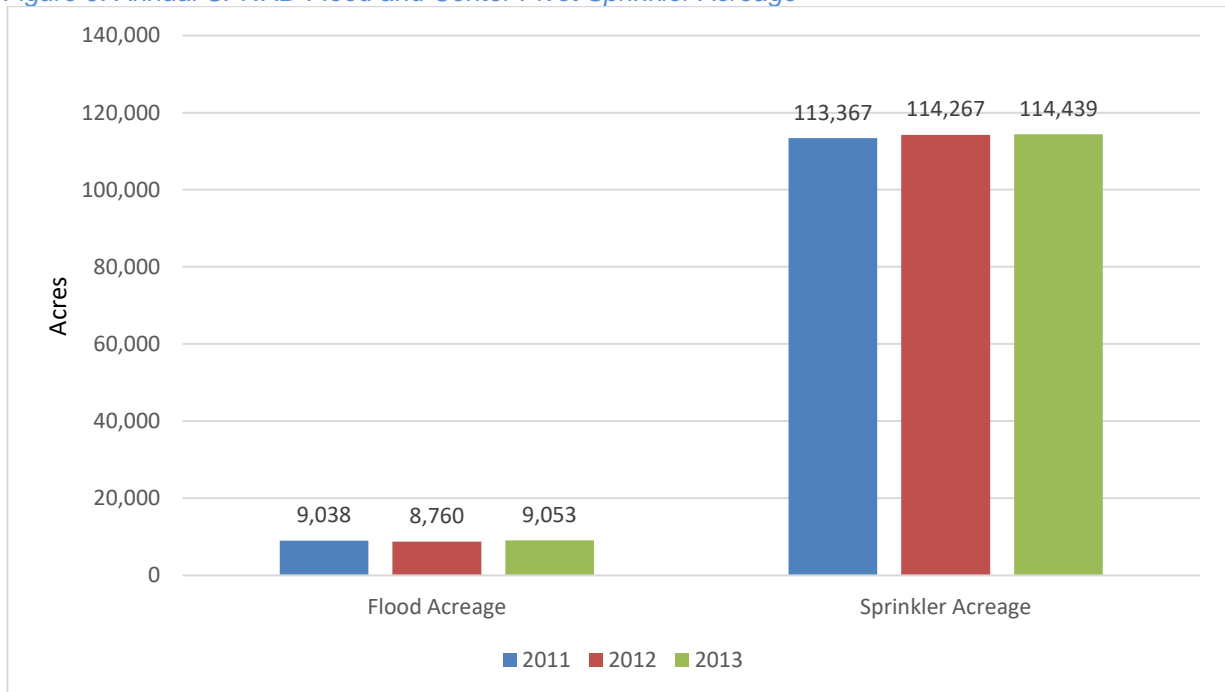
As observed in the original dataset, the conversion from flood irrigation to center pivot sprinkler irrigation in North Platte and South Platte NRDs continue. Figure 8 provides the annual flood and center pivot sprinkler irrigation for North Platte NRD.

Figure 8: Annual NPNRD Flood and Center Pivot Sprinkler Acreage



The South Platte NRD's change from flood to sprinkler irrigation is less pronounced, but there is a slight increase in center pivot sprinkler irrigated acres. Figure 9 provides the annual flood and center pivot sprinkler irrigation for South Platte NRD.

Figure 9: Annual SPNRD Flood and Center Pivot Sprinkler Acreage



### Irrigated and Dryland Acreage by County

Figures 10 and 11 provide the breakdown of the irrigated acreage over the extended study period by county for both NRDs. As discussed in the original land use dataset documentation, Scotts Bluff and Morrill Counties have the most irrigated lands in North Platte NRD. In South Platte NRD, Cheyenne and Kimball Counties have the most irrigated lands.

