

**Assessment of Health Risks to Farm Workers
of Agricultural Pesticide Use in
Santa Clara County**

by

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Prepared for Aguirre International
under contract with the
County of Santa Clara

January 16, 1997

“The (Santa Clara) valley was never California agriculture as we have historically known it, not the factories in the fields that in the Central Valley and elsewhere have proved so economically potent and so humanly arid. This was down-home farming, three generations of tranquility, beauty, health, and productivity based on family farms of small acreage but bountiful production. The Santa Clara Valley, even when I arrived here in 1945, provided the fresh, canned, and especially dried fruit for half the world. The dried peach pies that my mother baked in Saskatchewan during World War I almost certainly came from here. The smoked prunes that we had for breakfast in Norway in the 1950s probably did. This was *par excellence* a fruit bowl, and it spread its fragrant bounty world-wide.”

- Wallace Stegner
Passing Farms: Enduring Values
Forward, p. x

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Acknowledgments

The author wishes to acknowledge the wonderful cooperation of the staff of the Santa Clara County Agriculture Department, especially Mert Price and Kevin O'Day. Their prompt response to requests for data and assistance proved invaluable.

The author's colleagues at CIRS, especially the capable computer programming skills of Ms. Gretchen Bradfield, made it possible to organize a large volume of Santa Clara farm operator and pesticide use data in a manageable form. Julisa Ruiz, Rosario Ruiz-Dark and Merissa Wright develop the farm operator data files upon which much of the present work is based. Josh Aroner, while working as a student intern at CIRS, was responsible for the first set of 1994 farm operator data for Santa Clara County.

Dr. Susan Gabbard provided useful comments and helpful advice throughout the project. She also immediately recognized the significance of Wallace Stegner's writings as they pertain to Santa Clara County agriculture.

EXECUTIVE SUMMARY

This report summarizes a detailed review of the risk of occupational injury or illness presented to persons employed in agricultural production resulting from on-the-job exposure to pesticides used on Santa Clara County farms. Farm work, whether performed by a farmer, unpaid family member or hired worker, is direct participation in the production of an agricultural commodity for sale. By this definition we exclude from consideration post-harvest handling of commodities away from the production site, such as processing, packing, shipping or retail transactions.

Santa Clara County agriculture is a small but relatively important industry, employing about 5,000 persons doing farm tasks on an annual average basis, and generating about \$160 million per year in cash receipts from the sale of agricultural commodities. An estimated 500 families earn their living as farm operators in the county.

Vegetable and nursery crop production (including mushrooms) are the most important components of the county's agricultural system. Tree fruit and grapes are somewhat less important but some specific permanent crops are either expanding production (cherries) or remaining stable (grapes).

Reported commercial pesticide use has been increasing in recent years in the county but the majority of it is for urban purposes. Most importantly, structural pest control by itself accounts for far more pesticide use in the county than does all of agriculture. Non-commercial pesticide applications, such as home or garden use, is quite extensive throughout California but is not reported. It is not possible to estimate the amount of this usage.

Reported agricultural pesticide use in the county is quite small compared to that

reported in most adjacent counties. For example, the level of agricultural pesticide use in Monterey County is thirty times larger and in Santa Cruz County it is six times larger. In this respect, the level of reported use closely tracks the amount of crop farm activity in the county.

Within agriculture, pesticide use was reported by about 379 farms, out of the total of 472 which obtained restricted use or operator identification permits in 1994. Most farm operators report very low levels of pesticide use: among those reporting pesticide use, the median number of applications was 7 totaling less than 100 pounds of active ingredients in the course of the entire year.

By two independent measures, roughly one-half of Santa Clara County farms do not plan to use, nor do they actually use, any agricultural chemicals in a given year. This is because they produce agricultural commodities that do not usually require chemicals for pest control purposes.

