The Connecticut Agricultural Experiment Station, New Haven

Uses of Pesticides in Connecticut

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Concern over contamination of ground water with toxic chemicals has focused attention on the widespread use of pesticides. Although agriculture is the largest user nationwide, pesticides are also used on home lawns, parks and golf courses, for control of insects in and around homes and other buildings, and for control of weeds and brush along roadsides and other rights-of-way. Substantial amounts are also used as wood preservatives and disinfectants.

In Connecticut, the soil fumigant ethylene dibromide (EDB) was found in wells in the upper Connecticut River Valley in the fall of 1983. This caused the Station to investigate the major ground water aquifers in Connecticut tapped by public utilities (Frink and Hankin, 1986). Although no widespread contamination was revealed, the experience with EDB prompted further investigations to determine if contamination with other pesticides may occur.

Following the recommendations of the Governor's Pesticide Task Force, Special Act 86-44 was enacted by the Connecticut General Assembly which specified that:

> "The Commissioner of Environmental Protection, in consultation with the United States Geological Survey and The Connecticut Agricultural Experiment Station, shall conduct a study of pesticide pollution of the ground waters of the state. In conducting the study the Commissioner shall: (1) inventory usage of pesticides with the potential to contaminate ground water; (2) identify soil and hydrogeologic conditions susceptible to contamination with pesticides, and (3) conduct ground water sampling of pesticides at areas found to be most susceptible to contamination because of soil and hydrogeologic conditions."

The first step is a thorough inventory of both agricultural and non-agricultural uses of pesticides in the state, including amounts and acreages treated. The inventory, which is the subject of this report, is intended to serve as the basis for sampling wells where pesticides are used. It should also aid in the search for strategies to decrease pesticide use (Waggoner, 1986).

METHODS

Inventorying agricultural uses of pesticides in Connecticut seems deceptively simple: one can ask farmers how much they use, ask advisors how much they recommend that farmers use, or ask the pesticide companies how much the farmers buy.

Records of use by farmers in Connecticut can be found in the periodic U.S. Census of Agriculture. However, the information is limited to acreages treated by type of pesticide, rather than by crop, and to dollars spent by type of farm. Thus, additional information on rates of application and costs of pesticides must be obtained.

Summaries of amounts of pesticides recommended by various advisors for use on some major crops in the United States are available. However, amounts used on minor crops are less well known. Attempts to develop such estimates for Connecticut were less than satisfactory as will be seen.

Records of sales of restricted use pesticides

are maintained by the Department of Environmental Protection, but this includes only part of the total used in Connecticut. More information on agricultural sales and uses is available at the national level, and an analysis was first made of the national data to prorate uses to Connecticut where possible. Some information on non-agricultural sales and uses was also obtained. The sources of data and the types of analyses used are described in more detail in the sections that follow.

AGRICULTURAL USES NATIONWIDE

An accurate inventory of pesticide use in the United States is difficult to obtain. The U.S. Department of Agriculture (USDA) collects voluminous data on the agricultural sector of the economy, but only one of the 732 tables in the annual Agricultural Statistics (U.S. Department of Agriculture, 1986a) deals with production and foreign trade in pesticides. Similarly, the U.S. Department of Commerce (USDC) has maintained records since 1878, but only one of the nearly 1500 tables in the Statistical Abstract of the United States (U.S. Department of Commerce, 1987) contains information about production and sales of pesticides. The Office of Pesticide Programs in the U.S. Environmental Protection Agency (EPA) records production as well as agricultural and non-agricultural uses of pesticides, using various sources including access to unpublished proprietary information (U.S. Environmental Protection Agency, 1986). Data from all these agencies are gathered in Table 1 to delineate pesticide use in the nation.

Comparison of these production data from USDA and USDC with the unpublished estimates of uses of pesticides from EPA reveals some discrepancies. For example, pesticides used on major crops including corn, cotton, grain sorghum, and soybeans averaged about 475 million lb during 1982-85, which represents about 80% of all pesticides used in agriculture (U.S.

TABLE 1--PRODUCTION, TRADE AND USE OF PESTICIDES IN THE UNITED STATES AS ESTIMATED BY VARIOUS AGENCIES.

