CONSERVATION TILLAGE TRENDS IN VIRGINIA AGRICULTURAL PRODUCTION

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SUMMARY

Data from the Conservation Technology Information Center's (CTIC) National Crop Residue Management Survey was used to establish trend lines for Virginia agricultural commodities. In 2007, double crop soybeans had the highest use of conservation tillage at 95.6% while 100% of potatoes were planted using conventional tillage. Most Virginia producers are integrating conservation tillage into their cropping systems, but vegetable crops have challenges that make adoption more difficult. Higher value vegetable and specialty crops are the last frontier for conquering the widespread use of conventional tillage and should be the main focus of research and Extension education programs to implement reduced and conservation tillage when systematically feasible.

INTRODUCTION

Documentation of crops being grown without tillage has been recorded throughout history by many cultures. For instance, the Incas that thrived in the South American Andes documented planting their crops by forming a hole with a stick, inserting the seed, and covering the seed with soil using their foot (Derpsch, 1998). A historical review by Derpsch (1998) documented no-tillage of soil for food production since civilization primarily lacked the power to plow using available tools. Cultivation techniques drastically changed when technology advanced to easily make cultivation possible. Cultivation techniques again began to evolve around 1915 when the Department of Agriculture published a scientific bulletin noting the benefits of soil surface residue as a protectant from wind and water erosion (Duley and Mathews, 1947).

Research of modern agricultural conservation tillage techniques initiated in the 1920s by demonstrating that small grains could be grown without plowing every season, which became known as stubble mulch farming (Duley and Mathews, 1947). Interests in conservation tillage increased and research picked up steam after the Dust Bowl in the 1930s as more researchers began projects that demonstrated the benefits of leaving a surface residue to protect the soil from wind erosion (Derpsch, 1998). Research progressed and modern conservation agricultural systems as we know them improved with the implementation of modern herbicides. In the 1960s, research in Virginia, Kentucky, North Carolina, and other states were initiated and demonstrated the possibility of true chemically controlled no-tillage systems (Thomas and Blevins, 1996; Blevins, 1998). Equipment and chemical advancements have led to the current status of conservation agricultural systems being the predominant production systems for many crops (Brock et. al., 2000; Bradley, 2002; CTIC, 2009).

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Virginia has been on the forefront of conservation tillage technology since modern implementation in the 1960s. The objective of this report is to discuss trends in acceptance of conservation agricultural systems in Virginia.

MATERIALS AND METHODS

Data from the CTIC's National Crop Residue Management Survey (2009b) was used to establish trend lines for Virginia agricultural commodities. The CTIC composites road transect data from various stakeholders to summarize residue trends in localities across the United States. The procedures for taking transect data can be found on CTIC's website in their publication entitled, Cropland Roadside Transect Survey (CTIC, 2009a). Residue measurements divide cropland into 3 different categories that include conservation tillage (>30% residue cover), reduced tillage (15-30% residue cover), and conventional tillage (<15% residue cover). The CTIC survey data has a certainty of 90% or higher when compared to actual planted total acreage in a locality.

Data from 1989 to 1998 are segregated into 11 commodity categories that include full season corn (*Zea mays*), spring planted small grain, winter planted small grain, full season soybeans (*Glycine max*), double crop soybeans, cotton (*Gossypium hirsutum*), sorghum (*Sorghum bicolor*), forages, pasture, and fallow, with remaining crops grouped into the "other" category. Data from 2000 to 2007 are divided into 23 commodity categories that include corn, full season soybeans, double crop soybeans, cotton, spring wheat (*Triticum aestivum*), winter wheat, oats (*Avena sativa*), sorghum, edible beans and peas (*Pisum sativum* ssp. *Sativum*), barley (*Hordeum vulgare*), canola (*Brassica napus*), forage crops, peanuts (*Arachis hypogaea*), potatoes (*Solanum tuberosum*), rice (*Oryza sativa*), rye (*Secale cereal*), sunflowers (*Helianthus annuus*), sugar beets (*Beta vulgaris*), sugarcane (*Saccharum officinarum*), tobacco (*Nicotiana tabacum*), vegetables, permanent pasture, and fallow. Transect data, in acres for each tillage practice, were converted to % by dividing the acreage of each surface residue bracket by total acreage for each year for each crop. Tread lines were established by graphing percentage of each crop under each residue regime over time from 1989 to 2007. The best fit correlation along with the R^2 is presented and is a quadratic or linear relationship.

