Studies of Agricultural Effects on Groundwater Quality In Kentucky

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Abstract

Several small watersheds and tiled fields have been selected in Kentucky to assess the influence of agricultural practices on groundwater quality. Sites were selected to represent the dominant agricultural systems used in the most agriculturally important areas of the state. Within each study site, water samples from springs, wells, streams, or tile lines are being sampled monthly to monitor content of NO_3-N, atrazine, alachlor, and fecal bacteria. Although sampling will continue for at least another year, results to date indicate little relationship between NO_3 content and N fertilizer use. In watersheds where atrazine and alachlor have been used, content in water sources sampled has been variable, and below the health advisory limit in most instances. However, in several instances we have observed increased atrazine levels immediately following corn planting, which subsequently drop to the background level within two months. We have found fecal bacterial contamination to be widespread in all but deep-well samples.

The Kentucky General Assembly passed and funded legislation in 1990, directing the University of Kentucky to assess the effects of agricultural practices on groundwater quality and to conduct research to develop management practices which may be needed to protect the state's groundwater resources. Since little information was available to determine if agricultural practices are affecting the state's groundwaters, a core planning group made up of soil scientists, weed scientists, entomologists, agricultural engineers, geologists, and a forester was appointed to develop such a program.

In considering the potential for agricultural groundwater degradation, it must be kept in mind that Kentucky has a very diverse physiography which largely determines the intensity of agricultural practices in any given area. Nearly half (47%) of the state is in forest cover and another 39% is used for pasture and hay production. Row crops, on which most of the fertilizers and agricultural chemicals are used, are grown on the remaining 14% of the land (see Table 1). Except for small acreages of vegetable and fruit crops in scattered localities, all the row crops are agronomic, with corn and soybeans making up nearly three-fourths of the total row crop acreage.

The greatest concerns about the potential for agricultural practices to affect groundwater quality are from use of nitrogen fertilizers, herbicides, insecticides, fungicides, and disposal of animal manures. Relative to the animal manure potential, the concern largely is for manure

disposal from confined animal enterprises. In Kentucky, this will mostly be hog farms and dairy farms even though there are a few local concentrations of poultry production. Although beef represents the largest type of animal production in Kentucky, nearly all beef animals, as is the case with horses, are kept in pasturefields, and their manure is widely dispersed over the 30 percent of Kentucky's landscape used for pastures.

Relative to nitrogen fertilizer use, most of the approximate 180,000 tons of nitrogen currently purchased annually by Kentucky farmers is used on corn, wheat, and tobacco, with lesser amounts used on grass hay and pastures. Although heavily fertilized with nitrogen, the relatively small acreage used for tobacco is rather widely dispersed across the state, usually in small fields. Corn and wheat production, together with soybeans, is mostly concentrated in the western third of Kentucky. Of the total pesticide use determined in 1989, about 89% was herbicides and 11% insecticides. And, 89% of all herbicides and insecticides used was on corn and soybeans (see Table 2).

We selected study sites in eight areas of the state where most of Kentucky's agricultural production occurs, to assess the impact of agricultural practices and underlying geology on groundwater content of nitrates, pesticides, and fecal coliform and streptocci bacteria. Water samples are being taken monthly from wells, springs, tile flow, and streams at these sites.

Sampling from the first sites selected was begun in October, 1990. Sites, sources, and dates sampled have collectively resulted in 535 observations as of September, 1991. These samples are being taken from 27 springs, 11 wells, 11 tiles and 13 streams.

Each site was selected to reflect local geology and prevalent agricultural practices. Row cropping, dairy, hogs and extensive cattle raising on pasture are all included in the watersheds. In each watershed or drainage area, most of the available sources of water that are influenced by ground water are being sampled. Characteristics of the study sites are shown in table 3.

Results of the sampling show that NO_3-N in springs averaged 4.9 ppm, in wells 5.0 ppm, in drain tiles 6.9 ppm and in streams the average was 2.5 ppm (figure 1). The herbicide atrazine was present in nearly all samples (figure 2) and averaged from 0.3 to 0.4 ppb with the exception of one well which was very high. It was considerably higher in tile flow after corn was planted from the two tiled fields sampled. Alachlor was more variable ranging from 0 in several samples to more than 2.0 ppb. Springs averaged 0.49 ppb, wells 0.12 ppb, tiles 1.14 ppb, and streams 0.80 ppb (figure 3).

