STAFF PAPER

POTENTIAL ENVIRONMENTAL CONTAMINATION FROM CONVENTIONAL AND ALTERNATIVE CROPPING SYSTEMS IN NORTHEAST KANSAS

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Department of Agricultural Economics
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ABSTRACT

Surface-water contamination from agricultural chemicals is a problem in northeast Kansas. The objective of this study is to compare potential atrazine, nitrogen, and sediment loadings from regional conventional and alternative cropping systems. Results indicate that several alternative systems have lower loading levels for atrazine and sediment than the conventional system, but higher loading levels for nitrogen .

KEYWORDS: alternative agriculture, nitrogen, atrazine.

INTRODUCTION

In recent years, concerns regarding agrichemicals, especially atrazine, in surface water in northeast Kansas have increased significantly because the area is a major source of drinking water for Kansas City and nearby towns. Atrazine is one of the most frequently appearing chemicals. Atrazine is a herbicide used to selectively control broadleaf (dicot) weeds and certain grass weeds, particularly in corn and sorghum. It is used widely because it economically and effectively controls competition from weeds (Regehr, Peterson, and Hickman). Atrazine is also the most commonly used herbicide among the agricultural systems in northeast Kansas (Diebel, Llewelyn, and Williams, 1993a).

Atrazine contamination can affect human health adversely. For instance, a 150-pound person would have a 50 percent probability of death from poisoning by ingesting about 0.75 lb of atrazine in a single dose (Regehr, Peterson, and Hickman). Atrazine is also relatively persistent in large concentrations (Stamer). In 1992, the U.S. Environmental Protection Agency (EPA), with the cooperation of the Kansas State Board of Agriculture, designated part of northeast Kansas as a Pesticide Management Area (PMA). The PMA area overlies the Delaware River Basin and impacts an estimated 4,000 farmers in parts of Nemaha, Brown, Jackson, Atchison, and Jefferson counties. The basin empties into Perry Reservoir in Jackson County and the Kansas River, which supply drinking water for Kansas City, Kansas. Perry Reservoir is the fifth largest reservoir in Kansas.

The acceptable level of atrazine residue in drinking water is 3 ppb. The 1989 mean concentration of atrazine in Perry Reservoir exceeded this standard, although streams throughout the PMA continued less (Stamer). The

Kansas State Board of Agriculture restricted the maximum application of atrazine to 2.25 lbs per acre in any given crop year within the PMA. This program is voluntary during the first year, but the regulations become mandatory if no progress is made in reducing the atrazine levels in drinking water. Atrazine levels in runoff have been monitored since January 1, 1993 and will be monitored for at least two more years. Other regulations are currently mandatory, such as the prohibition of atrazine use within 500 feet of any public water supply source. In addition, atrazine is banned from use on noncroplands, including highway and railroad rights-of-way, and lawns.

In a voluntary situation, the farmer's production decisions are the most important factors in reducing contamination. If a manager's primary goal is to maximize net returns, the additional objective of reducing the application and/or loss of atrazine now must be considered. The widespread adoption of alternative agricultural practices could be a possible solution to these pollution problems, if it can satisfy both goals. Alternative agriculture includes a spectrum of farming systems, ranging from organic systems that attempt to use no purchased synthetic chemical inputs to slightly modified conventional practices that use fewer off-farm inputs, such as chemicals (National Research Council).

In this study, nonpoint pollution simulation is used to develop potential contaminant loadings caused by agricultural chemicals and nutrients in northeast Kansas for the period, 1987 to 1991. The economic feasibility of the conventional and alternative cropping systems also are considered.

CROPPING SYSTEMS

In 1993, Diebel, Llewelyn, and Williams (1993a) conducted on-farm interviews with 15 northeast Kansas farmers using alternative cropping practices to identify such practices. Information on crop rotations, operation schedules, yields, and equipment needs was collected from each participant. Average characteristics of the 332 farms in a 14-county study area for the period 1986-1990 were used to determine the representative farm. The northeast region study area included Atchison, Brown, Doniphan, Douglas, Jackson, Jefferson, Johnson, Leavenworth, Marshall, Nemaha, Pottawatomie, Shawnee, Wabaunsee, and Wyandotte counties. The average area for dryland crops was 640 acres, with 40 percent owned and 60 percent rented. Field operation schedules were derived from the survey data and ongoing research at the Corn Belt Experiment Station.

