WHEEL TRAFFIC IN ALFALFA – WHAT DO WE KNOW? WHAT CAN WE DO ABOUT IT?

Jerry Schmierer, Dan Putnam, Dan Undersander, Jee Liu and Herman Meister[1]

ABSTRACT

Alfalfa yield is reduced by the damage that is caused by the normal hay harvest operations. This yield reduction is mainly due to physical damage to new shoots re-growing after cutting. There is a subsequent reduction in root stored carbohydrates and reduced plant vigor. Soil Compaction can be a contributing factor to reduced yield. Compaction is especially evident under irrigated sandy loam soils and on heavy soils that are driven upon when wet. Crown rot diseases increase when there is damage to plants such as the mechanical damage caused by wheel traffic. Historic and recent traffic x variety trials have documented a range of yield reduction (16-26%) when traffic treatments were applied at 5 to 7 days following cutting. Earlier traffic treatments resulted in much less damage (5-8%). New "grazing and wheel traffic resistant" varieties that were selected by testing under wheel traffic conditions have less traffic caused yield reduction than many of the standard varieties. The percentage of field area exposed to harvest traffic varies with the type and size of equipment, the need for extra trips to turn hay in wet conditions, and the configuration of the equipment to track over previous equipment tracks. There is a difference when the traffic occurs, traffic imposed soon after cutting being less damaging as compared to the baler and bale wagon traffic. There is a large variation in damage and yield reduction ranging from no damage, light to moderate damage and heavy damage. In order to more accurately evaluate the effect of wheel traffic on varieties, the results from traffic and no-traffic treatments should be combined to rate the variety under both traffic and no-traffic. Equipment modifications can help in establishing traffic lanes that concentrate heavy traffic into narrow bands. This has both a positive and negative effect. It reduces the damaged area but intensifies the damage on the traffic lane. Wheel traffic and shoot damage to regrowth has the effect of delaying the growth and maturity of alfalfa. Alfalfa in wheel traffic areas should not be used in taking tissue sample for nutrients as the stage of maturity effects the level of nutrients in the plant sample.

Key words: alfalfa, wheel traffic, harvest, equipment, regrowth, soil compaction, diseases

DEFINE THE PROBLEM

Wheel traffic is a common problem in the modern culture of alfalfa hay. Over the years, the equipment used to cut, rake, bale and remove the hay from the field have changed dramatically as mechanization has reduced the requirement for arduous hand labor. With mechanization, the

---

[1] J. Schmierer, UCCE Farm Advisor, Colusa, Sutter, Yolo & Glenn Counties, PO Box 180, Colusa, CA 95932 Email: jlschmierer@ucdavis.edu; D. Putnam, Alfalfa & Forage Extension Agronomist, Department of Plant Science, University of California, Davis, CA 95616; D. Undersander, Dept. of Agronomy, Univ. of Wisconsin, 1575 Linden Dr., Madison, WI 53706; J. Liu, Department of Plant Science, University of California, Davis, CA 95616; H. Meister, UCCE Farm Advisor, Imperial County, 1050 East Holton Road, Holtville CA, 92250-9615. **In**: Proceedings, National Alfalfa Symposium, 13-15 December, 2004, San Diego, CA, UC Cooperative Extension, University of California, Davis 95616. (See http://alfalfa.ucdavis.edu for this and other proceedings).

equipment size has increased. However, the need to drive over the field multiple times for each harvest continues. Early studies demonstrated that as much as 70% of the field area could be driven upon for each cutting. Equipment traffic occurs at various times during the harvest operation. Traffic during cutting does not have the same harmful effect of later traffic from the baling and bale removal. The resulting reduction in yield from the traffic areas has been attributed mainly to new shoot and regrowth damage. Soil compaction and increased disease incidence are also contributing factors in plant damage and yield reduction (Sheesley et. al., 1982).

In the late 1970's research at the University of Nevada, Reno was conducted to measure the effects of wheel traffic damage. The test was done on irrigated alfalfa in the arid growing region of Western Nevada. In that 4 year study, 10 varieties were treated with no traffic or a traffic treatment of a fully loaded bale wagon driven over the entire plot area at either one or seven days after cutting. Yield reduction was similar for all 10 varieties but there was a significant difference in yield among the varieties. Plant density was not decreased nor was crown rot increased by the traffic treatments.

