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Alfalfa Agrochemical Use Survey

Final Report

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Public concern over pesticide residue in food has increased dramatically in the past decade. Consumers are demanding assurances that their food supply is safe from contamination. It is this consumer concern that has forced agriculture to re-evaluate its use of agrochemicals. However, prior to evaluating use patterns, it's important to determine how much pesticide is actually being applied. Pesticide use surveys have been used in the past as a tool for developing this information. In this specific case, alfalfa is the crop that will be surveyed.

Objective

The objective of the study was to determine the number and amount of agrochemicals (specifically pesticides) that were applied to Arizona alfalfa in 1990.

Methodology

A one-page survey (front & back) was made available to 500 alfalfa growers in Arizona. (See appendix for survey form.) This survey was generated with the help of the Arizona Agricultural Statistics Service (AASS) in Phoenix. We requested information on how many acres were harvested in 1990; how many cuts were normal; average yield in tons/acre; what pests were encoun-

tered; what non-chemical methods of pest control, if any, were used; and if used, how did these alternative control measures affect yields.

We also asked them which county has the majority of their alfalfa acreage. As for the pesticides themselves, we asked for the brand name, formulation, EPA number, acres treated with product, acres never treated with product, rate per acre, number of time acres were treated, cost/acre, and method of application.

The confidential survey, requesting a voluntary response, was mailed out by AASS with a return envelope addressed to the Pesticide Coordinator's Office at the University of Arizona. Upon return, questionnaires were evaluated for completeness, and if necessary, contacts to responders were made.

Each questionnaire was entered into a LOTUS 1-2-3 file that had the following form. Columns were set up to hold over 20 variables to record answers to the survey.

The method used to identify a sample of individual farmers responding to the survey was a simple step in the process of reducing the data from the questionnaires to the data file. Since farmers used from one to several lines on the back of the questionnaire to report chemical applications, the variable LINE was created to keep track of each individual chemical application per farmer. Every respondent (whether or not he or she reported chemical use) had a value of 1 coded in the LINE field of the data file. For chemical users, chemical application information they reported on the first line of the questionnaire was entered along with the LINE variable coded as a 1. For non-users, the

line variable was coded as a 1 also, but zeroes were entered for all variables connected with chemical application. If farmers used more than just the first line of the back of the survey to report their chemical applications, each successive line's information was coded with a LINE variable [coded] according to the order in which the information was listed.

A different row in the LOTUS file was made for each LINE. If a farmer had more than 1 LINE of information in his response, two procedures were followed. First, a row was created to hold each additional line's pesticide application variables. Second, information from the front of the questionnaire for items such as YIELD, for example, was entered into the appropriate column for all LINEs representing that single farmer's response. Thus, each row in the LOTUS data file forms the pesticide applications sample. A unique farmer sample formed a subset of the pesticide applications sample for LINE = 1. If the two samples had not been separated, two problems would have occurred. Initially, it would be impossible to recover meaningful statistics for each unique respondent because farmers with more than 1 LINE would have their YIELD counted twice. The second problem which would have plagued the work had the samples not been separated relates to the usefulness of the chemical application data. Because each different LINE contains specific responses to chemical application questions, and because these application variables are not additive due to different units and chemicals, usable chemical application results require a sample composed differently than on a unique farmer basis.

Two sets of detailed statistical outputs are thus obtained. The first set, "Run on Unique Farmer Data" contains state-wide results for all variables in the SYSTAT statistical package data file constructed from survey responses prior to imputation for missing chemical-related responses. The second set, "Unique Farmer Statistics by County" is composed of individual county results constructed from the same data file.

Because the survey was also designed to measure details of agrochemical application, a special sub-sample of chemical treatments was created to permit estimation of state-wide pesticide applications. All questions concerning chemical application are based on a sample of 241 treatments reported by the 48 farmers who reported using chemicals at any time in 1990 on their alfalfa. Many farmers who used chemicals reported more than one treatment during 1990. The design of the questionnaire permitted us to capture these multiple applications of the same (or different) pesticides a special coding procedure. The responses of both chemical users and non-users are then used to provide estimates of the total amounts of various chemicals applied on alfalfa in Arizona in 1990.