The structures of the conventional and four alternative cropping systems are illustrated in Figure 1. The 640 acres of the representative farm are distributed among four major crops in the conventional system: wheat, 110 acres; grain sorghum, 125 acres; soybeans, 250 acres; and corn, 155 acres. Five crop rotations common in northeast Kansas are included in the conventional system. Corn is grown on 125 acres in rotation with soybeans, with an additional 30 acres of corn cropped continuously. Soybeans are grown in rotation with corn on 125 acres, in rotation with sorghum on 70 acres, and in rotation with wheat on 55 acres. Sorghum is produced on 70 acres in rotation with soybeans and on 55 acres in rotation with wheat. Wheat is grown on 55 acres in rotation with soybeans and on 55 acres with sorghum.

Four alternative systems were selected for analysis based on their repeated appearance among current practices and the detailed operation information available. Alternative 1 has 213.3 acres allocated to wheat interplanted with clover in the spring. The clover serves as a nurse crop for wheat, as well as a nitrogen source, and is harvested after wheat for seed.

Sorghum is planted on 213.3 acres, and the remaining 213.3 acres are used for soybeans. The total acreage is divided equally in Alternative 2, with 320 acres planted to sorghum annually and 320 acres utilized for wheat and vetch. Vetch, a legume, is used as a nitrogen source, similar to clover in the previous system; however, it is not harvested. Vetch is seeded after fall harvest of wheat, killed, and disced in the spring at sorghum planting. In Alternative 3, alfalfa accounts for 384 acres. Each year, 128 acres of new alfalfa interseeded with oats are planted following soybeans that are grown in the previous year. Oats are harvested, and the straw is baled a month before the single harvest of alfalfa in the first year. Alfalfa is harvested three times in the second year and once in the third year, after which it is incorporated as a green manure. This land then is planted to wheat in the following fall and to soybeans in the spring following wheat harvest. Alternative 4 has 183 acres planted to corn and rotated with soybeans. One-half of the soybean acreage, 91 acres, is planted to alfalfa interseeded with oats in the following spring. There are 273 acres of alfalfa each year, with one-third of the acres being newly planted. Harvesting of alfalfa does not occur in year 1, but occurs three times in years 2 and 3. Oats are harvested, and the straw is baled in late summer of the first year. The final year of alfalfa provides nitrogen for the following corn crop.

ENTERPRISE BUDGETS

Enterprise budgets were developed by Diebel, Llewelyn, and Williams (1993a) to summarize the annual operating expenses and fixed costs of each system, making it possible to compare costs and average net returns of each cropping system. The variable costs included the costs of labor, seed, herbicide, insecticide, fertilizer, fuel, oil, equipment repair, custom hire, and interest on variable cost. The fixed costs included real estate taxes, interest on land, share rent, depreciation and interest on machinery, and insurance and housing. The data regarding these costs were collected from Kansas Farm Management Association, Kansas Agricultural Statistics, northeast Kansas cooperatives, and the producer survey. In calculating average net returns for the 5-, 10-, and 20-year periods, only the variation of crop yields was considered; costs were held constant over the 20-year period. Yield data were obtained from the Kansas Farm Management Association (1972-1991). Crop yield data for the Conventional System was used for alternative systems, because historical experimental yield data on alternative systems were not available. Diebel, Llewelyn and Williams (1993b) reported a detailed yield sensitivity analysis.

CONTAMINATION SIMULATION

The nonpoint pollution simulation model, GLEAMS 2.01 (Leonard, Knisel and Still), was used to simulate potential contaminant loadings under each system. GLEAMS is a mathematical simulation model developed for a field-sized area to evaluate the effects of agricultural practices on the movement of agricultural chemicals and nutrients through the plant root zone (Knisel, Davis and Leonard). The model requires five sets of input data files, consisting of daily precipitation, hydrology, erosion, pesticides, and nutrients. Pesticide data files are not needed for Alternative Systems 3 and 4, because they do not use pesticides. Nutrient files are required for every system, even if no additional nutrients are applied, in order to measure soil N levels and potential fixed N levels. Daily precipitation and hydrology inputs were drawn from historical, 1972 to 1991, weather data for northeast Kansas. The hydrology file contained monthly temperature and radiation data and basic soil condition information for the area. Regional historical data were used, except for monthly radiation, which had to be simulated using the WEPP Climate Generator and Parameter Data Base (CLIGEN; Nicks and Gander) weather simulator. The erosion file contained information regarding soil condition and geological structure of the representative farm. The pesticide file contained chemical application schedules and rates and chemical properties of pesticides. The nutrient file contained schedules and amounts of fertilizer applications and types of tillage operations. The data for the simulation model were collected from soil surveys of the study area (Soil Conservation Service), GLEAMS 2.0 User Manual (Knisel), and expert opinion. Detailed description of the input files were published by Koo.