Traffic	4 yr total yield	Reduction Tons	Reduction %
No	19.4	--	--
1 day	17.8	1.6	8.2
7 days	14.2	5.2	26.8

"Because there was no reduction in yield of the first harvest in 1980, it was concluded that soil compaction from wheel traffic of the previous three years was not the cause of the reduction in yield for subsequent harvests." The cause of the yield reduction was damage to new shoots or regrowth, the damage being greater when traffic was imposed at 7 days after cutting (Jensen et.al., 1982).

The reduction in alfalfa plant populations and the resulting decrease in yield and hay quality is a major reason for growers to decide to remove an alfalfa field from production. Heavy wheel traffic in which plants are trafficked multiple times per cutting can increase crown damage and decrease shoot and root growth. In tests conducted in the San Joaquin Valley of California on irrigated sandy loam soils, heavy traffic increased soil density and decreased water infiltration to a depth of 90 to 120 cm. Repeated damage to new shoots from multiple traffic passes attributed to a change in carbohydrate partitioning in which greater root reserves are needed for plant recovery. These factors combined in the result of reduced alfalfa plant growth and vigor (Rechel, 1984).

Stand decline under warm, humid growing conditions is often associated with the crown rot complex, the most common causal organisms being *Fusarium*, *Phoma* and *Rhizoctonia* species. Damage from these diseases is most severe after some sort of damage to the crown such as mechanical injury from harvest equipment (Univ. of IL Extension, 1999). Recent research has shown that there are varietal differences in yield and persistence when alfalfa is subjected to normal grower harvest traffic conditions. Advanced "grazing and traffic resistant" breeding lines have displayed increased *Phoma* crown rot resistance due to the selection of these lines under traffic conditions. It is also believed that the germplasms selected under traffic conditions display increased food reserves in the roots. (Miller & Hafez, 2003). This new germplasm selection procedure was not used in the development of older alfalfa varieties, such as those evaluated by Jensen in the late 1970's.

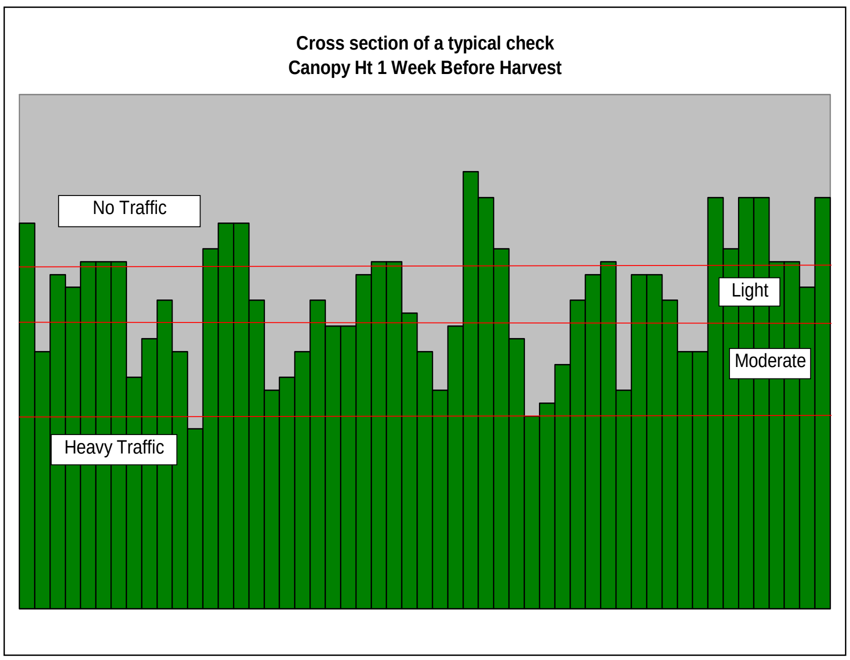
DEALING WITH THE PROBLEM

Reduce traffic.

It only stands to reason that reducing the amount of traffic will reduce the amount of damage done by traffic. Traffic occurring at cutting or within a few days is less damaging to alfalfa shoots than traffic during the later harvest operations. Wheel traffic my overlap, either from the same operation or from subsequent operations. There is a normal field pattern with several different levels of traffic damage occurring. Wheel traffic yield reduction can be light, normally caused by the cutting equipment. Moderate and heavy traffic patterns occur from operations done later in the harvest operation. Moderate traffic can be from the tractor and rake and heavy traffic can be from the tractor, baler and bale wagon. When any of these tracks overlap, the total area is decreased, but the yield reduction is increased.