Results and Discussions

A total of 109 usable surveys were returned. Not all individual questions within the 109 responses could be used. The sample size of 109 refers to the number of different farmers who

responded to the survey and does not reflect the sample size for the chemical application results.

Survey Question #1: ACRES OF ALFALFA HARVESTED IN 1990 (TOTAC)

The sum of the TOTAC variable gives the total number of acres planted to alfalfa by survey respondents in 1990. This was 24,609.4 acres. The 1990 published estimate of harvested acres of alfalfa in Arizona for 1990 by the Arizona Agricultural Statistics Service is 165,000, thus the sample contains approximately 14.9% of all of the state's alfalfa hay acreage.

State-wide, the 109 respondent answers ranged from a minimum of 3 acres to a maximum of 1,550 acres of alfalfa harvested in 1990. The mean acreage was 225.8 per farm, with a median of 239.0. This would indicate a larger number reported of smaller acreage farms.

Survey Question #2: CUTTINGS IN A NORMAL YEAR (CUTS)

Responses to this question were tabulated under the variable CUTS. In some cases, where a farmer gave a range of cuttings in a normal year, the midpoint of the range was used to represent CUTS. The number of cuttings reported state-wide in an average year ranged from 0 to 10. The mean number across Arizona was 6.4, and the median was 8 (N=107).

Table 1, which represents the number of cuts/county, would indicate that the counties in the lower elevations (i.e. Maricopa, Pinal, Yuma) used chemicals and had more cuts/year, than non-users of agrochemicals in the higher elevation counties. One needs to recognize that a relatively small sample was obtained in some counties.

County	Elevation (County Extension Office)	Mean Cuts Per County (Users only)	Mean Cuts Per County (Non-users only)	Mean Cuts Per County (all sample)
APACHE	5725	No users	2.5	2.5
COCHISE	4167	No users	5.22	5.22
COCONINO	6879	No users	1.75	1.75
GILA	3509	No users	6.0	6.0
GRAHAM	2970	5.67	5.71	5.67
GREENLEE	3466	No response	No response	No response
LA PAZ	420	7.87	7.0	7.75
MARICOPA	1082	7.72	7.92	7.82
MOHAVE	3340	7.5	2.0	4.75
NAVAJO	5062	4.0	3.38	3.46
PIMA	2386	No users	7.5	7.5
PINAL	1398	8.0	6.43	6.8
SANTA CRUZ	3865	No users	5.0	5.0
YAVAPAI	5355	No response	No response	No response
YUMA	137	8.59	6.15	7.72
ARIZONA		7.24	5.32	6.4

Note: Cuts per county are average per farmer responding and are not weighted by harvested acres or size of operation.

Survey Question #3: AVERAGE YIELD PER ACRE IN 1990 (YIELD)

A total of 104 farmers reported their average yield per acre in tons per acre. The range of yields for growers responding throughout the Grand Canyon state was a minimum of 0 to a maximum of 16. The mean average yield per acre was 6.8 with a median of 8.

Survey Question #5: COUNTY REPRESENTATION IN SAMPLE

Unique farmers (109) listed by county along with the percentage of the state-wide sample are represented in the table below. The Arizona Agricultural Statistics Service three-digit code for each Arizona county appears in parentheses after the county names listed below. Almost half of the farmers responding were in either Maricopa or Yuma county, with over 60% of the reported acreage in the survey from the same two counties.