	USDC	USDA				EPA	
Year	Production[1]	Production[2]	Exports[2]	Imports[2]	Use[3]	Total Use[4]	Agr. Use[4]
	million lb						
1977	1388	1448	602	2	848	1075	720
1978	1416	1487	671	2	818	1110	780
1979	1429	1506	670	2	838	1150	840
1980	1468	1537	647	2	892	1175	846
1981	1430	1509	521	1	989	1205	860
1982	1113	1184	508	1	677	1100	880
1983	1017	1099	499	2	602	953	733
1984	1189	1264	606	2	660	1080	850
1985	NA	NA	NA	NA	NA	1112	861

1. Table 337, Statistical Abstract of the United States (U.S. Department of Commerce, 1987.
2. Table 593, Agricultural Statistics (U.S. Department of Agriculture, 1986a).
3. Production less exports plus imports from Table 593, Agricultural Statistics and is assumed to be use.
4. Pesticide use in the United States (U.S. Environmental Protection Agency, 1986). Excludes wood preservatives, disinfectants and sulfur.

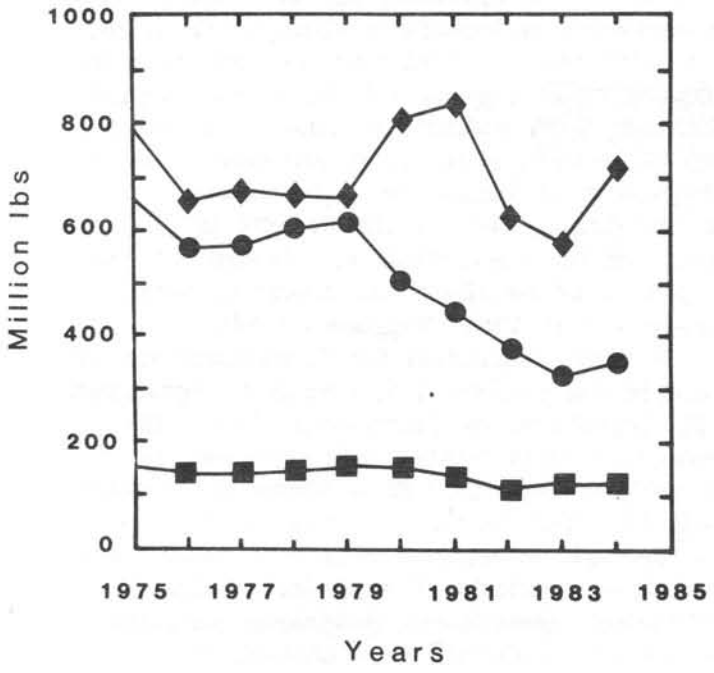

FIGURE 1—Production of herbicides (diamonds), insecticides (circles) and fungicides (squares).

Department of Agriculture, 1986b). This implies a total of about 600 million lb for agricultural uses alone. Recently, L.P. Gianessi of Resources For the Future (Conservation Foundation, 1987) estimated agricultural use nationwide to be 660 million lb in 1985, in reasonable agreement with the uses estimated by USDA for 1984. However, agricultural uses estimated by EPA averaged a relatively constant 830 million lb for 1982-85.

The data in Table 1 also reveal different trends in the use of pesticides with time. Data from Statistical Abstract and Agricultural Statistics generally show a decrease with time, while the EPA data show little change. The amounts of herbicides, insecticides, and fungicides produced during 1975-85, from Statistical Abstract, are shown in Figure 1.

The amounts of insecticides produced have decreased steadily, while the amounts of herbicides and especially fungicides have remained constant. The decline in quantity of insecticides produced during 1976-82 is attributed primarily to the introduction of synthetic pyrethroids which are applied at about 10% the rate of older materials (U.S. Department of Agriculture, 1986b). The relative prices of the three classes of compounds have changed considerably with time. According to the U.S. Department of Agriculture (1986b), herbicide prices have declined while insecticide prices have increased over the last five years. Thus, the apparent cost of the individual components cannot be calculated from these data alone.

OTHER USES NATIONWIDE

Another striking feature of Table 1 is that although the agricultural use estimated by EPA

TABLE 2—ESTIMATES OF PRODUCTION AND USE OF PESTICIDES, 1985 (U.S. ENVIRONMENTAL PROTECTION AGENCY, 1986).