Traffic	% of Area
None	41%
Light	26%
Moderate	27%
Heavy	6%

(Data from Sheesley, 1982)



Compaction due to the multiple trips is a factor, but breaking shoots that may have started to grow for the 2nd time after cutting, has a depleting effect on stored root carbohydrates.

Modifying the way that tractors and implements track can effectively reduce the total amount of traffic area in an alfalfa field. These harvest equipment modifications (Sheesley, 1982) were tested in grower fields along side the conventional equipment configuration. Two separate studies (Munier, 1985 and Shonnard, 1984) were not able to measure a significant increase in yield due to the equipment modifications. However, similar type modifications are commonly used in the Imperial Valley of California where alfalfa is grown on 40 inch beds and the wheel traffic is concentrated in the furrows. Bedded alfalfa is used to drain fields better, eliminating standing water and reducing scald. Limiting traffic to furrow in this bedded alfalfa system did not adversely affect soil compaction and permeability in the shrinking-swelling fine textured soil common to the Imperial Valley (Mitchel & Swain, 1987).

Green chopping instead of conventional baling does have the potential to reduce damage and increase yield. A field scale experiment in the San Joaquin Valley of CA measured a 12 % increase in yield from green chopping over conventional hay making (Munier, 1989). This corresponds with the lower level of yield reduction in traffic trials where the traffic treatment is applied at 2 days compared to that at 5 days.

Stay off wet soils.

Harvesting alfalfa grown under non-irrigated, rainfall conditions can be difficult due to untimely rain at or near harvest time. Growers are often forced to drive on soil that is not as dry as desired in order to get the hay off the field. Soil compaction can be a problem under these conditions, especially in heavy soils. When soil moisture in the top 3 to 6 inches is near field capacity, the potential for soil compaction increases as clay content increases and soil organic matter decreases (Wortmann & Jasa, 2003). These heavy soils hold more water than the sandy, lighter soils and do not drain excess water as quickly. This problem is not as prevalent in the West where summer rain is unusual and soil moisture is provided by irrigation. With these controlled conditions, heavy soils are allowed to dry and may even crack due to the shrinking and swelling chareristic. In the West, it was the sandy loam soils that have a higher tendency to compact (Mitchell & Swain, 1987).

Use Traffic resistant varieties.

Alfalfa variety x wheel traffic trials with a number of the varieties that had been selected for grazing and wheel traffic tolerance have been conducted in 7 mid-western states and California. Traffic treatments (100 hp tractor driven over 100% of the traffic plots) were applied at 2 and 5 days after cutting and the yields were compared to plots of the same variety with no wheel traffic. The following tables present the preliminary data from these trials.

Multi-State Variety x Traffic Study, preliminary results from 2003 & 2004.

Combined average from no traffic, 2 day and 5 day traffic.			
entry	Yield 2002 ton/a	Yield 2003 ton/a	Yield 2 yr ton/a
Var 1	4.79	5.26	10.05
Var 2	4.72	5.30	10.02
Var 3	4.61	5.15	9.76
Var 4	4.62	5.08	9.70
Var 5	4.63	5.03	9.66
Var 6	4.49	5.00	9.50
Var 7	4.43	4.89	9.32
Var 8	4.39	4.90	9.29
Var 9	4.39	4.76	9.15
Var 10	4.37	4.74	9.11
Var 11	4.29	4.73	9.02
Var 12	4.32	4.60	8.92
Mean	4.50	4.95	9.46
CV%	8.70	8.00	6.80
LSD 5%			
State site	0.10	0.10	0.16
Traffic	0.07	0.07	0.11
Entry	0.14	0.14	0.22
Traffic x Entry	ns	ns	ns
Site x Traffic x Entry	ns	ns	ns

	IA		KY	
traffic	2 yr Total	% Loss	2 yr Total	% Loss
NO	10.28		9.43	
2 DAY			9.30	1.16
5 DAY	8.59	16.49	8.33	11.51

	MN		NY	
traffic	2 yr Total	% Loss	2 yr Total	% Loss
NO	10.22		12.43	
2 DAY	8.84	13.38	12.19	1.89
5 DAY	7.36	27.97	10.66	14.20