TABLE 2: COUNTY REPRESENTATION IN SAMPLE FOR 1990 ALFALFA AGROCHEMICAL SURVEY

County & (Code)	No. of Responses	% of Total Farms	Acres Reported	% Total Sample Acres
APACHE (001)	7	6.42	816.0	3.32
COCHISE (003)	9	8.26	1570.0	6.38
COCONINO (005)	2	1.84	14.0	0.06
GILA (007)	1	0.92	25.0	0.10
GRAHAM (009)	9	8.26	546.0	2.22

GREENLEE (011)	0	0.00	0.0	0.00
LA PAZ (012)	6	5.51	1837.0	7.47
MARICOPA (013)	27	27.75	7293.8	29.63
MOHAVE (015)	2	1.84	1540.0	6.26
NAVAJO (017)	7	6.42	198.0	0.80
PIMA (019)	4	3.67	157.0	0.64
PINAL (021)	10	9.17	2605.6	10.59
SANTA CRUZ (023)	1	0.92	30.0	0.12
YAVAPAI (025)	0	0.00	0.0	0.00
YUMA (027)	24	22.02	7977.0	32.41
TOTALS (15 COUNTIES)	109	100.00	24609.4	100.00

A comparison was conducted between our sample and the Arizona Agricultural Statistics Service estimates for 1990 (Table 3). The comparisons show that La Paz county seems under-represented in the sample since it represents only 7.5% of acres reported in the survey, but contains 25.4% of all alfalfa acres in the state according to AASS. No questionnaires were returned from either Yavapai or Greenlee county. Pinal county and Yuma county may be somewhat over-represented in the sample since their acres reported in the survey exceed AASS estimated acreage. Because the survey was randomized on a per-farmer basis and because it was a mail-in instrument, such results are not surprising, nor disconcerting. If future surveys are field enumerated, sample representation of the entire state's alfalfa sector could be targeted in more closely and stratified sampling techniques could be used. Field enumeration would also be of consid-

erable help in eliciting more accurate farmer responses to technical questions concerning chemical use and application.

TABLE 3: COUNTY REPRESENTATION FOR 1990 ALFALFA AGROCHEMICAL USE SURVEY--COMPARED TO 1990 AASS ESTIMATES SURVEY

County & (Code)	Acres Reported	AASS Acres Est. for 90	Sample % based on AASS	County AASS % of total re-ported
APACHE (001)	816.0	3000	27.2	1.8
COCHISE (003)	1570.0	7000	22.4	4.2
COCONINO (005)	14.0	*	*.*	*.*
GILA (007)	25.0	*	*.*	*.*
GRAHAM (009)	546.0	4000	13.7	2.4
GREENLEE (011)	0.0	*	0.0	*.*
LA PAZ (012)	1837.0	42000	7.5	25.4
MARICOPA (013)	7293.8	48000	15.2	29.1
MOHAVE (015)	1540.0	7500	20.5	4.6
NAVAJO (017)	198.0	2000	9.9	1.2
PIMA (019)	157.0	1800	8.7	1.1
PINAL (021)	2605.6	11000	23.7	6.7
SANTA CRUZ (023)	30.0	500	6.0	0.3
YAVAPAI (025)	0.0	2000	0.0	1.2
YUMA (027)	7977.0	35000	22.8	21.2
OTHER (*)	39.0	1303.5	3.0	0.8
ARIZONA TOTAL	24609.4	165000	14.9	100.0

* -- denotes counties where AASS cannot report separate county estimates because of federal disclosure requirements.

CHEMICAL USE AND NON-USE:

Survey results from the 109 farmers who returned questionnaires are useful in that they provide information about whether or not they used pesticides. Fifty-nine farmers, (55.1% of the 107 answering) reported using no chemicals in 1990 on their alfalfa. These farmers indicated that a total of 6,075 acres, or 25.64% of all acres reported to have been harvested in 1990 by the surveyed farmers did not receive agrochemicals. In addition, of the 13 counties from which surveys were returned, no chemical use was reported from six counties: Apache, Cochise, Coconino, Gila, Pima, and Santa Cruz.

Results of the Alfalfa Agrochemical Use Survey are presented in Tables 4 - 6. Of the pesticide treatments reported, insecticides (60.5%) and herbicides (36.5%), made up the majority, with adjuvants and others making up only 3% of the total. There were no fungicides or nematicides reported. Only pesticides that appeared on three or more forms were reported on Tables 4 - 6. The greatest amounts reported were insecticidal use, with Furadan, Lannate and Lorsban averaging 25 farms or 23% of the total reported treatments.