The chemicals, including pesticides and fertilizers, used in these systems are indicated in Table 1. The Conventional System is the most chemically intensive among the systems. Some of the four Alternative Systems use several chemicals; however, the amounts applied are smaller than those in the Conventional System. The number of tillage operations under each system is one of the most important factors in the nonpoint pollution simulation model. Several of the Alternative Systems have multiple years of alfalfa, after which a deep plowing is needed before another crop is planted. Annual deep plowing is not necessarily an environmentally or agronomically beneficial practice; however, the plowing in these systems occurs only once every 5 or 7 years.

Each cropping system (or rotation) was simulated once for every year in the rotation sequence. The starting dates were lagged each year so that each crop was simulated for every year. The annual contaminant levels were calculated by weighting the contribution of each crop by the acres grown.

RESULTS AND DISCUSSION

Tables 2-4 contain, respectively, the 20- (1972-1991), 10- (1982-1991), and 5- (1987-1991) year average net returns and simulated contaminant loadings for the Conventional and alternative Systems. Figure 2 depicts the physical contamination levels for atrazine, nitrogen, and sediment across production activities. All the contaminants in the area were simulated (Koo), although the results of this study focus on atrazine in runoff, nitrogen in runoff and leachate, and soil erosion. Atrazine levels in leachate are not discussed, because they are either very small amounts or zero in most years. Net returns are the returns to management calculated as the gross return per acre less the total cost per acre.

The minimum and maximum values, and the coefficients of variation (CV) are also included in Tables 2-4. The CV measures relative variability and is equivalent to the standard deviation divided by the mean of the distribution multiplied by 100. It measures the variability to the mean. A system with a positive and small CV value has low risk and will be preferred by a risk averter. Producers are assumed to be risk averse, preferring a high mean and low CV on their net returns. A low mean and low CV on environmental loadings are assumed to be preferred.

For all systems, mean net returns and mean environmental loadings tend to increase with time. As the time period lengthens, years with unusually high or low levels of contaminants are more likely to be included in the simulation. This is due to years of either drought or greater than average precipitation. As expected, coefficients of variation (relative risk) also increase with longer time periods. Rankings of systems by average net returns or environmental loadings do not vary much over selected time periods.

The Conventional System has a negative average net return over each of the time periods used in the analysis. Annual net return data reveal a positive net return in only 7 of the 20 years simulated. Low net returns are partly due to a mix of crops that has a high number of corn acres and a low number of soybean and wheat acres. The 5-year average price of corn is lower ($2.07 per bu) than prices for all crops except sorghum ($1.87 per bu) in this study. The Conventional System has the highest average values of atrazine in runoff (Figure 2), but moderate CV's are associated with those levels. Nitrogen contamination of runoff is relatively low under the Conventional System; nitrogen in leachate is lower than in all other systems. Sedimentation under the Conventional System is the highest in all time periods, although CV's are fairly moderate.

Alternative 2 has lower average net returns than the Conventional System. Alternatives 1, 3, and 4 have positive net returns. Alternative 4 has the highest average net returns for all three time periods; however, the associated CV's are larger than those of Alternatives 1 and 3. Alternatives 3 and 4 use no chemicals and, therefore, have no potential contaminant levels of atrazine. Alternative 3 ranks very poorly based on potential nitrogen contamination, with Alternative 4 not far behind (Figure 2). High average nitrogen levels in leachate may be due to the N-fixing characteristics of alfalfa. Foltz, Lee, and Martin found that alfalfa-based cropping systems increase potential nitrogen leachate contamination because of their N-fixing process and deep root systems. Nitrogen levels in both surface water and leachate also may be due to soil nitrogen that is unused by the N- fixing plant being carried off the field. Sediment rates are less under all the alternative systems than the Conventional System. The alfalfa-based systems do not have significantly better soil erosion control than the other alternative systems. Much of this reduction in sediment rates is due to tillage practices. The Conventional System requires numerous tillage and cultivation practices and uses chisel type tillage (Table 1). The alternative systems have fewer disturbances because a single rotation is used. Discing is the most common tillage practice among the alternative systems, except where alfalfa must be broken up. Alternative Systems 3 and 4 require a deep plowing to break up the established alfalfa; however, this occurs only every 5 and 7 years, respectively.