RESULTS AND DISCUSSION

Virginia crop production acreage has decreased from over 2.1 million acres in 1989 to 1.6 million acres in 2007 (Table 1). Virginia farmland is under pressure from other use categories, similar to other parts of the United States. Table 1 also demonstrates the crop shifts that occurred in Virginia over time due to commodity price shifts and changes in federal government programs, such as the peanut quota system.

Acreage from the CTIC National Crop Residue Management Survey for Virginia crops shows that acreage amongst crops varies on a yearly basis (Table 2). Therefore, the best way to compare crop reside trends from year to year is on a percentage basis (Table 3). Overall, total acreage indicates that conservation is on the rise among Virginia crops and has increased from 48.2% to 67.6% for 1989 and 2007, respectively (Table 3). Likewise, conventional tillage has decreased from 40.8% in 1989 to 23.2% in 2007. Reduced tillage has remained relatively constant over the 1989 to 2007 time period. Positive trends in increased surface residue indicates

that Virginia farmers are cognizant of the benefits of low and no-tillage regimes and are consistently improving their production systems to move towards sustainability.

Regarding specific trends over time, double crop soybeans have consistently been predominated by conservation tillage systems with less than 8% being planted as conventional or reduced tillage (Fig. 1). However, a significant trend towards full season soybeans shifting from conventional to conservation tillage is observed (Fig. 2). Inverse quadratic functions correlate with and R^2 of 0.88 and 0.81 for conservation and conventional tillage, respectively. By 2007, 71.5% of full season soybeans were planted with conservation tillage while 21.1% were planted with conventional tillage (Table 3). Full season corn conservation tillage acreage is linearly increasing over time with an inverse reduction in conventional tillage (77.3 and 13.7% for 2007, respectively; Fig. 3 and Table 3). Conservation tillage winter small grain acreage has recently surpassed conventional tillage acreage and is currently increasing as a quadratic function (Fig. 4). By 2007, 53.6% of winter wheat was planted with conservation tillage and 29.4% was planted using conventional tillage (Table 3).

Vegetable crops remain one of the last frontiers for transition to conservation or reduced tillage systems since 91.3% of vegetable crops were planted using conventional tillage in 2007 (Fig. 5 and Table 3). The only cropping systems utilizing more conventional tillage than vegetable crops was edible beans and peas (99.2%), peanuts (98.4%), potatoes (100%), and tobacco (98.6%). All of the cropping systems predominantly utilizing conventional tillage has challenges that make adoption of conservation tillage difficult. For instance, the necessity to dig potatoes and peanuts means that soil inversion must occur for harvest while use of plasticulture in tomatoes necessitates bed formation. A renewed technology and education effort needs to be executed to promote reduced and conservation tillage in vegetable and specialty crops.

CONCLUSION

In conclusion, most Virginia cropping systems are trending towards increased use of conservation tillage with an inverse decrease in conventional tillage. An upwards trend for conservation tillage is especially noticeable in agronomic crops such as soybeans, wheat, and corn. Higher value vegetable and specialty crops are the last frontiers for conquering conventional tillage and should be the main focus of research and Extension education programs to implement reduced and conventional tillage when systematically feasible.

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TABLES AND FIGURES

Table 1. Total acres grown in Virginia cropping systems for 1989, 2000, and 2007. Data derived from the Conservation Technology Information Center (CTIC) National Crop Management Residue Survey (CTIC, 2009b).

