Adoption and Use of Yield Monitor Technology for U.S. Crop Production

by Terry Griffin and Bruce Erickson

Precision agriculture technology has been on the market for nearly twenty years. Global Positioning Systems (GPS), Geographic Information Systems (GIS), yield monitors, variable rate technologies (VRT) and other spatial management technologies are being used by farmers across the U.S. and around the world. This article summarizes data on adoption of yield monitors and how farmers are making use of the technology. The estimates are based on face-to face interviews with farmers conducted by the USDA from 1996 to 2005.

TECHNOLOGY ADOPTION

In the most recent years that data are available, 28% of U.S. corn planted acres (in 2005), 10% of winter wheat (in 2004), and 22% of soybeans (in 2002) were harvested with a combine equipped with a yield monitor (Table 1). Wheat, rice and cotton acres have not experienced the same level of adoption as corn and soybean. One might expect high value crops like cotton to have higher adoption rates, but the cotton yield monitor came to the marketplace in 1998, later than those for corn, wheat, or soybeans.

On less than half of the acres where yield monitors are used they are also interfaced with a GPS system (Table 2). The reason why this is important is that GPS allows farmers or their advisers to create a yield or moisture map of their fields, which can help them better identify the variation that is occurring and then potentially manage their fields accordingly. For instance, a low-yielding portion of a field may pinpoint a soil fertility issue that the farmer can specifically address in just that area, instead of the whole field.

These yield monitor adoption numbers are somewhat comparable to those reported in the Purdue/CropLife Precision Agricultural Dealership Survey, where in 2005 U.S. retailers estimated 24% of the acres in their market area were utilizing a yield monitor, 14% utilizing a monitor with GPS. The Purdue/CropLife survey is not specific to individual crops. The 2008 results are 26% and 22%, respectively, for use of yield monitor with and without GPS. See the Publications section of SSMC for the complete dealership survey results.

HOW FARMERS UTILIZE YIELD MONITOR INFORMATION

Beginning in 2002, eight questions relating to how farmers use yield monitor data were asked on the Agricultural Resource Management Survey (ARMS) survey. Soybean was the crop examined by the 2002 ARMS survey; in 2003, cotton, sorghum, and barley; in 2004, spring wheat, winter wheat, and durum wheat; and in 2005 corn and oats. Figures 1-5 graphically display information for some selected crops, and Table 3 presents information for all ten crops surveyed.

The data show that the leading use of yield monitors by farmers has been to monitor crop moisture. Anecdotal evidence suggests that farmers use the moisture sensor to determine if the crop is ready to be harvested and/or in deciding on which drying or storage facility to send the particular crop. Although the moisture sensor on yield monitors was initially intended more to accompany the mass flow sensor to correct for moisture when calculating yields, the moisture reading on its own has been the most commonly used data from the technology.

Table 1. Share of U.S. crops on which yield monitor technologies were used, percent of planted acres [1/]

	Oats	Soybean	Cotton	Barley	Sorghum	Peanuts	Durum wheat	Spring wheat	Winter wheat	Corn	Potatoes	Sunflower	Rice	Sugarbeet
1996		14					9	3	2					
1997		10					6	11	6	12				
1998		15	*				4	6	6	12				
1999		17	4			*			17	16	3	8		
2000		21	1				*	9	10	18			18	1
2001										19				
2002		22												
2003			2	13	100									
2004						2	16	14	10					
2005	3									28				

1/ Revised from previously published estimates based on updated weights from the ARMS.
* = less than 1 percent
Source: Agricultural Resource Management Survey, ERS/NASS, USDA

Table 2. Share of U.S. crops on which yield monitor technologies were used and were also linked to GPS, percent of planted acres [1/]

	Oats	Soybean	Cotton	Barley	Sorghum	Peanuts	Durum wheat	Spring wheat	Winter wheat	Corn	Potatoes	Sunflower	Rice	Sugarbeet
1996		3					*	*	*					
1997		4					*	*	1	5				
1998		6	*		2		*	1	*	3				
1999		6	*						7	6	3	*		
2000		7	*					*	3	6			6	*
2001										7				
2002		8												
2003			2	4	11									
2004						0	7	4	2					
2005	1													

1/ Revised from previously published estimates based on updated weights from the ARMS.
* = less than 1 percent
Source: Agricultural Resource Management Survey, ERS/NASS, USDA

Documenting yields is the second most common use of yield monitors and what many involved in precision agriculture view as the original intent of the technology. The remaining questions regarding uses of yield monitor data give more detail into how yield documentation has been used by farmers:

Conducting Field Experiments Yield monitors and other site-specific sensors have allowed farmers to collect low-cost yield observations. Farmers have used this information to compare crop varieties, tillage treatments, and other inputs or systems. For cotton pickers equipped with GPS, conducting field experiments was the greatest use of the technology (no moisture sensor for cotton monitor).