SUMMARY AND CONCLUSIONS

The Conventional System is identified as relatively inferior because of negative average net returns, high levels of atrazine in runoff, and high soil erosion levels. However, many of the CV's for environmental loadings are moderate, indicating that a manager could be faced with relatively consistent contamination levels.

Alternative 4 yields some of the highest annual and average net returns. These are primarily due to low variable costs. The net returns of this alternative are also sensitive to alfalfa prices (Diebel, Llewelyn, and Williams, 1993b). Widespread increases in alfalfa production may cause a fall in alfalfa prices, which would significantly affect these net returns. Alternatives 3 and 4 have high and variable average nitrogen contaminant levels. Alternative 2 is inferior because of negative average net returns, although several environmental benefits exist. Alternative 1 is the most moderate in income, nitrogen contamination, and soil erosion. Atrazine levels in runoff exist under Alternative 1 but are far less than those of the Conventional System. Total levels of atrazine are low and may not approach contaminant restriction levels when monitored in a larger body of water.

Final results imply that a policy targeting only a few chemicals may ignore changes in the levels of other contaminants. For example, if farmers in the study area adopt one of the alternative systems, they could accrue benefits from higher net returns and reduced levels of atrazine in runoff and soil erosion. However, the same system could produce more nitrogen in runoff and leachate than the Conventional System.

Converting the whole farm into a new cropping system may not be feasible because of the high costs of transition and the desire for production diversification under the Conventional System. Basic forms of transitional systems are described in Diebel, Llewelyn, and Williams (1993a), in which alternative systems are incorporated onto some portion of acres in the Conventional System. Those systems can be introduced through educating farmers in the area about economic and environmental benefits.

One of the greatest limitations of this study revolves around data availability. Calculation of true 5-year average net returns is impossible because of the lack of data regarding historical input prices. In addition, crop yields do not vary across systems because long-term average crop yields associated with the alternative systems are not available. Another data limitation arises because this study assumes a representative farm case, the average of 14 counties in the study area; therefore, the simulation model does not use specific field observations.

The simulation of potential contamination is significantly sensitive to the weather data incorporated into the model. These types of models do not adjust the operation schedule as a producer would do, if inclement weather prevailed. Therefore, these results represent a worse case scenario, where tillage and chemical and nutrient applications occur on a date without regard to precipitation or other weather conditions. A producer is able to manage the operation schedule to avoid undertaking these practices during poor weather.

REFERENCES

Diebel, P.L., R.V. Llewelyn, and J.R. Williams. "An Economic Analysis of Conventional and Alternative Cropping Systems for Northeast Kansas. Report of Progress 687, Agricultural Experiment Station, Kansas State University, Manhattan, Kansas, 1993a.

Diebel, P.L., R.V. Llewelyn, and J.R. Williams. "A Yield Sensitive Analysis of Conventional and Alternative Whole-Farm Budgets for a Typical Northeast Kansas Farm." Staff Paper No. 93-11, June 1993b, Department of Agricultural Economics, Kansas State University.

Foltz, J.C., J.G. Lee, and M.A. Martin. "Farm-Level Economic and Environmental Impacts of Eastern Corn Belt Cropping Systems." *J. Prod. Ag.* 6(1993):290-296.

Kansas Agricultural Statistics. *1987-1991. Average Prices Received by Farmers.* Selected Issues. Kansas State Board of Agriculture.

Kansas Farm Management Association. *1975-1991. The County Report.* Department of Agricultural Economics and Cooperative Extension, Kansas State University, Manhattan, Kansas.

Knisel, W.G., F.M. Davis, and R.A. Leonard. *GLEAMS Version 2.0, Part 3: User Manual.* USDA, 1992.