Crop	1989	2000	2007
	----------%----------		
Corn	562,523	455,908	482,882
Soybeans, Full Season	372,712	221,483	294,532
Soybeans, Double Crop	257,846	250,909	200,362
Cotton	2,539	91,766	60,842
Spring Wheat	24,785	3,842	980
Winter Wheat	300,000†	266,066	209,088
Oats	27,000†	6,054	10,742
Sorghum	16,878	11,544	4,222
Edible Beans, Peas	NA†	1,838	3,143
Barley	95,000†	50,056	38,764
Forage Crops	73,505	82,365	71,988
Peanuts	91,000†	61,087	21,938
Potatoes	13,000†	2,830	3,491
Rye	8,000†	18,158	45,165
Sunflowers	NA‡	125	754
Tobacco	49,590†	25,842	22,626
Vegetables	46,664§	50,023	24,508
Permanent Pasture	84,271	90,907	90,370
Fallow	84,245	14,229	34,526
Total	2,121,103¶	1,705,032	1,620,946

†Acreage information is from the USDA-National Agricultural Statistics Service (2009). Crop specific data was not available from CTIC and was lumped together in a general “winter small grains” or “other” category in their survey.

‡Data was not available from CTIC or the USDA-National Agricultural Statistics Service (2009).

§Vegetables for 1989 = CTIC “Other” category – peanuts – potatoes – rye – tobacco from USDA-NASS survey.

¶Total acreage is from the CTIC National Crop Residue Management Survey and does not equal the above column due to insertion of unknown CTIC data from USDA-NASS (2009).

Table 2. Percentage of acres grown with surface residue representing conservation tillage (>30% surface residue), reduced tillage (15 to 30% surface residue), and conventional tillage (<15% surface residue) in Virginia cropping systems for 1989, 2000, and 2007. Data derived from the Conservation Technology Information Center (CTIC) National Residue Management Survey (CTIC, 2009b).

	Conservation			Reduced			Conventional		
Crop	1989	2000	2007	1989	2000	2007	1989	2000	2007
	----------%----------								
Corn	324,891	301,730	373,063	64,324	39,690	43,881	173,308	114,488	65,938
Soybeans, Full Season	132,229	84,591	210,495	54,373	18,510	22,018	186,110	118,382	62,019
Soybeans, Double Crop	246,788	229,124	191,466	2,190	3,903	2,642	8,868	17,882	6,254
Cotton	350	18,550	38,302	0	1,623	6,970	2,189	71,593	15,570
Spring Wheat	6,761	2,637	580	1,735	330	230	16,289	875	170
Winter Wheat	158,518†	71,356	112,160	64,026†	29,357	35,507	219,001†	165,353	61,421
Oats	158,518†	2,509	2,474	64,026†	1,064	1,260	219,001†	2,481	7,008
Sorghum	9,542	6,813	2,127	720	481	634	6,616	4,250	1,461
Edible Beans, Peas	5,597‡	0	25	5,672‡	90	0	188,985‡	1,748	3,118
Barley	158,518†	17,806	22,499	64,026†	17,599	7,788	219,001†	14,651	8,477
Forage Crops	48,240	49,433	44,503	4,940	8,982	8,189	20,325	23,950	19,296
Peanuts	5,597‡	218	307	5,672‡	1,949	50	188,985‡	58,920	21,581
Potatoes	5,597‡	0	0	5,672‡	0	0	188,985‡	2,830	3,491
Rye	158,518†	8,977	16,129	64,026†	3,952	12,727	219,001†	5,229	16,309
Sunflowers	5,597‡	9	192	5,672‡	0	106	188,985‡	116	456
Tobacco	5,597‡	120	314	5,672‡	38	0	188,985‡	25,684	22,312
Vegetables	5,597‡	3,699	1,164	5,672‡	714	973	188,985‡	45,610	22,371
Permanent Pasture	63,014	65,568	61,026	4,945	8,074	4,104	16,312	17,265	25,240
Fallow	25,770	1,451	18,179	30,435	3,774	2,304	28,040	9,004	14,043
Total	1,021,700	864,591	1,095,005	233,360	140,130	149,383	866,043	700,311	376,558

†In 1989, CTIC data only had select crops categorized and discrete numbers for these crops are not known. The given number is the 1989 number for small grains planted in the fall that encompasses that crop.

‡In 1989, CTIC data only had select crops categorized and discrete numbers for these crops are not known. The given number is the 1989 number for the “Other” category that encompasses that crop.

Table 3. Percentage of acres grown with surface residue representing conservation tillage (>30% surface residue), reduced tillage (15 to 30% surface residue), and conventional tillage (<15% surface residue) in Virginia cropping systems for 1989, 2000, and 2007. Data derived from the Conservation Technology Information Center (CTIC) National Residue Management Survey (CTIC, 2009b).