	Use		Value of purchase		
	million lb	%	million $	%	$/lb
U.S. Active Ingredient[1]	1110	100	6600	100	5.94
Agricultural Use Share	855	77	4620	70	5.40
Ind./Comm./Govt. Share	178	16	1056	16	5.93
Home & Garden Share	78	7	924	14	11.85

1. Production 1400 million lb, exports 400 million lb, imports 100 million lb. Excludes 1,000 million lb wood preservatives, 300 million lb disinfectants, and 200 million lb sulfur.

for 1982-85 is about 190 million lb greater than is suggested by USDA or USDC production data, about 230 million lb are used outside agriculture. This difference becomes even larger if Gianessi's estimate for agricultural use of 660 million lb is correct. A more detailed estimate by EPA of uses of pesticides in 1985 is shown in Table 2 along with the calculated cost per pound. Specific uses by class of chemical are shown in Appendix Tables I and II. These data make it clear that considerable quantities of pesticides are used outside agriculture.

In summary, some large discrepancies in the amounts of pesticides used nationwide are evident in comparisons of data obtained from USDA, USDC, and EPA. Some discrepancies could be attributed to the fact that USDA tends to survey use, while EPA surveys sales. However, EPA also has access to proprietary information from manufacturers on use as well as sales and the two would be expected to balance. Lacking any better national information at present, I now examine uses of pesticides in Connecticut.

AGRICULTURAL USES IN CONNECTICUT

A first approximation of agricultural uses of pesticides in Connecticut can be obtained by prorating the total amounts used nationwide by the amount of cropland or by the cash value of agriculture in Connecticut relative to the United States as a whole. Connecticut's farmland is 0.0475% of U.S. farmland, but the cash value of Connecticut's agriculture is about 0.21% of the nationwide value. Combining the two measures produces an average of 0.128%, which, coupled with the USDA estimate of about 600 million lb used nationwide, provides an estimate of use in Connecticut of 768,000 lb. This is not unreasonable in view of the 664,000 lb calculated for Connecticut by Gianessi[1] or the 216,000 lb of restricted use chemicals sold in Connecticut in 1984 (Waggoner, 1986).

Detailed information for Connecticut can be found in the periodic U.S. Census of Agriculture (U.S. Department of Commerce, 1982). The acreage of crops treated with chemicals in Connecticut from 1959-82 is shown in Appendix Table III. The census questionnaire stipulated that acreage be reported only once regardless of how many chemicals of a particular class (i.e., insecticides, nematicides, fungicides, herbicides and growth regulators) were applied.

Thus, further information on costs, rates and frequency of application is needed in order to determine amounts used. The average cost per pound of specific classes of chemicals can be calculated from the EPA data for 1985 in Appendix Tables I and II: herbicides ($5.52/lb), insecticides ($4.89/lb), fungicides ($6.18/lb), and other ($5.00/lb), with an overall average of $5.36/lb. According to the 1982 Census of Agriculture, farmers in Connecticut spent $3,365,000 on pesticides, which at $5.36/lb is 628,000 lb. This matches estimates by Gianessi.

TABLE 3--COST AND ACRES OF FARMLAND TREATED WITH PESTICIDES IN CONNECTICUT, 1982 (U.S. DEPARTMENT OF COMMERCE, 1982).

		Acres Treated		
Farm	Dollars	Herbicides	Insecticides	Fungicides
Livestock	1,045,000	47,243	23,790	2,904
Hort Spec	738,000	3,083	6,088	1,761
Fruits and Nuts	600,000	3,465	4,468	3,998
Tobacco	469,000	841	3,589	1,471
Veg and Melons	295,000	3,131	3,980	1,880
Other crop farms	209,000	6,270	6,314	1,556
Total	$3,356,000	64,033	48,229	13,570

A more detailed account of expenditures for agricultural chemicals and acres of cropland treated with pesticides in Connecticut is contained in Table 50 of the 1982 Census of Agriculture. Because uses of pesticides are listed by standard industrial class of farm, rather than by crop, rearrangement of the data was required. In particular, acres treated with nematicides were combined with insecticides, and growth regulators were included with herbicides. Cash grain farms were combined with "other field crops" and with "crop farms". All animal farming activities (except poultry) were combined under the heading "livestock". The data are summarized in Table 3.