The pesticide accounting for the largest amount of Santa Clara County farm use in 1994 was sulfur, an unrestricted material that is approved for organic farm production under state law. The ten leading on-farm pesticides accounted for more than two-thirds of all agricultural pesticide use in the county. Only three of the ten were restricted materials in 1994, the other seven being less hazardous unrestricted materials.

The average number of applications and of pounds of active ingredient applied are much larger: 51 applications, and 767 pounds. That the average is much larger than the median for both number of applications and pounds applied means that a very few of the farms account for most of the applications and of chemicals applied. In fact, the ten largest

Santa Clara County farm users of agricultural chemicals in 1994, based on individual use reports, accounted for two-thirds of the pounds applied in the county.

Based on the specific chemicals used in the county's agriculture and the amount of each applied in 1994, there are seven pesticides that need to be considered in this report: chlopyrifos, diazinon, glyphosate, metam-sodium, methomyl, methyl bromide and sulfur.

The rate of expected agricultural occupational pesticide illnesses is computed using statewide illness and injury data for all chemical ingredients. Comparing the rate of injuries and illnesses associated with these chemicals in California together with the amount used in Santa Clara County leads to the conclusion that the expected annual number in the county is probably in the range of about one to two per year.

The most important material from this epidemiological point of view is metam-sodium, a soil disinfectant. If this material were applied in Santa Clara County agriculture in the same way as it is in the Central Valley, then about half of the county's expected annual number of farm worker pesticide illnesses would be expected to be caused by exposure to this chemical. However, local restrictions imposed by the county require that fields where this material is applied must be covered with tarpaulins. We find that the material was applied in three vegetable farms during the months of March, April and May of 1994. Since the weather is cooler during this time frame volatility is substantially less. Both of these considerations lead to the conclusion that the risk of occupational pesticide illness due to exposure to metam-sodium is far lower in Santa Clara County than is the case in most of the state.

Sulfur, a naturally occurring chemical element, is the second most hazardous material with one-fifth of the expected number of pesticide illnesses. Sulfur is widely used as a

fungicide but most county use is in the grape industry.

Review of all reported pesticide illnesses in Santa Clara County for the three years 1991-94 reveals that more than 95% were non-agricultural. Only 4.7% of all reported pesticide illnesses were associated with agricultural production. In 1994 there were 88 case reports of pesticide illness and two of these were occupational pesticide illness associated with agricultural production.

Nearly all reported occupational pesticide illnesses during this period were in urban settings, not in production agriculture. The overwhelming majority of such cases were in the janitorial, landscape maintenance, structural pest control or food processing industries.

The most important finding of this report is that non-agricultural pesticide use in Santa Clara County is responsible for all but a handful of reported cases of occupational pesticide illness or injury. Since the County Agricultural Department also has responsibility for regulation of urban and industrial commercial pesticide use, additional efforts directed to protect workers in these settings are warranted.

Santa Clara County Agriculture

Once regarded as the Eden of California, Santa Clara County is better known today for its high tech companies and the rapidly expanding city of San Jose. Nevertheless, Gilroy is still home to the annual Garlic Festival and proudly proclaims its place in history as the Garlic Capitol of the World. Annual receipts from the sale of agricultural commodities produced in the county have averaged about \$160 million per year over the past three years, and are actually 13% higher today than they were eight years ago (measured in nominal dollars).

Figure 1 shows the relative importance of different commodities in Santa Clara County agriculture, based on 1995 farm cash receipts. At present, the most important category of agricultural commodities in the county is fresh and processed vegetables, accounting for half of all farm production (based on value). Next in importance is nursery crops and cut flowers, together comprising one-fourth of farm cash receipts. The remaining one-fourth consists of livestock and poultry products, fruit and nut crops, field crops, berry crops and seed crops, in relative order of the market value of annual sales.

In 1992, the U.S. Department of Commerce enumerated 1,057 farms in Santa Clara County, of which about one-half were operated by farmers and the remaining one-half were operated by individuals who indicated that their principal occupation was something other than farming. Roughly speaking, there are about 500 families who today earn their livelihood by operating farms in the county. However, just as in the state as a whole, approximately one-half of Santa Clara's farms and ranches are operated by part-time farmers.