To Justify Tile Drainage In areas of the U.S. that rely upon subterranean tile to drain soils, anecdotal evidence has suggested that yield monitors equipped with GPS have helped substantially to quantify the yield reduction due to poor drainage and the potential benefit from drainage improvements. The quantification of yield and profit losses due to poor drainage can be a factor in making land improvements where the farmer owns or leases the land. The ARMS data supports the notion that farmers are using yield monitors with GPS to make tile drainage decisions especially for soybeans, winter wheat, and corn with over 30% of farms with a GPS yield monitor.

Irrigation Decisions Except for barley, making irrigation decisions based on yield monitor data has not been a common use of the technology.

Leasing Issues With the exception of cotton, farmers have not widely used yield monitors in lease negotiations or splitting crop shares. Early in the use of yield monitors, it was expected that leasing arrangements would benefit from the technology; however, from this data and anecdotal evidence, farmland lease arrangements have not been greatly influenced by precision technology especially for negotiating the lease. Farmers producing cotton, durum wheat, and sorghum have made at least some use of the technology for splitting crop shares.

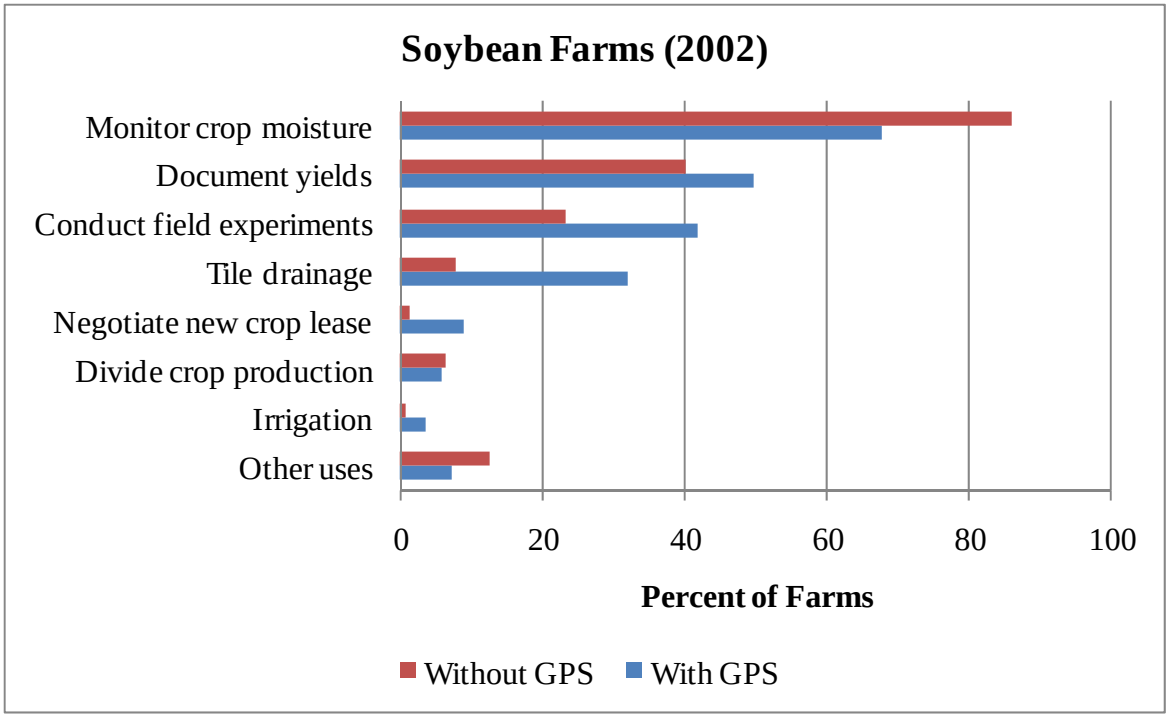

Figure 1. Use of Yield Monitor Data for Soybean Farms With and Without a GPS Unit, 2002