Given the EPA estimates of the cost per pound of herbicides, insecticides and fungicides, I attempted to determine the average rate of application in lb per acre for each of the three classes of compounds using multiple regression analyses with acres treated as the independent variates and cost as the dependent variate. The high degree of correlation between the independent variates prevented any meaningful analysis. If the rates of application are assumed to be the same, the equation is:

$$\$3{,}356{,}000 = 64{,}033 \text{ acres} \times \$5.52/\text{lb} \times \text{lb/acre} + 48{,}229 \text{ acres} \times \$4.89/\text{lb} \times \text{lb/acre} + 13{,}570 \text{ acres} \times \$6.18/\text{lb} \times \text{lb/acre}$$

This yields an average rate of application of about 5 lb/acre. If 125,832 acres were treated, the total is 629,000 lb.

In a separate exercise, my colleagues G.S. Taylor and J.F. Ahrens used recommendations by the Cooperative Extension Service in Connecticut and elsewhere in the region for applications of specific pesticides to the major crops in Connecticut. They estimated the percentage of acres treated, and the rates of application, including the number of times the application might be repeated. A summary of their data produced the following estimates of the pounds of pesticides that might be used in Connecticut:

Herbicides	510,000
Insecticides	1,085,000
Fungicides	686,000
Total	2,281,000

This is nearly four times the estimate from the U.S. Census Data or from that of Gianessi and suggests that farmers use pesticides at a much lower rate than calculated from recommendations by their advisors.

Hence, after examination of all available data, I conclude that about 660,000 pounds of pesticides were applied to 126,000 acres of agricultural land in Connecticut in 1982 at a cost of $3,365,000 (Table 4).

TABLE 4--ESTIMATED COSTS AND USES OF PESTICIDES (ACTIVE INGREDIENT BASIS) IN CONNECTICUT.

	lb AI	Acres	$/lb	$
Agricultural	660,000	126,000	5.36	3,365,000
Home & Garden	530,000	106,000	11.85	6,300,000
Ind./Comm./Govt.				
Commercial urban	177,000	35,000	11.85	2,100,000
State highways	3,250	1,625	4.35	14,000
Utility right-of-way	6,900	2,500	4.35	30,000
Golf courses	97,000	15,000	5.82	565,000
Railroads	16,000	2,300	4.35	70,000
Total	300,150	56,425	---	2,779,000
Insecticides in buildings	530,000	---	11.85	6,300,000
Total	2,020,150	288,425		18,744,000

OTHER USES IN CONNECTICUT

According to estimates by EPA of other uses of pesticides nationwide (Table 2), homes and gardens used about 7% of the total in 1985 or 78 million lb of pesticides at a cost of about $924 million. This can be prorated to Connecticut by housing units. There were about 80,390,000 occupied housing units in the U.S. in 1980, and 1,094,000 of them were in Connecticut (U.S. Department of Commerce, 1987). Accordingly, home and garden uses of pesticides in Connecticut amount to about 1,060,000 lb at an apparent cost of $12.6 million or $11.86/lb. However, not all of these pesticides are applied outdoors: A recent report in Chemical and Engineering News[2] indicates that insecticides used in and around the house cost about $500 million nationwide in 1985 and represent a major portion of the home and garden market. Lacking more quantitative information, I estimate that half the pesticides, or 530,000 lb, are applied outdoors by Connecticut homeowners at a cost of $6.3 million. At the calculated average agricultural rate of 5 lb/acre, this implies treatment of 106,000 acres of lawns and gardens by homeowners.

Although the amounts of pesticides used by homeowners were prorated on the basis of total housing units, the number of homeowners using pesticides can be better estimated from additional data on the characteristics of Connecticut households. According to the Connecticut Department of Housing (1985), 60% of the housing units in 1980 were detached single family homes. About 44% of the households in the Northeast have some form of vegetable or flower garden, and 58% reported some lawn care activity (U.S. Department of Commerce, 1987). Thus, about half of the total or 547,000 homeowners tend lawns and gardens in Connecticut, which corresponds to about 0.2 acres per dwelling. The Professional Lawn Care Association of America estimates that about 25% of these homes or 136,750 use a professional lawn care service (New England Interstate Water Pollution Control Commission, 1987). Thus, 75% or 410,250 homeowners on 106,000 acres apply 530,000 lb of pesticides at a cost of $6,300,000. If the lawn care services apply pesticides to lawns of 136,750 homeowners on 35,000 acres at the same rate, the amounts would be 177,000 lb at a cost for the pesticides of $2,100,000. Gianessi obtained estimates from EPA of uses of a number of pesticides by urban applicators totaling 112,750 lb so that these two estimates of professional lawn care seem reasonable.