Koo, Seungmo. "A Comparative Analysis of Conventional and Alternative Systems in Northeast Kansas." Master's Thesis. Department of Agricultural Economics, Kansas State University, Manhattan, Kansas, 1993.

Leonard, R.A., W.G. Knisel, and D.A. Still. "GLEAMS: Groundwater Loading Effects of Agricultural Management System." *Trans. ASAE* 30(5)(1987):1403-1418.

National Research Council. *Alternative Agriculture*. Academy Press, Washington, DC, 1989.

Nicks, Arlin D. and Gene A. Grander. 1989. *WEPP Climate Generator and Parameter Database*. USDA-ARS, Water Quality and Watershed Research Laboratory, Durant, OK.

Regehr, D.L., D.E. Peterson, and J.S. Hickman. "Questions and Answers about Atrazine". *Atrazine and Water*. Coop. Ext. Serv., Kansas State Univ., Manhattan, Kansas, 1992.

Soil Conservation Service. *Soil Survey of Nemaha County, KS*. Soil Conservation Service, USDA, Washington, DC, 1982.

Stamer, J.K. "Organonitrogen Herbicide in Unregulated and Regulated Streams in the Lower Kansas River Basin, Kansas and Nebraska." Presented at the Symposium on Agricultural Nonpoint Sources of Contaminants: A Focus on Herbicides, September 1993, Lawrence, Kansas.

Table 1. Pesticide and Fertilizer Application Rates and Tillage Practices for Conventional and Alternative Systems.

Cropping System[a]	Pesticides	Rate per Acre	Fertilizer	Rate per Acre	Number of Tillage or Cultivation (Tillage Type)
Conventional					
C-Sb	Lariat (C)	4 qts		90 lbs	7(disc and chisel)
	Tri-Scept (Sb)	2.33 pts	Anhydrous (C)		
Sg-Sb	Ramrod/Atrazine (Sg)	5 qts	Anhydrous (Sg)	90 lbs	7 (disc and chisel)
	Tri-Scept (Sb)	2.33 pts			
W-Sg	2,4-D 4 LVE (W)	1.5 pts	28-0-0 (W)	215 lbs	6 (disc and chisel)
	Ramrod/Atrazine (Sg)	5 qts	Anhydrous (Sg)	120 lbs	
W-Sb	2,4-D 4 LVE (W)	1 pt	Potassium (W)	60 lbs	5 (disc and chisel)
	Treflan (Sb)	2 pts	Ammonium (W)	115 lbs	
	Sceptor (Sb)	0.67 pts			
C-C	Atrazine (C)	1.5 lbs	Anhydrous (C)	180 lbs	4 (disc and chisel)
	Lasso (C)	2 qts	18-46-0 (C)	70 lbs	
	Lorsban (C)	8.75 lbs			
Alternative 1					
W/Cv-Sg-Sb	Squadron (Sb)	3 pts	18-46-0 (Sg)	30 lbs	8 (disc)
	Bicept (Sg)	1.8 qts	Urea (Sg)	100 lbs	
	Atrazine (Sg)	1.1 lbs	18-46-0 (W)	30 lbs	
			Urea (W)	70 lbs	
Alternative 2					
Sg-W/V	2,4-D 4 LVE (W)	1 pt	34-0-0 (W)	150 lbs	8 (disc)
	Roundup (V)	8 oz	10-34-9 (V)	130 lbs	
	2,4-D 4 LVE (V)	1 pt	18-46-0 (W)	100 lbs	
	Lasso (Sg)	2 qts			
	Atrazine (Sg)	1.5 lbs			
	Furadan (Sg)	6 lbs			
Alternative 3					
A/O-A-A-W-Sb	None	-	18-46-9 (W)	30 lbs	13 (disc and plow)
Alternative 4					
C-Sb-C-Sb-A/O-A-A	None	-	None	-	13 (disc and plow)

[a]Conventional: C-Sb=corn-soybeans, Sg-Sb=sorghum-soybeans, W-Sg=wheat-sorghum, W-Sb=wheat-soybeans, C-C=continuous corn; Alternative 1=wheat/clover-sorghum-soybeans; Alternative 2=sorghum-wheat/vetch; Alternative 3=alfalfa/oats-alfalfa-alfalfa-wheat-soybeans, Alternative 4=corn-soybeans-corn-soybeans-alfalfa/oats-alfalfa-alfalfa.