In Table 4, the estimated total treated acres for Arizona ranged from less than 1% (BT) to over 24% (Lorsban) use reported. The Arizona Agricultural Statistics Service estimated that we had 165,000 acres of alfalfa in Arizona in 1990. Thus, using our percent treated, we generated a column estimating the acres treated/chemical followed by a percent of acres treated (column #3). Average area applied per treatment on farms (acre treat-

ed/total harvested) ranged from 85.6 (methyl parathion) to a low of 44.1% (BT). This indicates once used, it was used throughout most or that percentage of the total acreage on the farm.

In Table 5, in the treated alfalfa the range in numbers of cuts (7.7 to 7.3), yield (9.3 to 7.7) tons and acres harvested (667 to 120) was greater than the untreated alfalfa in all three categories; cuts (5.3), yield (5.3), and harvested acres (1029). In a majority of the cases of cuts, yield, and harvested acres, a significant difference (.05) was obtained between untreated and use of a pesticide. In some cases, the harvested acres gave no significant differences even though the value would appear to be significant. This was due to the small sample size. These results again support the probability that a majority of the untreated alfalfa came from the higher elevation counties (see Table 1). The mean total acres (last two columns) shows the number treated and untreated by each chemical. In all cases but two (BT and Phosdrin) the individual pesticide treatments were greater than untreated. It also indicates that not every acre on all the farms received a pesticide treatment. A management decision (i.e. scouting) was rendered to treat or not.

The rate per acre and the mean number of times each chemical was used is presented in Table 6. The rate in almost all cases was below label rate, with the mean number of times used almost always below two applications per 12 months. The cost per acre of application ranged from $5.58 to $29.23, which indicates a 5X spread in the cost per acre. Some insecticides cost less than all the herbicides reported. The total chemical load to environ-

ment to all farms reporting in 1990 is represented in total amount applied. Eptam was, by far, the chemical most applied to the soil. A majority of the applications were done by aerial applications (see Fig. 1). It appears aerial applications were cheaper, allowed easier access along with quicker response time, and allowed for less soil compaction.

In summary, we were able to sample approximately 15% of the total alfalfa acres in Arizona for 1990. Almost half of the farmers responding were either in Maricopa or Yuma county, with over 60% of the reported acreage in the survey from the same two counties. Of the 109 useable responses, 55% reported using no chemicals for a total of over 6,000 acres. Of the pesticide treatments reported, insecticides (60.5%) and herbicides (36.5%) made up the majority, with no fungicides or nematicides reported. The estimated total treated acres for Arizona ranged from less than 1% (BT) to over 24% (Lorsban use reported). Significant differences were obtained in number of cuts, yield and in some cases acres harvested of pesticide use compared to untreated fields. Insecticides (55%) and herbicides (44%) made up the significant pesticide load to the environment. It appears that in almost all cases, rates were below label rate, with just under two applications per year. As for method of application, aerial application represented nearly 80% of the total method of application reported.

Table 4. 1990 Agrochemicals use reported on Arizona alfalfa compared with Arizona Agricultural Statistics Service's estimations of use.

Chemical Name	No. of Farms[3]	% of Farms in Sample	Total Treated Acres (%)[4]	AZ Ag. Statistics Service[1]		Avg. Area Applied per treat-ment[2]
				State Est. Acres Treated	State % Acres Treated	% of Sample Farms
Untreated	59	25.7	6075	42313	25.6	0.0
Diazinon	9	3.9	868.2	6047	3.7	81.6
Dimethoate	11	4.8	4336	30202	18.3	72.8
Furadan	25	10.9	4298	29241	17.7	56.7
Lannate	23	10.0	5598	38995	23.6	70.2
Lorsban	27	11.7	5744	40008	24.3	51.9
Malathion	16	7.0	3594	25033	15.2	82.1
Methyl Parathion	4	1.7	1970	13724	8.32	85.6
BT	3	1.3	219	1531	0.9	44.1
Phosdrin	3	1.3	352	2458	1.5	55.8
Pounce	10	4.3	2444	17027	10.3	86.3
Adjuvants	3	1.3	95	665	N/A	66.7
Other Insecticides	6	2.6	2138	14895	9.0	82.3

Estimated acres treated derived by state, taking the average percent of harvested acres treated per treatment or each chemical, multiplied by 165,000 (AASS estimated acres of alfalfa harvested in 1990). Percentages dd to more than 100% due to use of more than one chemical on some farms.