The industry/commercial/government share of the market in Connecticut includes uses for maintenance of railroads and roadsides, utility transmission rights-of-way, golf courses, and control of pests in buildings (wood preservatives and disinfectants are excluded). It also includes pesticides used by commercial urban applicators as discussed above. Prorating the amounts based on the area of Connecticut relative to the United States provides a first approximation of 244,000 lb of pesticide costing $1.4 million.

The Connecticut Department of Transportation maintains 4,000 miles of state highway, and in 1985 sprayed about 1325 acres of roadside with herbicides at an average rate of 2 lb/acre, with an additional 300 acres of spot treatment for vegetation in paved areas, poison ivy control and vegetation control around traffic signs and light standards (Rocco V. Laraia, Personal Communication, February 24, 1987). The cost of herbicides for industry/commercial/government is estimated from Appendix Tables I and II at $4.35/lb. If the additional 14,000 miles of highway belonging to the towns were treated similarly, an additional 4,600 acres would be sprayed. Observation suggests that town roads are not treated as extensively as state highways; hence this calculation is not included in data in Table 4.

Northeast Utilities kindly provided detailed information on their uses of herbicides in 1986 (Mr. Robert L. Smuts, Personal Communication, May 1, 1987). Approximately 2,500 acres of transmission rights-of-way were treated with herbicides at an average rate of 2.3 lb/acre. Another 330 acres of land in the vicinity of substations and other properties were treated with herbicides at an average rate of 3.5 lb/acre (Table 4). The costs were assumed to be the same as for highways, i.e., $4.35/lb.

According to the National Golf Foundation (1984) there are 63 9-hole courses and 115 18-hole courses in Connecticut. A 9-hole golf course was assumed to occupy 50 acres and an 18-hole course 100 acres, for a total of 15,050

acres. Not all acres are treated, so that the total of 97,000 lb estimated by Gianessi must be applied at a higher rate than was estimated for agricultural uses (Table 4).

Some comparative data on uses of herbicides in Massachusetts were assembled in a generic environmental impact study of control of vegetation along rights-of-way (Harrison, 1985). After adjusting their estimates for the differences in size between the two states, the corresponding acres in Connecticut would be: 1675 acres highways, 4,900 acres utilities, and 2,300 acres railroads. These estimates for highways and utilities compare reasonably well with those shown in Table 4. Therefore, 2,300 acres of railroad rights-of-way in Connecticut were assumed to be treated with herbicides at 2.5 lb/acre (Table 4).

The total for these industry/commercial/ government uses is 300,150 lb costing $2.8 million which agrees reasonably well with the total of 244,000 lb and $1.4 million prorated from the national data on an area basis.

SUMMARY

Estimates of pesticides used in Connecticut were obtained by first estimating the amounts used nationwide based on a variety of published and unpublished sources. Some discrepancies were evident in comparisons of data obtained from USDA, USDC, and EPA. The relative amounts used by various sectors of the economy are probably more accurate, and they were used where available. Uses were then prorated to Connecticut based on appropriate comparisons such as acres of farmland, population, housing units and the like. Several methods were used where possible to provide some degree of internal consistency.

The inventory shows that about 2 million lb of pesticides are used in Connecticut annually at a cost of about $18.7 million dollars. About 530,000 lb of insecticides are estimated to be used in and around buildings and are not included in the estimated 288,000 acres thought to be treated with pesticides. Agricultural uses amount to about 33% of the total, with uses by homeowners totaling 61%. The remaining 6% is split amongst a variety of industrial, commercial and government uses.

While the data point to the need for more accurate inventories at both the state and national level, it is clear that an accurate study of the possible contamination of ground water with pesticides must include urban and agricultural areas in Connecticut.

NOTES

1. Leonard Gianessi of Resources For the Future (RFF) has generously shared with me detailed estimates of the amounts of specific pesticides used on specific crops in New York. Gianessi then prorated these uses to Connecticut based on the relative acreage of these crops in the two states. He also provided me with estimates of other uses of pesticides on lawns and golf courses. This information will be published by RFF, and I thank Gianessi for allowing me access to the data. Any further references to Gianessi refer to personal communications of March 24, 1987 and subsequent exchanges of information by telephone and mail.