Table 2. Twenty-Year Average Net Returns and Average Contaminant Loadings for Conventional and Alternative Cropping Systems, 1972-1991.

	Cropping System[a]				
20 years	C	A 1	A 2	A 3	A 4
Net Return ($/acre)					
Mean	-7.69	14.35	-44.11	12.10	18.00
Coefficient of Variation	-375.66	145.28	-35.67	131.79	160.88
Maximum	40.95	45.80	-16.85		73.87
Minimum	-53.32	-14.94	-71.85	-11.43	-24.72
Atrazine Runoff (oz/acre)					
Mean	0.09	0.04	0.01	0.00	0.00
Coefficient of Variation	109.18	142.19	198.67	.	.
Maximum	0.44	0.20	0.09	0.00	0.00
Minimum	0.00	0.00	0.00	0.00	0.00
N Runoff (lbs/acre)					
Mean	1.46	1.49	1.50	1.92	1.65
Coefficient of Variation	67.39	63.52	63.21	63.38	64.26
Maximum	4.04	3.75	3.80	5.25	4.62
Minimum	0.39	0.36	0.35	0.54	0.46
N Leachate (lbs/acre)					
Mean	6.26	7.77	7.77	10.21	7.85
Coefficient of Variation	188.49	40.18	140.18	138.28	159.18
Maximum	56.95	42.42	50.67	58.30	57.56
Minimum	0.68	0.30	0.35	1.35	1.29
Sediment Yield (ton/acre)					
Mean	6.54	3.97	2.38	2.41	3.59
Coefficient of Variation	76.33	79.79	81.78	82.39	80.29
Maximum	22.07	13.79	8.17	8.48	11.95
Minimum	1.40	0.81	0.49	0.55	0.80

[a]C=Conventional, A1=Alternative 1 (wheat/clover-sorghum-soybeans), A2=Alternative 2 (sorghum-wheat/vetch), A3=Alternative 3 (alfalfa/oats-alfalfa-alfalfa-wheat-soybeans), A4=Alternative 4 (corn-soybeans-corn-soybeans-alfalfa/oats-alfalfa-alfalfa).

Table 3. Ten-Year Average Net Returns and Average Contaminant Loadings for Conventional and Alternative Cropping Systems, 1982-1991.

	Cropping System[a]				
10 years	C	A 1	A 2	A 3	A 4
Net Return ($/acre)					
Mean	-3.61	15.54	-42.71	14.61	24.14
Coefficient of Variation	-807.69	131.02	-33.60	111.46	125.02
Maximum	40.95	45.78	-18.80	39.88	73.87
Minimum	-53.32	-14.65	-59.59	-4.95	-24.72
Atrazine Runoff (oz/acre)					
Mean	0.08	0.04	0.02	0.00	0.00
Coefficient of Variation	73.64	140.11	182.96	.	.
Maximum	0.17	0.20	0.09	0.00	0.00
Minimum	0.00	0.00	0.00	0.00	0.00
N Runoff (lbs/acre)					
Mean	1.29	1.27	1.31	1.67	1.43
Coefficient of Variation	48.20	50.09	45.42	45.31	47.04
Maximum	2.43	2.37	0.09	2.99	2.64
Minimum	0.39	0.36	0.00	0.54	0.46
N Leachate (lbs/acre)					
Mean	3.58	5.57	5.57	5.88	4.26
Coefficient of Variation	51.37	64.97	64.97	35.82	36.38
Maximum	6.51	3.76	2.23	9.02	6.51
Minimum	0.68	0.30	0.35	1.97	1.29
Sediment Yield (ton/acre)					
Mean	5.21	3.32	1.97	2.03	2.94
Coefficient of Variation	50.92	49.63	50.33	48.84	52.41
Maximum	10.02	6.15	3.62	3.64	5.25
Minimum	1.40	0.81	0.49	0.55	0.80

[a]C=Conventional, A1=Alternative 1 (wheat/clover-sorghum-soybeans), A2=Alternative 2 (sorghum-wheat/vetch), A3=Alternative 3 (alfalfa/oats-alfalfa-alfalfa-wheat-soybeans), A4=Alternative 4 (corn-soybeans-corn-soybeans-alfalfa/oats-alfalfa-alfalfa).