	Conservation			Reduced			Conventional		
Crop	1989	2000	2007	1989	2000	2007	1989	2000	2007
	----------%----------								
Corn	57.8	66.2	77.3	11.4	8.7	9.1	30.8	25.1	13.7
Soybeans, Full Season	35.5	38.2	71.5	14.6	8.4	7.5	49.9	53.4	21.1
Soybeans, Double Crop	95.7	91.3	95.6	0.8	1.6	1.3	3.4	7.1	3.1
Cotton	13.8	20.2	63.0	0.0	1.8	11.5	86.2	78.0	25.6
Spring Wheat	27.3	68.6	59.2	7.0	8.6	23.5	65.7	22.8	17.3
Winter Wheat	35.9†	26.8	53.6	14.5†	11.0	17.0	49.6†	62.1	29.4
Oats	35.9†	41.4	23.0	14.5†	17.6	11.7	49.6†	41.0	65.2
Sorghum	56.5	59.0	50.4	4.3	4.2	15.0	39.2	36.8	34.6
Edible Beans, Peas	2.8‡	0.0	0.8	2.8‡	4.9	0.0	94.4‡	95.1	99.2
Barley	74.8	35.6	58.0	5.9	35.2	20.1	19.4	29.3	21.9
Forage Crops	65.6	60.0	61.8	6.7	10.9	11.4	27.7	29.1	26.8
Peanuts	2.8‡	0.4	1.4	2.8‡	3.2	0.2	94.4‡	96.5	98.4
Potatoes	2.8‡	0.0	0.0	2.8‡	0.0	0.0	94.4‡	100.0	100.0
Rye	35.9†	49.4	35.7	14.5†	21.8	28.2	49.6†	28.8	36.1
Sunflowers	2.8‡	7.2	25.5	2.8‡	0.0	14.1	94.4‡	92.8	60.5
Tobacco	2.8‡	0.5	1.4	2.8‡	0.1	0.0	94.4‡	99.4	98.6
Vegetables	2.8‡	7.4	4.7	2.8‡	1.4	4.0	94.4‡	91.2	91.3
Permanent Pasture	74.8	72.1	67.5	5.9	8.9	4.5	19.4	19.0	27.9
Fallow	30.6	10.2	52.7	36.1	26.5	6.7	33.3	63.3	40.7
Total	48.2	50.7	67.6	11.0	8.2	9.2	40.8	41.1	23.2

†In 1989, CTIC data only had select crops categorized and discrete numbers for these crops are not known. The given number is the 1989 number for small grains planted in the fall that encompasses that crop.

‡In 1989, CTIC data only had select crops categorized and discrete numbers for these crops are not known. The given number is the 1989 number for the “Other” category that encompasses that crop.

Figure 1. Double crop soybean tillage trends based on surface residue for Virginia farms from 1989 to 2007 using data from the Conservation Technology Information Center's National Residue Management Survey (CTIC, 2009b).