2. Demand for Home and Garden Pesticides Spurs New Products, Chemical and Engineering News, April 6, 1987.

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APPENDIX TABLE I--ESTIMATES OF USER EXPENDITURES FOR PESTICIDES IN THE UNITED STATES, 1985 (U.S. ENVIRONMENTAL PROTECTION AGENCY, 1986).

	Herbicides[1]		Insecticides[2]		Fungicides[3]		Other[4]		Total	
	Million Dollars	%	Million Dollars	%	Million Dollars	%	Million Dollars	%	Million Dollars	%
Agricultural	2,900	78	1,100	56	315	61	300	80	4,615	70
Ind./Comm./Govt.	500	14	375	19	115	22	35	10	1,025	16
Home & Garden	300	8	500	25	85	17	35	10	920	14
Total	3,700	100	1,975	100	515	100	370	100	6,560	100

1. Includes plant growth regulators.
2. Includes miticides and contact nematicides.
3. Does not include wood preservatives.
4. Includes rodenticides, fumigants, and molluscicides.

APPENDIX TABLE II--ESTIMATES OF VOLUME OF U.S. PESTICIDE ACTIVE INGREDIENT USED, 1985 (U.S. ENVIRONMENTAL PROTECTION AGENCY, 1986).

	Herbicides[1] Million Pounds	%	Insecticides[2] Million Pounds	%	Fungicides[3] Million Pounds	%	Other[4] Million Pounds	%	Total Million Pounds	%
Agriculture	525	78	225	75	51	62	60	100	861	77
Ind./Comm./Govt.	115	17	40	13	21	26	.105	-	176.105	16
Home & Garden	30	5	35	12	10	12	.105	-	75.105	7
Total	670	100	300	100	82	100	60.210	100	1,112.210	100

1. Includes plant growth regulators.
2. Includes miticides and contact nematicides.
3. Does not include wood preservatives.
4. Includes rodenticides, fumigants, and molluscicides.

APPENDIX TABLE III--CHEMICALS USED ON CONNECTICUT FARMS, 1959-1982.

Year		Farms	Fertilizers	Insecticides	Nematicides	Fungicides	Herbicides	Grth Reg
1982	Number	3,754	2,256	1,024	182	542	1,053	145
	Acres	444,242	120,995	37,876	11,312	13,684	60,260	4,867
1978	Number	3,519	2,721	1,017	172	738	1,329	103
	Acres	455,731	125,653	36,834	7,663	18,099	61,816	3,888
1974	Number	3,421	1,703	558	48	152	776	47
	Acres	440,056	103,940	27,933	3,439	5,347	42,122	1,884
1969	Number	4,490	1,810	651	45	233	1,009	75
	Acres	541,372	113,554	27,540	941	8,208	44,400	1,677
1964	Number	6,068	3,211	1,714	NA	NA	1,486	NA
	Acres	721,314	146,520	45,580	NA	NA	36,529	NA
1959	Number	8,292	4,265	NA	NA	NA	NA	NA
	Acres	884,443	162,020	NA	NA	NA	NA	NA

1. Figures for 1982 are based on the 1982 CENSUS OF AGR., Vol. 1, Part 7, Table 1, Table 16, All farms; 1978 on 1978 CENSUS OF AGR., Vol. 1, Part 7, Table 15, All farms; 1974 on 1974 CENSUS OF AGR., Vol. 1, Part 7, Table 13, Farms with sales over $2500; 1969 on 1969 CENSUS OF AGR., Vol. 1, Part 6, Table 19, Farms with sales over $2500; 1964 and 1959 on 1964 CENSUS OF AGR., Vol. 1, Part 6, Table 18, All farms. Insecticides include fungicides in 1964.
2. NA means: Not Applicable.

The Connecticut Agricultural Experiment Station, founded in 1875, is the first experiment station in America. It is chartered by the General Assembly to make scientific inquiries and experiments regarding plants and their pests, insects, soil and water, and to perform analyses for State agencies. The laboratories of the Station are in New Haven and Windsor; its Lockwood Farm is in Hamden. Single copies of bulletins are available free upon request to Publications; Box 1106; New Haven, Connecticut 06504.

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