Average percent of all harvested acres treated in a given treatment per farm.

Number of farms exceeds 109 due to use of more than one chemical on some farms.

Eptam	7	3.0	2051	14292	8.7	80.5
Roundup	3	1.3	253	1767	1.1	52.7
Treflan	14	6.1	4218	29384	17.8	81.6
Other Herbicides	5	2.2	630	4392	2.7	65.1

Table 5. Mean cuts, yield, acres harvested (treated and untreated) as reported on 1990 agrochemical alfalfa survey.

				Mean Total Acres per Treatment	
Chemical Name	Mean Number of Cuts	Mean Yield (Tons)	Mean Total Acres Harvested	Treated	Untreated
Untreated	5.3	5.3	102.9	0.0	102.9
Diazinon	7.3*	8.9**	223.7	160.7	63.0
Dimethoate	8.2**	8.3*	604.0*	537.5	66.5
Furadan	7.6*	8.8**	353.6**	199.0	154.6
Lannate	8.0**	8.7**	527.5**	410.7	116.8
Lorsban	7.9**	8.7**	431.9*	262.2	169.7
Malathion	8.1**	8.1*	595.7**	471.7	124.0
Methyl Parathion	8.7**	9.3*	667.5	615.7	51.8
BT	8.0	8.5*	445.3	97.6	347.7
Phosdrin	8.3*	9.1*	358.3	156.8	201.5
Pounce	7.7*	8.1*	457.9	388.9	69.0
Adjuvants	7.6	7.0	120.0	63.6	56.7
Other Insecticides	8.1**	8.2	455.8	415.8	30.0
Eptam	8.0**	8.9**	528.6	476.3	52.3
Roundup	7.8*	8.6*	237.7	148.0	89.7
Treflan	8.1**	8.8**	372.1**	322.8	49.3
Other Herbicides	7.8*	7.7	347.0	168.2	178.8

** -- Significantly different from untreated mean for column variable at 99% confidence level.
* -- Significantly different from untreated mean for column variable at 95% confidence level.

Two different significance tests were used to compare the chemical treatment means with the untreated means. The most conservative result is reported. The test statistics used in each test and their distributions may be found in CRC Standard Probability and Statistics, 1991; page 25.

Table 6. Various values collected from the 1990 Arizona Agrochemical Alfalfa Survey.

Chemical Name	Cost per Acre	Applications (times/yr)	Rate per Application (lbs/acre)	Rate per Crop Year (lbs/acre)	Est. Total Applied (1,000/lbs)
Untreated	0.0	0.0	0.0	0.0	0.0
Diazinon	8.79	1.7	.4443	.7715	4.7
Dimethoate	7.70	1.4	.3675	.5097	15.4
Furadan	7.19	1.2	.3124	.3721	10.9
Lannate	14.05	1.7	.5194	.8879	34.2
Lorsban	9.14	1.3	.5408	.6844	27.4
Malathion	10.49	2.1	1.0249	2.1230	53.3
Methyl Parathion	5.58	1.0	.1970	.2073	2.8
BT	10.10	1.8	.6667	1.1666	1.8
Phosdrin	21.41	1.3	.3889	.6388	1.6
Pounce	23.63	1.4	.1183	.1701	2.9
Adjuvants	10.59	N/A	N/A	N/A	N/A
Other Insecticides	14.19	1.2	N/A	N/A	N/A
Eptam	12.08	1.6	2.5764	4.2369	60.6
Roundup	16.76	1.7	.8123	1.3745	2.4
Treflan	21.08	1.1	1.9917	2.1339	62.7
Other Herbicides	29.23	1.3	N/A	N/A	N/A