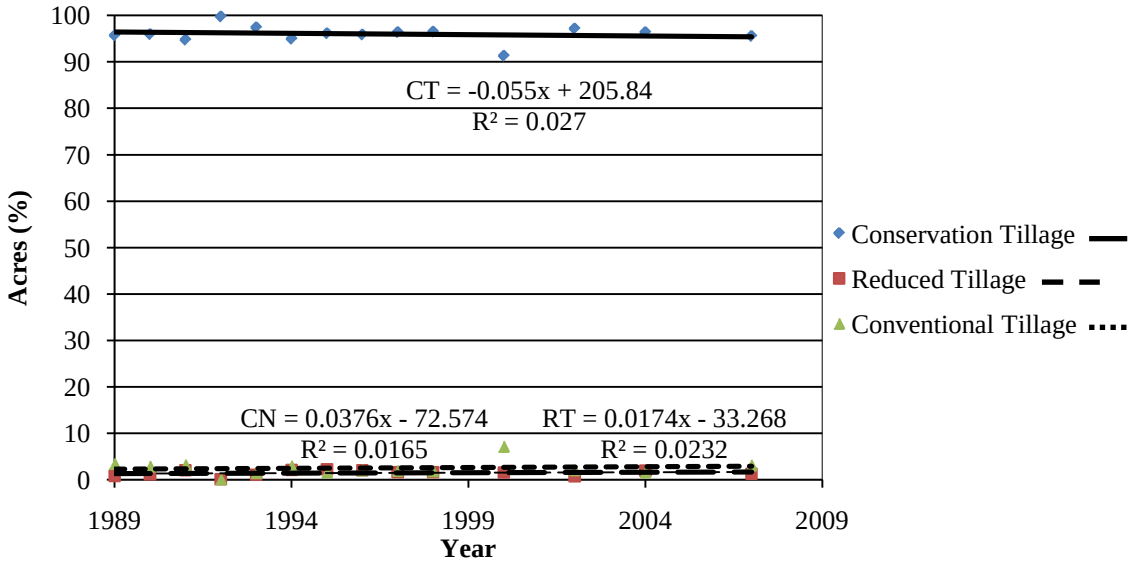

Figure 2. Full season soybean tillage trends based on surface residue for Virginia farms from 1989 to 2007 using data from the Conservation Technology Information Center's National Residue Management Survey (CTIC, 2009b).

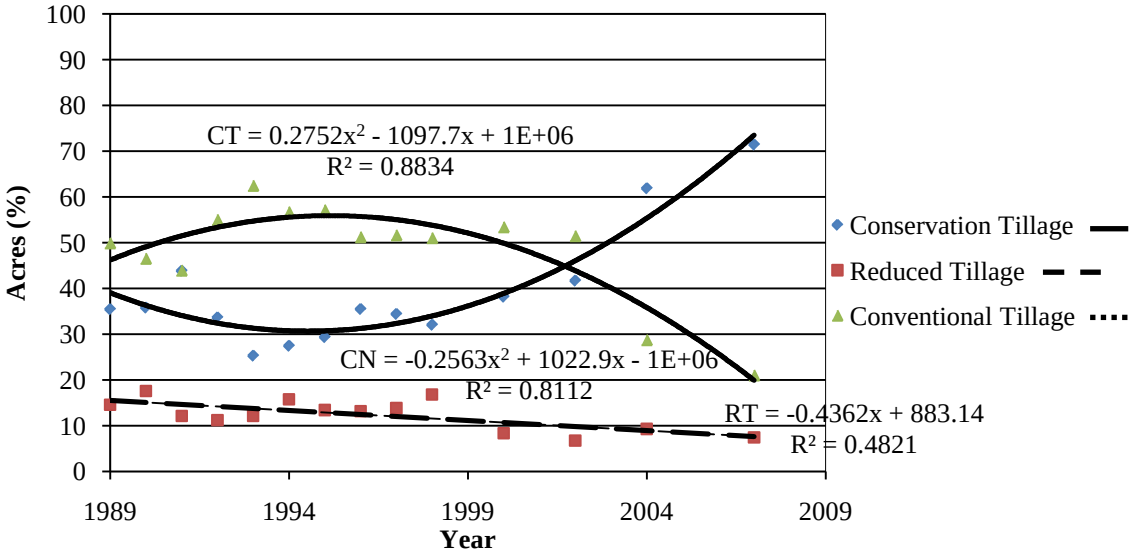

Figure 3. Full season corn tillage trends based on surface residue for Virginia farms from 1989 to 2007 using data from the Conservation Technology Information Center's National Residue Management Survey (CTIC, 2009b).