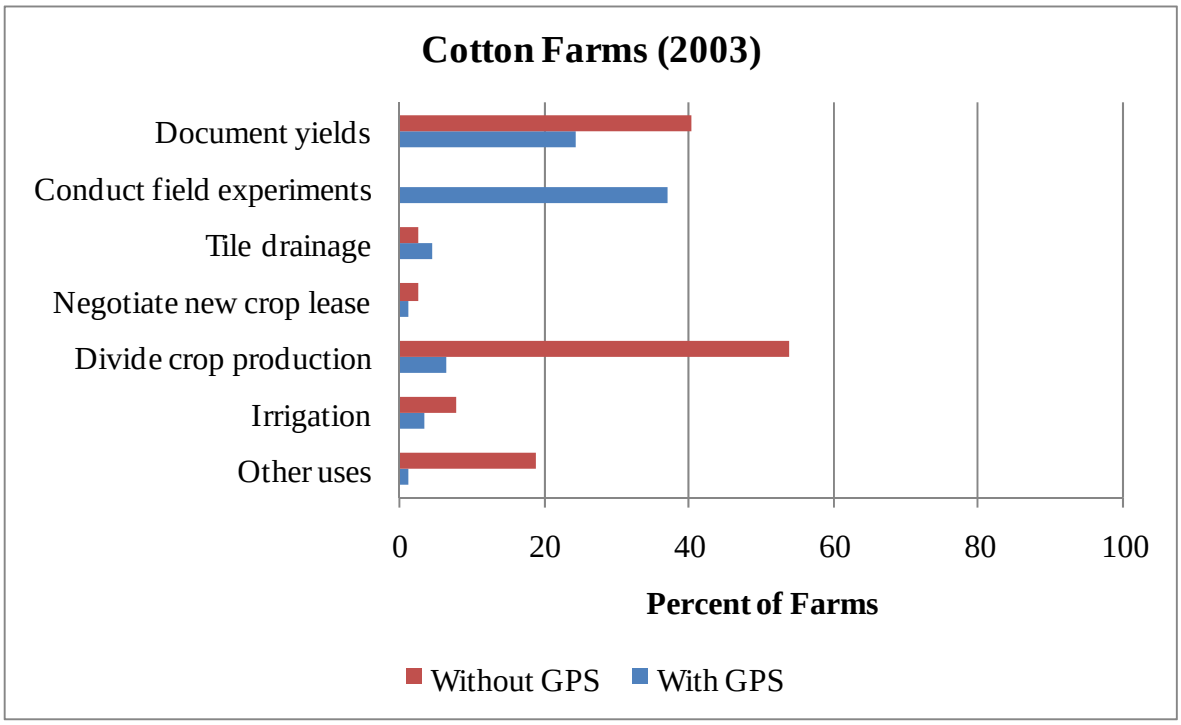

Figure 2. Use of Yield Monitor Data for Cotton Farms With and Without a GPS Unit, 2003