	WI		**Ave over all States**	
traffic	2 yr Total	% Loss	2 yr Total	% Loss
NO	11.31		10.73	-
2 DAY	10.75	4.88	10.27	5.33
5 DAY	10.10	10.59	9.01	16.15

2003-2004 UC DAVIS TRAFFIC VARIETY TRAIL (PLANTED 2002)						
	Yield 2003		**Yield 2004**		**Yield total**	
	Control	**Traffic**	**Control**	**Traffic**	**Control**	**Traffic**
Tons/Acre	12.6	10.1	11.8	8.8	24.4	18.9
% Reduction in yield from traffic:						
High Variety	26.06%		32.93%			
Low Variety	8.74%		15.46%			
Average	19.74%		25.90%		22.71%	

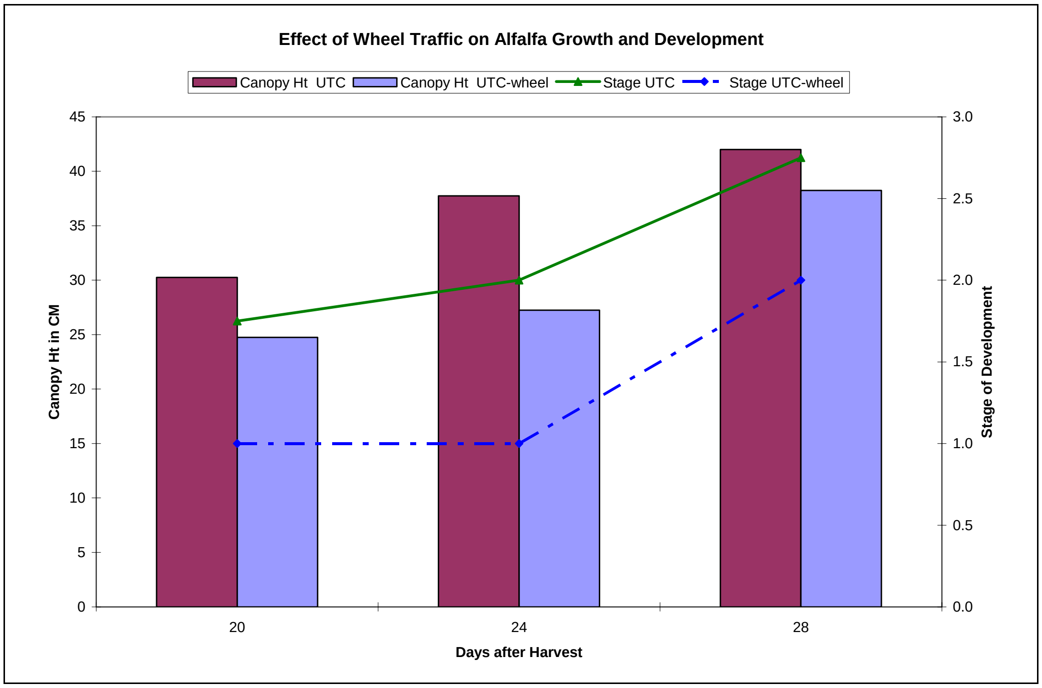
2003-2004 Prelimary results, Traffic Variety Trial at UC Davis, CA