Table 4. Five-Year Average Net Returns and Average Contaminant Loadings for Conventional and Alternative Cropping Systems, 1987-1991.

	Cropping System[a]				
5 years	C	A 1	A 2	A 3	A 4
Net Return ($/acre)					
Mean	-4.15	16.82	-39.83	10.97	19.21
Coefficient of Variation	-467.76	85.55	36.56	129.85	115.03
Maximum	24.40	34.44	-18.80	30.13	51.98
Minimum	-25.28	1.03	-59.59	-4.95	-4.94
Atrazine Runoff (oz/acre)					
Mean	0.06	0.02	0.00	0.00	0.00
Coefficient of Variation	95.19	61.02	93.98	.	.
Maximum	0.13	0.04	0.00	0.00	0.00
Minimum	0.00	0.00	0.00	0.00	0.00
N runoff (lbs/acre)					
Mean	0.84	0.84	0.86	1.13	0.95
Coefficient of Variation	46.75	51.05	50.69	40.24	47.06
Maximum	1.54	1.60	1.54	1.89	1.77
Minimum	0.39	0.36	0.35	0.54	0.46
N leachate (lbs/acre)					
Mean	1.99	2.68	2.68	4.37	3.07
Coefficient of Variation	46.91	75.81	75.81	35.55	36.35
Maximum	3.21	2.49	6.11	6.24	4.19
Minimum	0.68	0.30	0.35	1.97	1.29
Sediment Yield (ton/acre)					
Mean	3.52	2.32	1.85	1.41	2.05
Coefficient of Variation	50.40	51.90	52.60	49.09	59.87
Maximum	6.68	4.42	2.59	2.62	4.39
Minimum	1.40	0.81	0.49	0.55	0.80

[a]C=Conventional, A1=Alternative 1 (wheat/clover-sorghum-soybeans), A2=Alternative 2 (sorghum-wheat/vetch), A3=Alternative 3 (alfalfa/oats-alfalfa-alfalfa-wheat-soybeans), A4=Alternative 4 (corn-soybeans-corn-soybeans-alfalfa/oats-alfalfa-alfalfa).

a. Conventional cropping system; including corn-soybean (C-Sb), sorghum-soybean (Sg-Sb), wheat-sorghum (W-Sg), wheat-soybean(W-Sb), and continuous corn (C-C).

Corn (in C-Sb rotation) 125 acres	Sorghum (in Sg-Sb rotation) 70 acres	Wheat (in W-Sb rotation) 55 acres	Wheat (in W-Sg rotation) 55 acres	Corn (in C-C rot.) 30 acres
Soybeans (in C-Sb rotation) 125 acres	Soybeans (in Sg-Sb rotation) 70 acres	Soybeans (in W-Sb rotation) 55 acres	Wheat (in W-Sb rotation) 55 acres	

Corn:	155 acres
Soybeans:	250 acres
Sorghum:	125 acres
Wheat:	110 acres

b: Alternative cropping system 1: Wheat/Clover-Sorghum-Soybeans (W/Cv-Sg-Sb)

Wheat/Clover 213.3 acres	Sorghum 213.3 acres	Soybeans 213.3 acres

Wheat:	213.3 acres
Clover:	213.3 acres
Sorghum:	213.3 acres
Soybeans:	213.3 acres

c: Alternative cropping system 2: Sorghum-Wheat/Vetch (Sg-W/V)

Wheat/Vetch 320 acres	Sorghum 320 acres

Wheat:	320 acres
Vetch:	320 acres
Sorghum:	320 acres

d: Alternative cropping system 3: Alfalfa 3 years-Wheat-Soybeans (A1-A2-A3-W-Sb)

Wheat 128 acres	Soybeans 128 acres	Alfalfa/Oats 128 acres	Alfalfa (2nd year) 128 acres	Alfalfa (3rd year) 128 acres

Wheat:	128 acres
Soybeans:	128 acres
Alfalfa:	384 acres
Oats:	128 acres

e: Alternative cropping system 4: Corn-Soybeans-Corn-Soybeans-Alfalfa 3 years (C-Sb-C-Sb-A1-A2-A3)

Corn 183 acres	Alfalfa/ Oats 91 acres	Alfalfa (2nd year) 91 acres	Alfalfa (3rd year) 91 acres
Soybeans 183 acres			

Corn:	183 acres
Alfalfa:	273 acres
Oats:	91 acres
Soybeans:	183 acres

Figure 1. Conventional and alternative cropping systems for a Northeast Kansas representative farm.