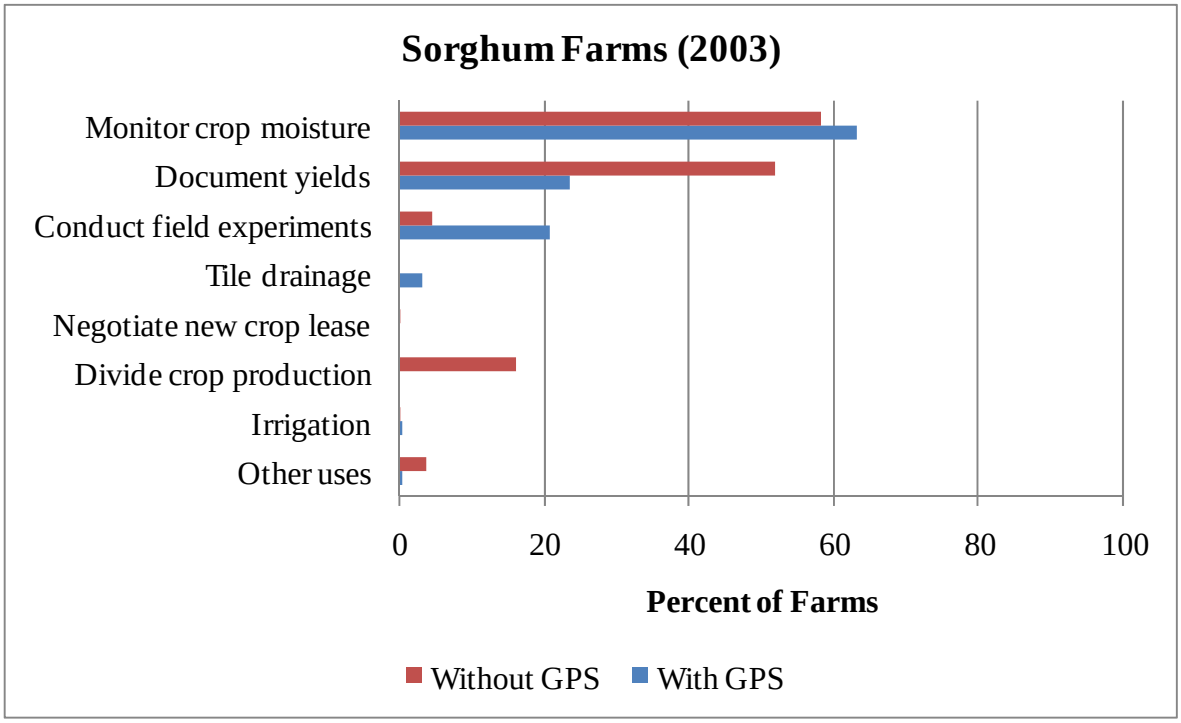

Figure 3. Use of Yield Monitor Data for Sorghum Farms With and Without a GPS Unit, 2003

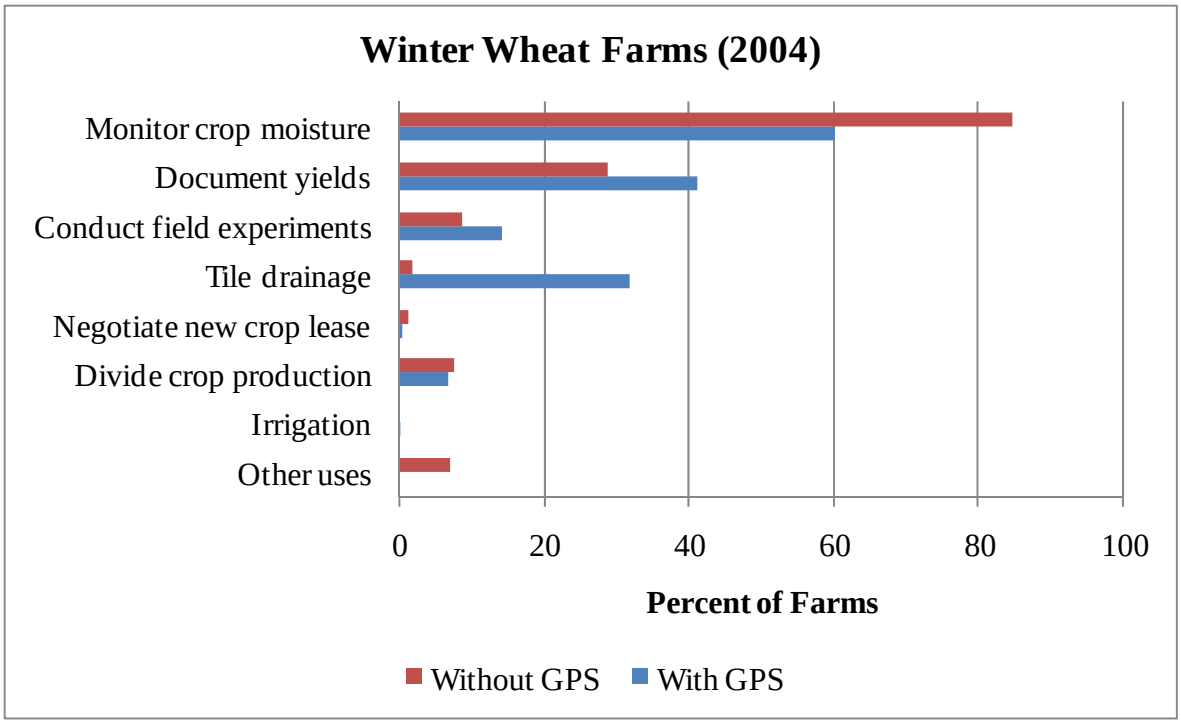

Figure 4. Use of Yield Monitor Data for Winter Wheat Farms With and Without a GPS Unit, 2004