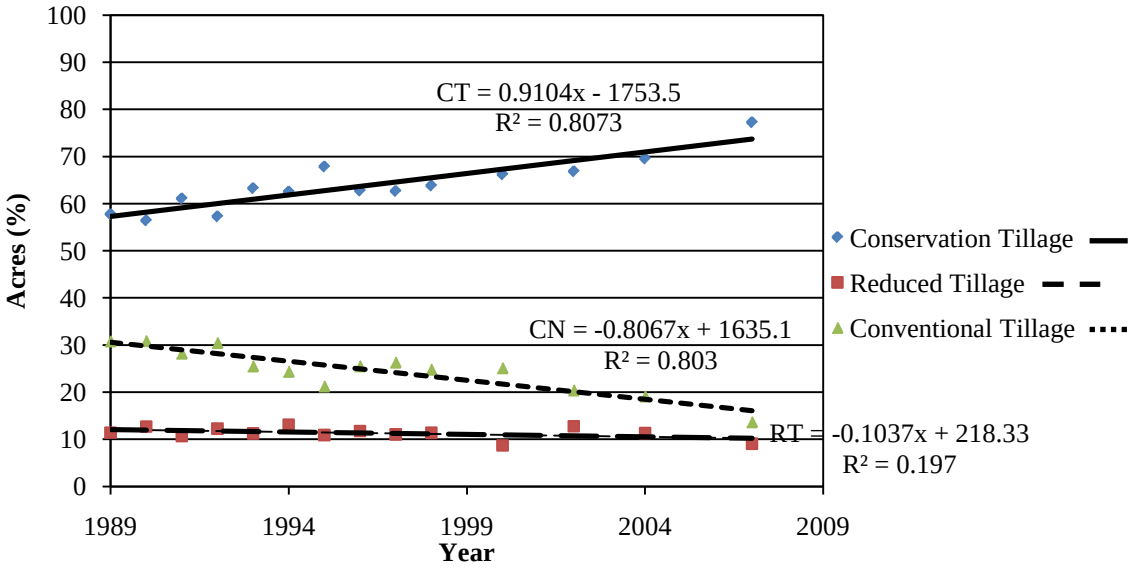

Figure 4. Winter small grain tillage trends based on surface residue for Virginia farms from 1989 to 2007 using data from the Conservation Technology Information Center's National Residue Management Survey (CTIC, 2009b).

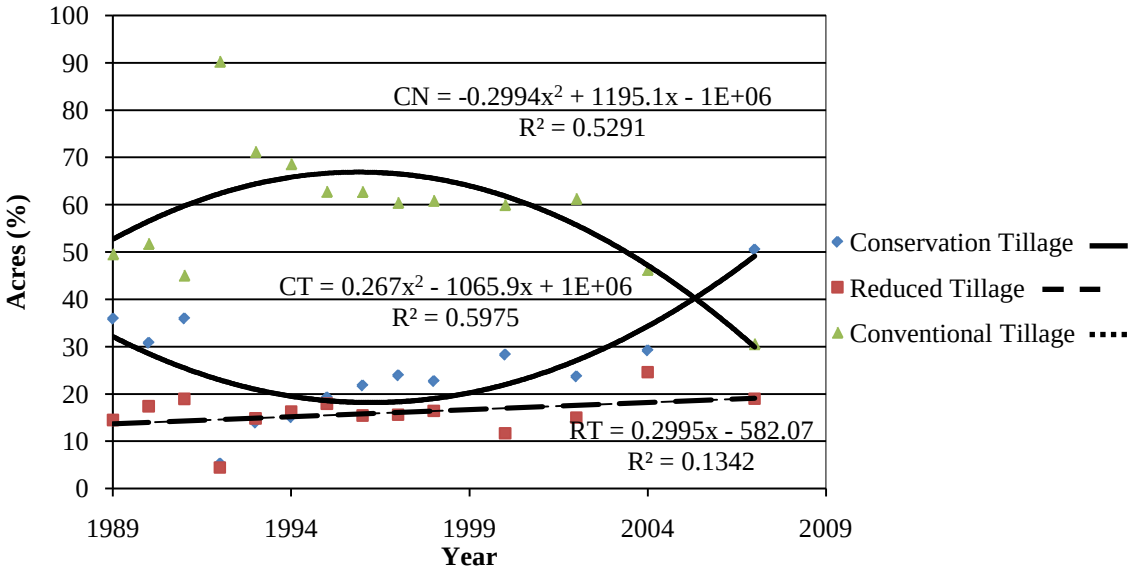

Figure 5. Vegetable tillage trends based on surface residue for Virginia farms from 1989 to 2007 using data from the Conservation Technology Information Center's National Residue Management Survey (CTIC, 2009b). The "other" category data was used for years 1989 to 1998 since vegetables were lumped into this category.