Figure 10: Distribution of NPNRD Irrigated Acreage by County

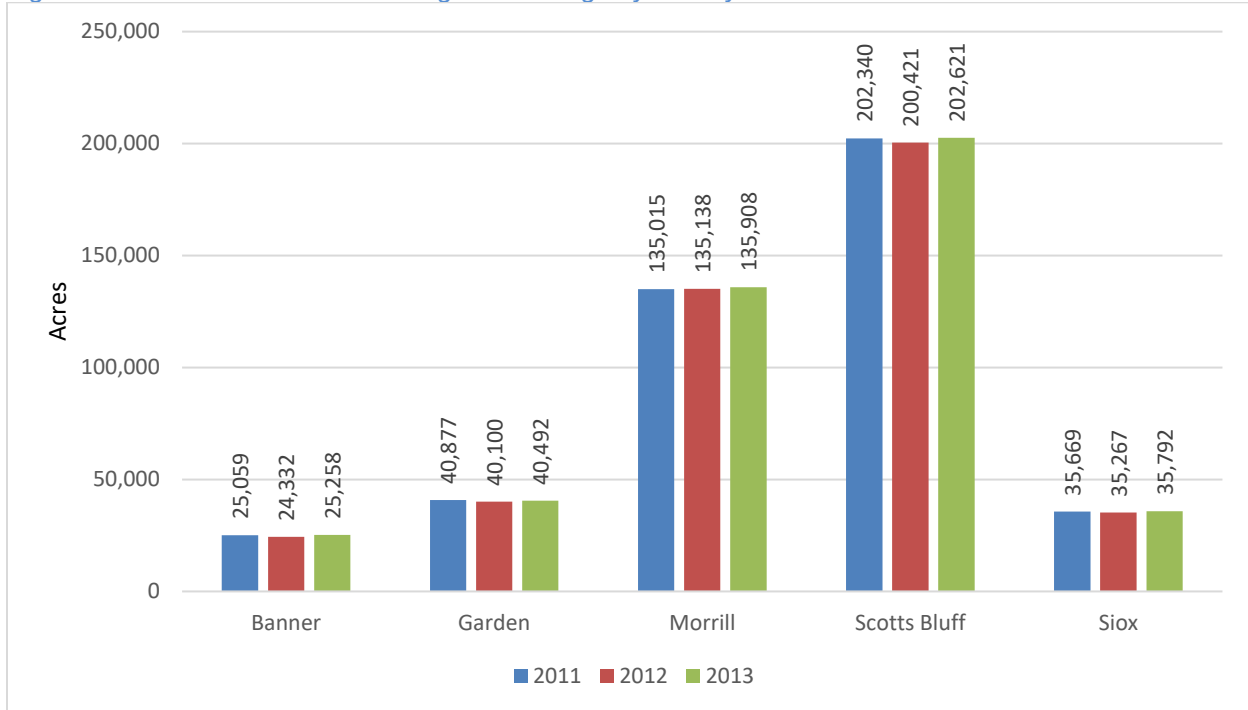
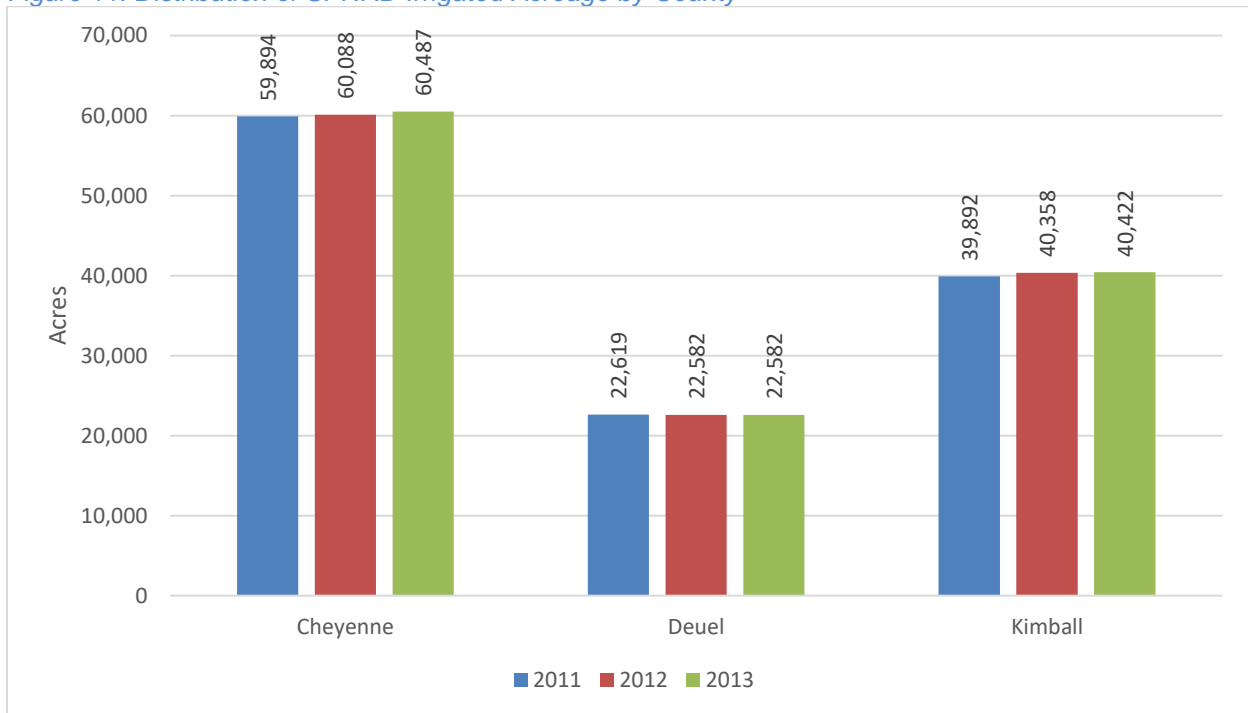