Bacterial levels were very erratic but contamination was quite prevalent in all water sources except wells. Nearly all of the spring samples were contaminated by fecal coliform, fecal streptococci or both on most of the dates sampled. Of the wells, 31% of the samples taken showed contamination, as did 59% of the tile samples taken and 91% of the stream samples taken. Ratios of fecal coliform to fecal streptococci indicate that human waste contributed to contamination in several instances in springs, wells, and streams. None of the tiles showed evidence of human

nor domestic animal contamination. Although contamination of waters with NO_3-N, atrazine and alachlor was very commonly encountered, only a very few sites showed levels above health advisory limits. In general, a low level of contamination exists in the majority of ground and surface waters that have been sampled. These waters are taken directly from watersheds where agricultural activities are the primary land use and thus do not necessarily represent average statewide conditions. Sampling of these sites will be continued for at least 2 years before conclusions will be made.

Table 1. LAND USE PATTERNS IN KENTUCKY - 1990

LAND USE	Acres (millions)	Percent of Total Acres
Major row crops	3.5	14
Hay	2.2	9
Pasture	7.5	30
Forest	11.8	47
TOTAL	25.0	100

Table 2. MAJOR USE OF PESTICIDES IN KENTUCKY - 1989

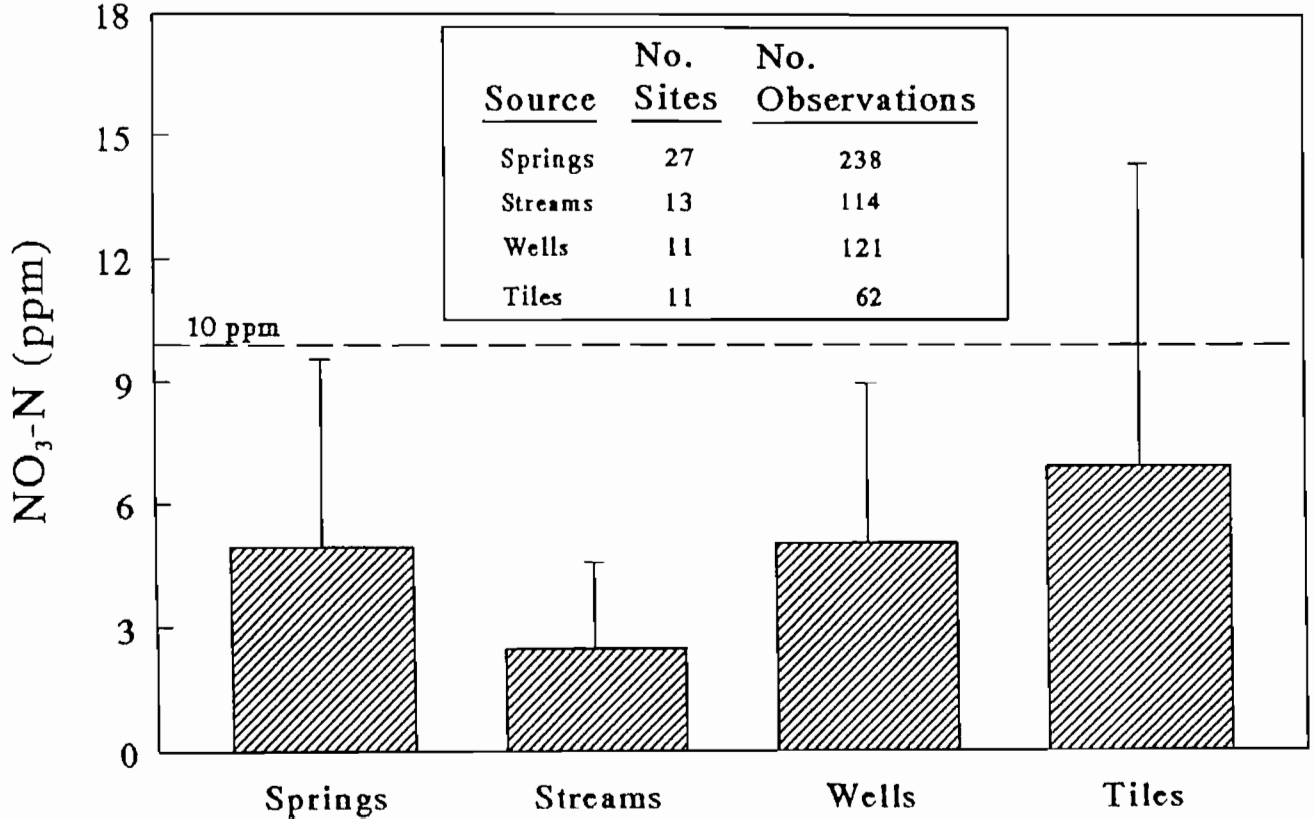
CROP	HERBICIDES		OTHER PESTICIDES[1/]	
	Lbs. A.I. (millions)	% of Total	Lbs. A.I. (millions)	% of Total
Corn	4.2	95	0.233	5
Soybeans	1.3	99.8	0.003	0.3
Tobacco	0.2	35	0.368	65
Alfalfa	0.007	7	0.093	93
Wheat	0.02	45	0.031	55
TOTAL	5.8	88.8	0.728	11.2