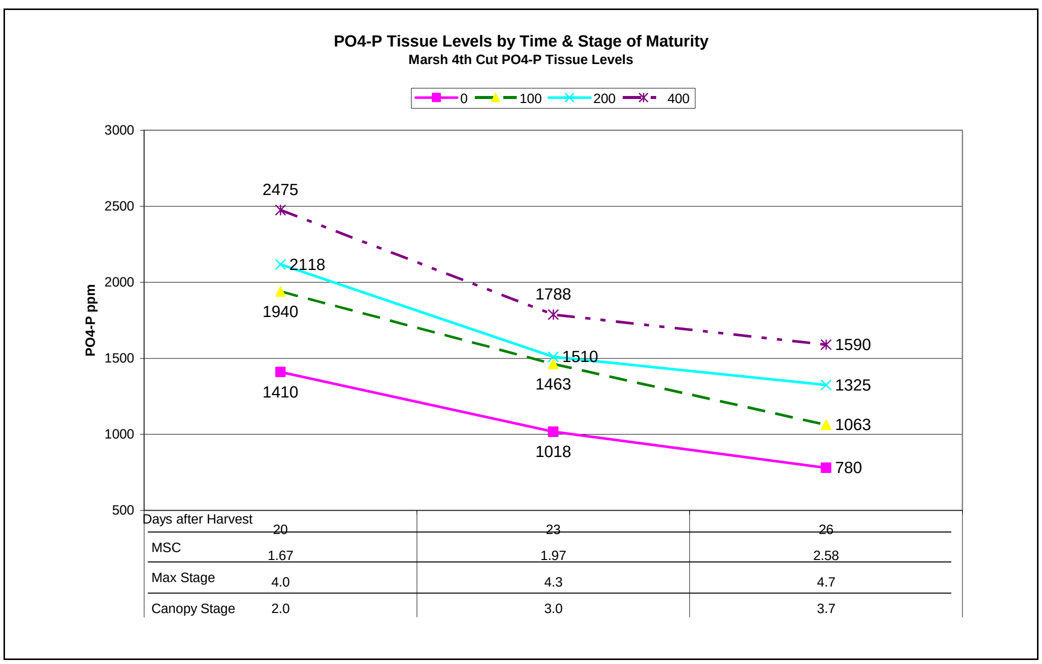
Variety	Yield 2003 Control	Yield 2003 Traffic	Yield 2004 Control	Yield 2004 Traffic	2003-2004 Yield total Control	2003-2004 Yield total Traffic	2003-2004 Yield average Control	2003-2004 Yield average Traffic	Combined: Traffic & No Traffic total	Combined: Traffic & No Traffic ave
Var 1	13.98	10.34	12.75	9.49	26.73	19.84	13.37	9.92	23.29	11.64
Var 2	13.67	10.51	13.35	9.02	27.02	19.53	13.51	9.77	23.27	11.64
Var 3	12.79	10.83	13.04	9.53	25.83	20.36	12.92	10.18	23.10	11.55
Var 4	13.39	10.16	13.52	9.06	26.91	19.22	13.45	9.61	23.06	11.53
Var 5	13.88	10.36	12.44	9.02	26.32	19.37	13.16	9.69	22.85	11.42
Var 6	13.14	10.08	12.21	9.05	25.35	19.12	12.68	9.56	22.24	11.12
Var 7	12.17	9.87	13.18	9.02	25.36	18.88	12.68	9.44	22.12	11.06
Var 8	12.69	10.89	12.03	8.50	24.72	19.39	12.36	9.69	22.05	11.03
Var 9	12.64	10.05	12.45	8.84	25.09	18.90	12.55	9.45	22.00	11.00
Var 10	12.71	10.90	11.51	8.80	24.23	19.70	12.11	9.85	21.96	10.98
Var 11	13.13	10.51	11.09	8.72	24.23	19.23	12.11	9.62	21.73	10.86
Var 12	12.78	10.03	11.59	8.74	24.37	18.77	12.18	9.38	21.57	10.78
Var 13	12.47	9.60	11.65	9.24	24.12	18.84	12.06	9.42	21.48	10.74
Var 14	12.26	10.25	11.42	8.33	23.68	18.58	11.84	9.29	21.13	10.56
Var 15	11.61	9.45	12.58	8.54	24.20	17.99	12.10	9.00	21.10	10.55
Var 16	11.36	10.37	11.17	8.88	22.54	19.25	11.27	9.63	20.89	10.45
Var 17	12.25	9.32	11.16	8.12	23.41	17.43	11.71	8.72	20.42	10.21
Var 18	12.42	9.90	9.86	8.14	22.28	18.04	11.14	9.02	20.16	10.08
Var 19	11.67	9.76	10.02	8.28	21.68	18.03	10.84	9.02	19.86	9.93
Var 20	11.66	9.62	9.22	7.80	20.88	17.41	10.44	8.71	19.15	9.57
Average	12.60	10.10	11.80	8.80	24.40	18.90	12.20	9.40		
Grand Ave	11.40		10.30		21.70		10.80			
Traffic F	***		***		***		***			
Variety F	***		***		***		***			
Traffic x Variety F	ns		***		**		**			
LSD	0.2654		0.1609		0.3571		0.1803			
Variety F	***	ns	***	***	***	*	***	*		

These data show that there is a wide variation in variety tolerance to wheel traffic. Using the combined total for traffic and non-traffic plots is a reasonable way to evaluate how varieties perform under real world conditions. The data presented here is only for 2 years. Disease and stand decline measurements will be taken later, at the end of the experiment.