Figure 11: Distribution of SPNRD Irrigated Acreage by County



The dryland acreage by county is provided in Table 6 and 7 for each NRD. In North Platte NRD, the most dryland is located in Banner and Garden Counties. All three counties in South Platte NRD has significant amounts of dryland acreage with Cheyenne and Deuel Counties having the most.

Table 6: Distribution of NPNRD Dryland Acreage by County

Year	Banner	Garden	Morrill	Scotts Bluff	Sioux	Total
2011	451,833	1,064,120	779,309	274,132	566,904	3,136,297
2012	452,463	1,064,432	779,478	290,452	567,322	3,154,146
2013	452,829	1,064,360	779,439	290,248	567,311	3,154,188

Table 7: Distribution of SPNRD Dryland Acreage by County

Year	Cheyenne	Deuel	Kimball	Total
2011	705,492	259,300	569,225	1,534,017
2012	705,295	259,337	568,764	1,533,396
2013	705,295	259,337	568,699	1,533,331

Figure 12 and 13 provides the breakdown of acres of crop or vegetation type for the dryland acreage of each NRD. In both NRDs the majority of all the dryland crop or vegetation is grass pasture. The next largest crop is small grains/fallow.

Figure 12: Distribution of NPNRD Crop or Vegetation Type for Dryland Acreage

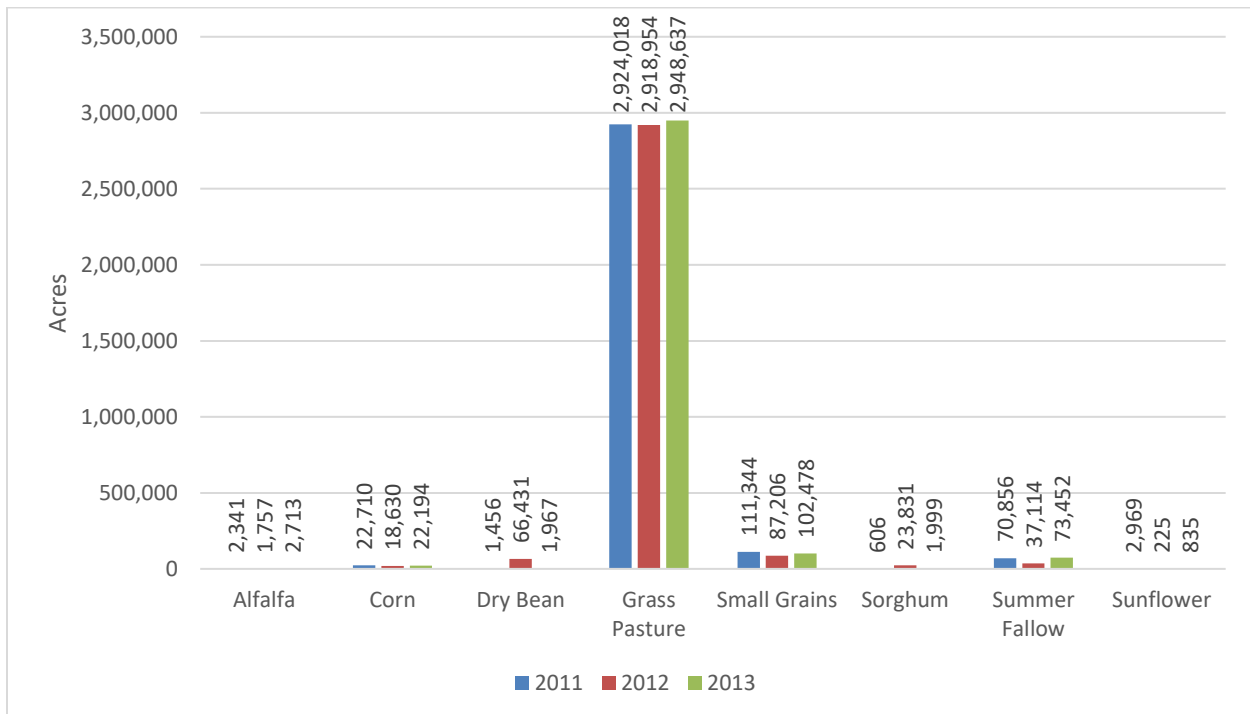


Figure 13: Distribution of SPNRD Crop or Vegetation Type for Dryland Acreage

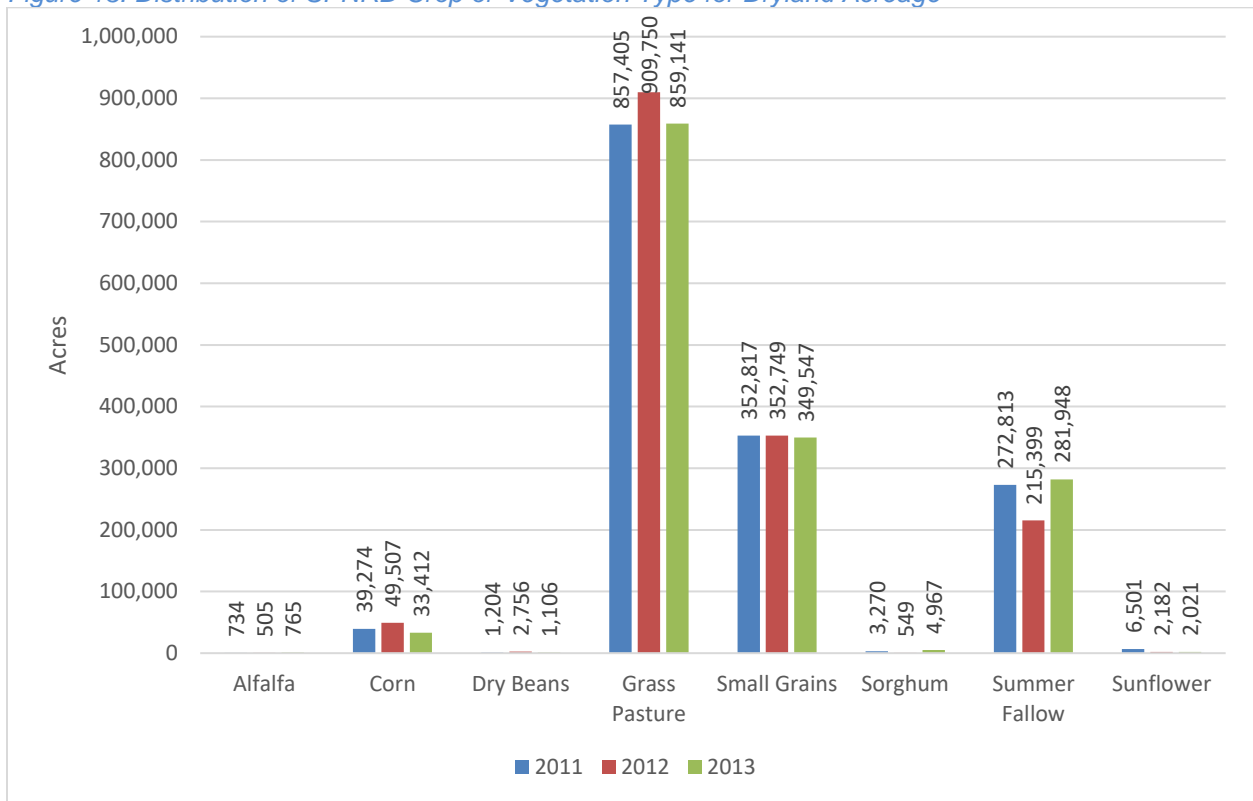


Figure 14 and 15, provide a comparison of the irrigated to dryland acreages. As seen in both NRDs, dryland acreage is the dominant land use.

Figure 14: NPNRD Irrigated and Dryland Acreage

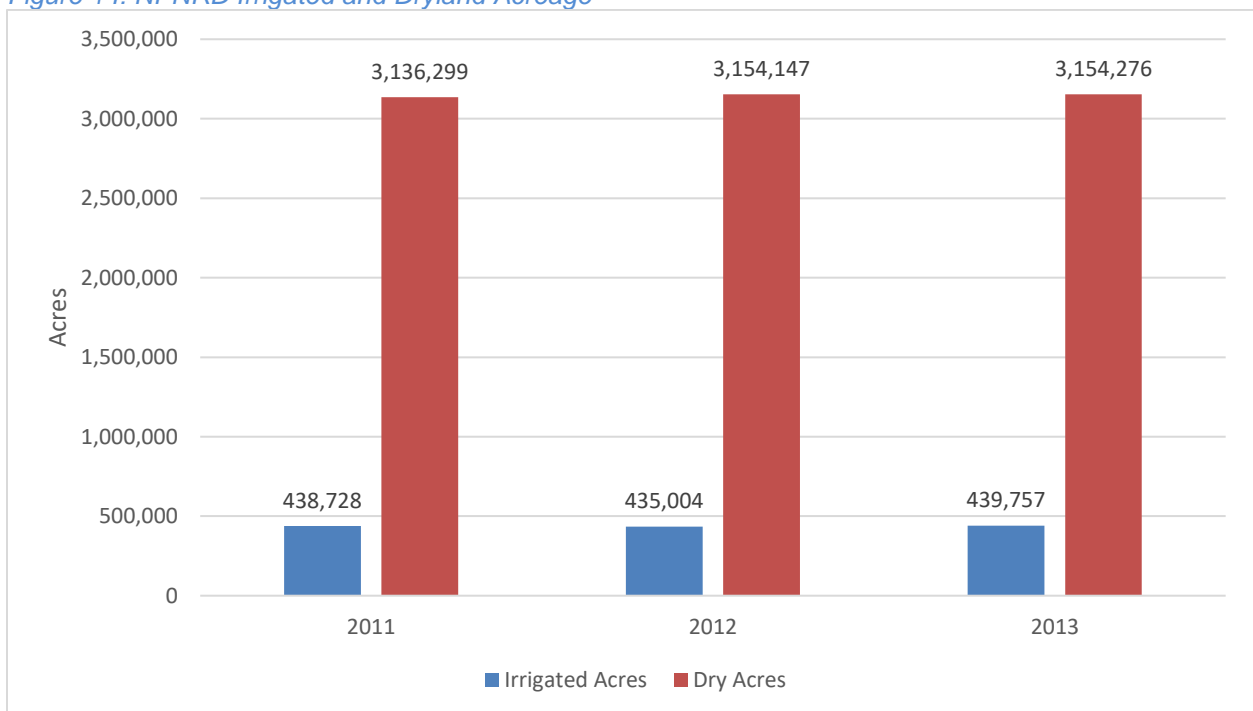


Figure 15: SPNRD Irrigated and Dryland Acreage