[1/] dominantly insecticides

Table 3. DESCRIPTION OF STUDY AREAS

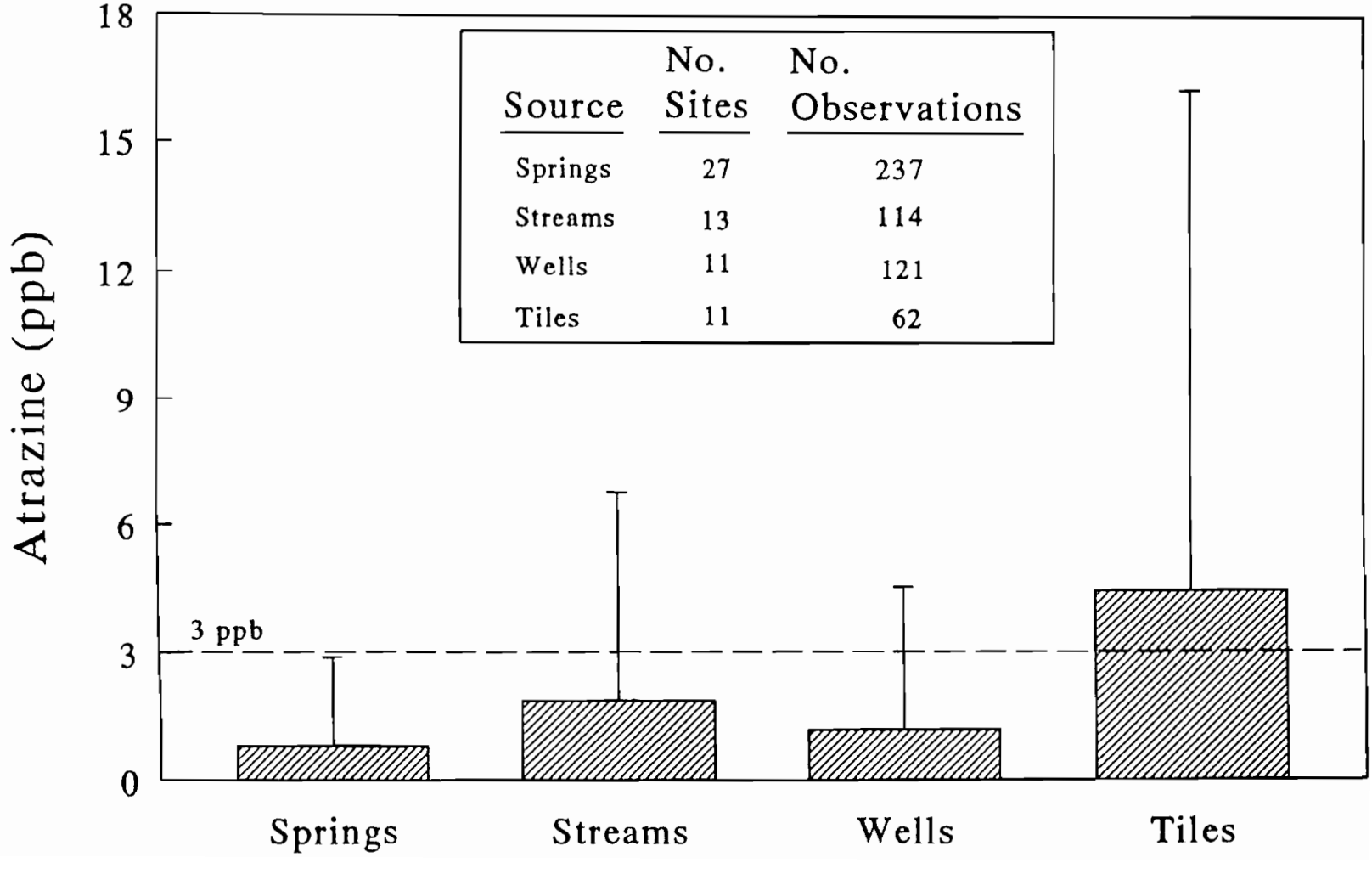
Resource Area	Size of Study Area	1991 Land Use						Animal Enterprises		
		%								
		Tobacco	Corn	Soybeans	Wheat	Hay/Pasture	Woods/Misc	Dairy	Beef	Hogs
	acres									
Purchase	737	--	19	61	(50)	11	9	--	--	X
Western Pennyrile	1154	--	55	31	(31)	7	7	X		X
Eastern Pennyrile	597	0.3	7.7	--	--	67	25	X	--	--
West. Coalfield Valleys	140	--	36	64	--	--	--	--	--	--
West. Coalfield Valleys	140	--	54	46	--	--	--	--	--	--
Outer Bluegrass	460	4	27	20	--	39	10	X	--	X
Outer Bluegrass	360	5	4	--	--	81	10	X	X	--
Inner Bluegrass	1143	3	8	11	--	74	4	--	X	--