Don’t tissue sample in traffic lanes.

Alfalfa tissue sampling is used to evaluate the nutrient status of the crop. The standard procedure for sampling has been to sample at $1/10^{th}$ bloom. Although this procedure is under revision, it is important that samples are uniform in maturity. Wheel traffic affects the maturity of the alfalfa. Samples of mixed maturity plants will result in tissue tests that are inaccurate. The best situation for tissue sampling is not to sample the obvious wheel traffic areas that are delayed in maturity by 3 to 5 days. As these graphs show, that time lag can make a tremendous difference in the sample results.





REFERENCES

Jensen, E.H., G.C. McGourty and R.E. Rose. 1982. Effect of Harvest Traffic on Alfalfa Yield. p.12-13. *In* 1982 Western Nevada Alfalfa Symposium Proceedings, Cooperative Extension, University of Nevada, Reno.

Meek, B.D., L.M. Carter, R.H. Garber and E.A. Rechel. 1983. Regrowth and Yield of Alfalfa as Influenced by Wheel Traffic. p.1-5. *In* 1983 California Alfalfa Symposium Proceedings, UC Cooperative Extension, University of California, Davis CA 95616.

Miller, D. R. and S. Hafez. 2003. Alfalfa Diseases and Stem Nematodes: What are the effects of Equipment and Varities. p.101-104. *In* 2003 California Alfalfa Symposium Proceedings, UC Cooperative Extension, University of California, Davis CA 95616.

Mitchell, A.R. and R.V. Swain. 1987. Controlled Traffic on Alfalfa in the Imperial Valley A Whole New Ball Game? p.71-76. *In* 1987 California Alfalfa Symposium Proceedings, UC Cooperative Extension, University of California, Davis CA 95616.

Munier, D.J. 1989. Alfalfa's Response to Baling versus Bagging. p.33-34. *In* 1989 California Alfalfa Symposium Proceedings, UC Cooperative Extension, University of California, Davis CA 95616.

Munier, D.J. 1985. Modified Traffic in Alfalfa Trial Results. Research Report, Kern County Cooperative Extension, University of California.

Rechel, E.A. and B. Meek. 1985. Water Intake Rates and Alfalfa Growth as Affected by Traffic. p. 60-65. *In* 1985 California Alfalfa Symposium Proceedings, UC Cooperative Extension, University of California, Davis CA 95616.

Rechel, E.A. 1984. Alfalfa Shoot and Root Growth under Traffic Conditions. p.48-58 . *In* 1984 California Alfalfa Symposium Proceedings, UC Cooperative Extension, University of California, Davis CA 95616.

Sheesley, W.R. 1982. Reduced Wheel Traffic could boost Alfalfa Grower Incomes. p.39-41. *In* 1982 California Alfalfa Symposium Proceedings, UC Cooperative Extension, University of California, Davis CA 95616.

Sheesley, W.R., D.W. Grimes, W.D. McClellan, C.G. Summers, V. Marble. 1982. The Influence of Wheel Traffic on Yield and Stand Longevity in Alfalfa. p. 42-46. *In* 1982 California Alfalfa Symposium Proceedings, UC Cooperative Extension, University of California, Davis CA 95616.

Shonnard, L. 1984. Traffic Modifications in Alfalfa Hay A Grower's Experiences and Results. p. 67. *In* 1984 California Alfalfa Symposium Proceedings, UC Cooperative Extension, University of California, Davis CA 95616.

Undersander, D. and J. Moutray. 2001. Effect of Wheel Traffic on Alfalfa Yield. (Available online at http://www.uwex.edu/ces/forage/wfc/proceedings2001/wheel_traffic.htm)

University of Illinois Extension. 1999. Report on Plant Disease: Root and Crown Troubles of Alfalfa. RPD No. 302, May 1999, Department of Crop Sciences, University of Illinois at Urbana-Champaign.

Wortmann, C.S. and P.J. Jasa. 2003. Management to Minimize and Reduce Soil Compaction. Nebraska Cooperative Extension G89-896 (Revised Dec. 2003) (Available online at http://ianrpubs.unl.edu/soil/g896.htm)