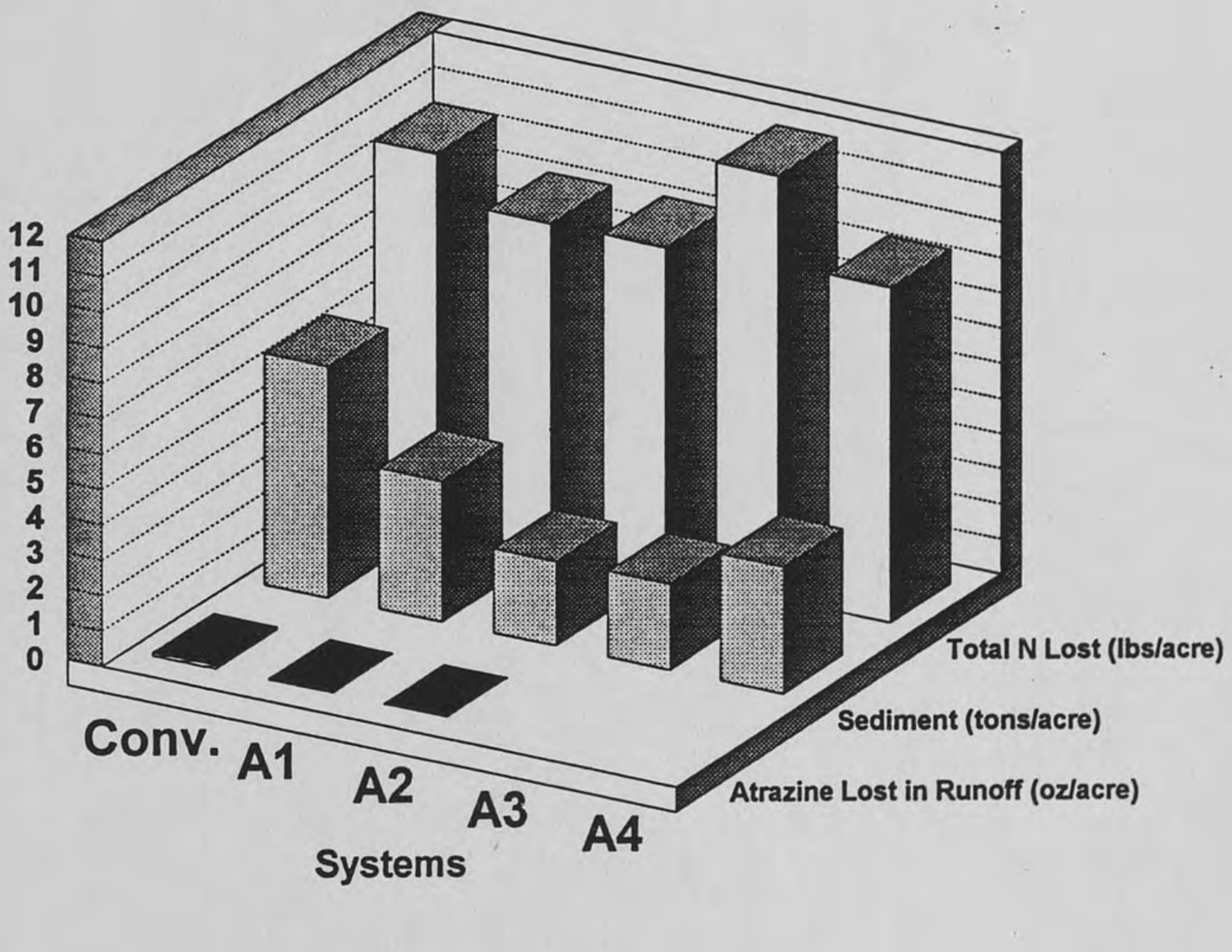

Figure 2. Twenty-Year Average Contamination Levels for Atrazine, Nitrogen, and Sediment under Conventional and Alternative Systems.

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