Fig. 1. Average Content of Nitrate-Nitrogen



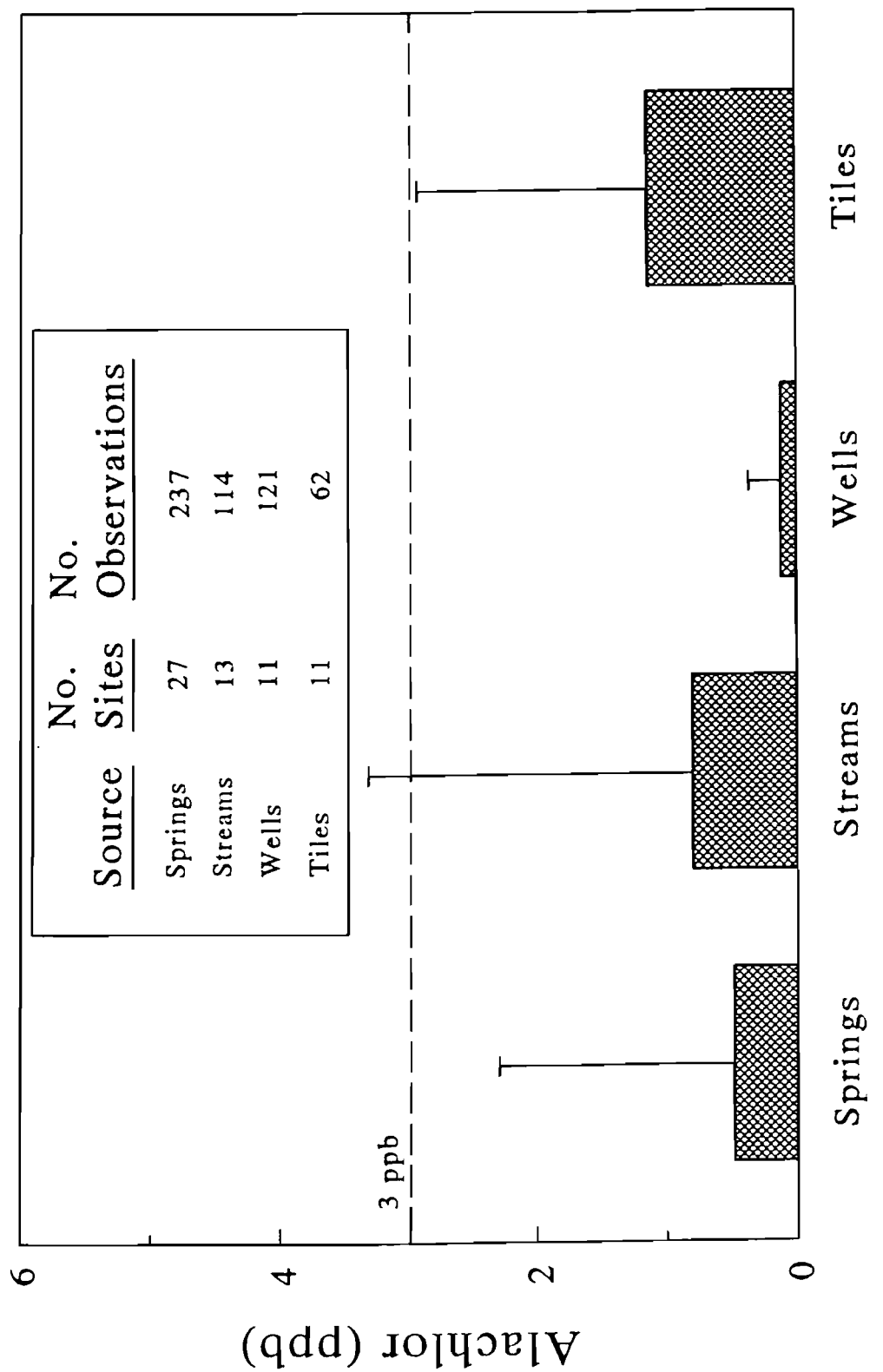
Source	No. Sites	No. Observations
Springs	27	238
Streams	13	114
Wells	11	121
Tiles	11	62

Fig. 2. Average Content of Atrazine



Source	No. Sites	No. Observations
Springs	27	237
Streams	13	114
Wells	11	121
Tiles	11	62

Fig. 3. Average Content of Alachlor



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