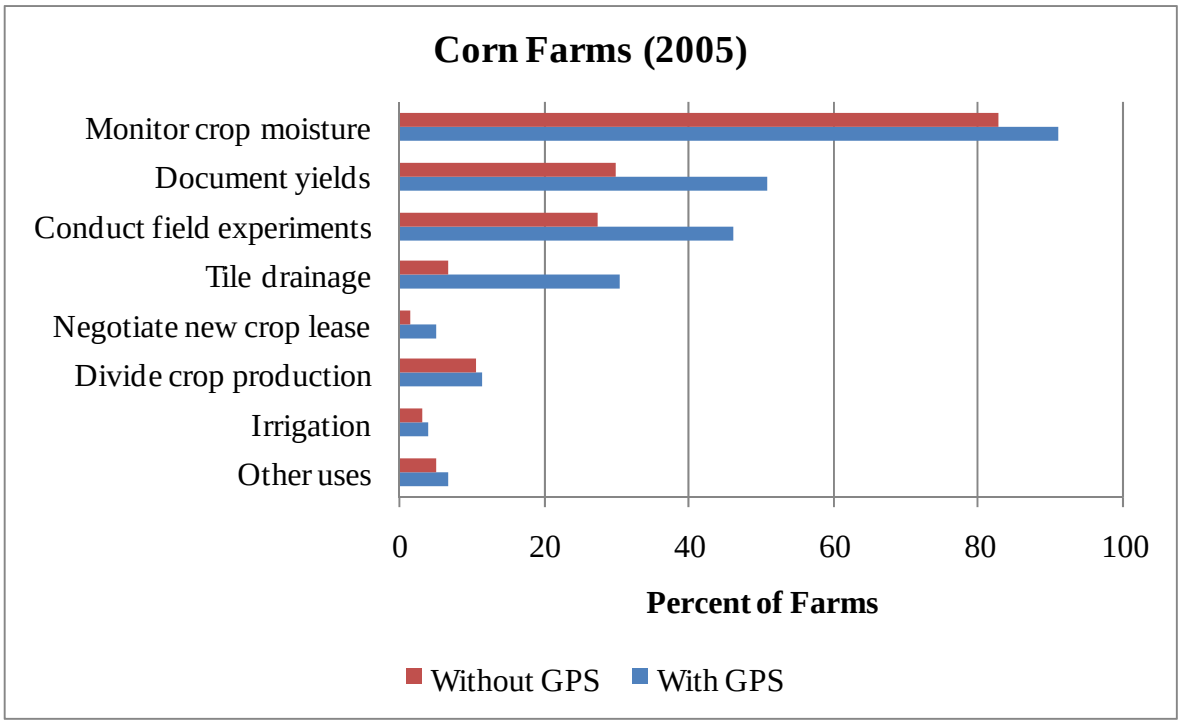

Figure 5. Use of Yield Monitor Data for Corn Farms With and Without a GPS Unit, 2005

Table 3. Use of Yield Monitor Data for Selected Crop Farms with and without a GPS Unit, 2002 – 2005 (percent of farms).

	Soybean (2002)		Cotton (2003)		Sorghum (2003)		Winter wheat (2004)		Corn (2005)	
With GPS?	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Monitor crop moisture	68	86	*	*	63	58	60	85	91	83
Document yields	50	40	25	41	24	52	41	29	51	30
Conduct field experiments	42	23	37	*	21	5	14	9	46	28
Tile drainage	32	8	5	3	3	*	32	2	31	7
Negotiate new crop lease	9	1	1	3	*	*	*	1	5	2
Divide crop production	6	7	7	54	*	16	7	8	12	11
Irrigation	4	*	4	8	*	*	*	*	4	3
Other uses	7	13	1	19	*	4	*	7	7	5

	Barley (2003)		Durum wheat (2004)		Spring wheat (2004)		Oats (2005)	
With GPS?	Yes	No	Yes	No	Yes	No	Yes	No
Monitor crop moisture	68	67	100	52	60	63	99	66
Document yields	76	38	69	65	54	37	8	18
Conduct field experiments	32	5	*	13	53	9	44	1
Tile drainage	6	6	*	*	7	**	*	1
Negotiate new crop lease	5	*	53	*	21	*	38	*
Divide crop production	12	11	*	48	*	3	*	*
Irrigation	24	3	*	*	*	*	*	*
Other uses	15	8	53	*	6	20	39	36

* Less than 1 percent

Summary

Utilization of yield monitor technologies has grown steadily in field crop production in the United States, but most are not linking to GPS, thus not taking full advantage of the site-specific management possibilities that this spatial information can provide. Whether GPS-linked or not, monitoring crop moisture is the most common way this information is used. Farmers have often made productive use of technology in ways that the manufacturer may not have foreseen. Farmers consistently answered "Other uses" in response to how they made use of yield monitors on the ARMS survey, suggesting that they are making use of yield monitor data in ways that did not fit well into the survey categories.

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