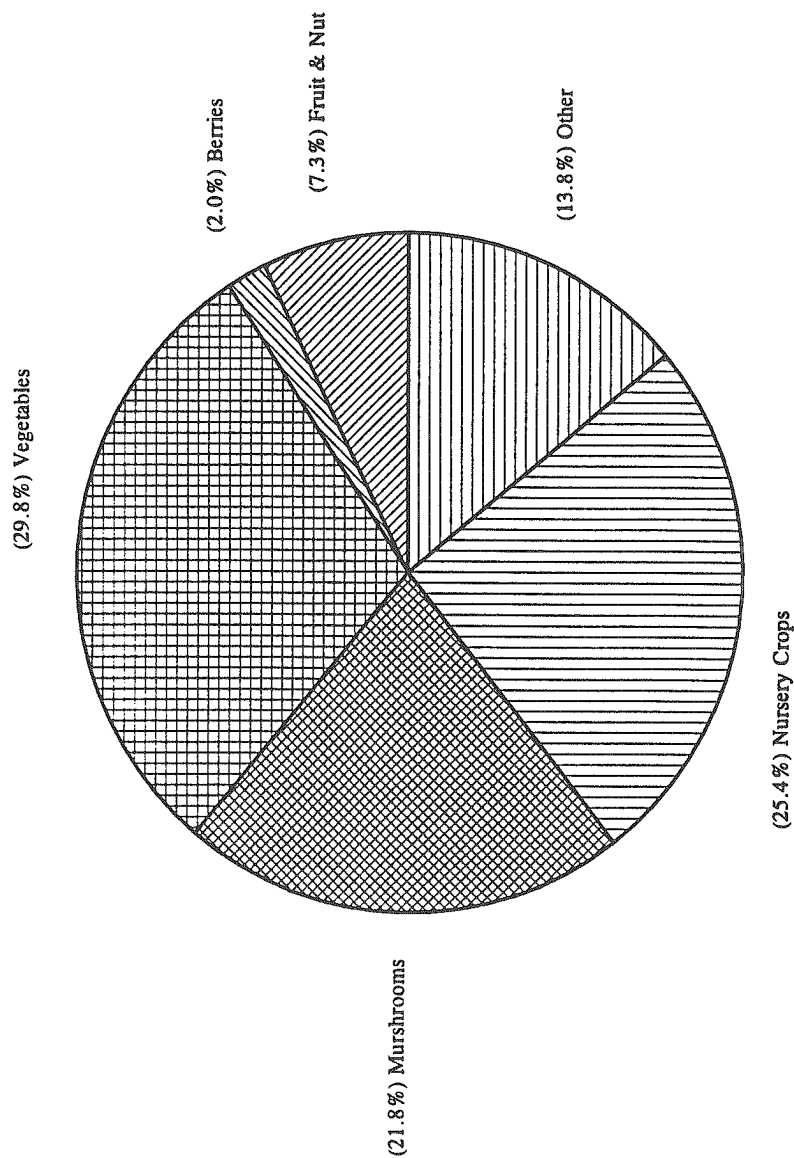
Farms which primarily produce crops, including ornamental horticulture, comprise six of every ten operations in the county. Fruit or tree nut farms are the most numerous of these. Nursery crop and cut flower operations account for another one-fourth, and vegetable farms are just one out of every ten crop farms. Farms which primarily produce livestock account for four of ten farms in the county.

Over the past ten years, Santa Clara County orchard acreage has continued a downward trend, declining from 5,800 harvested acres in 1986 to 5,100 acres in 1995. But during the same period harvested cherry acreage has increased by nearly two-thirds, to 1,200 acres, and grape acreage has remained stable, at about 1,600 acres.

FIGURE 1

Agricultural Production by Value of Commodity

Santa Clara County, 1995



Harvested vegetable acreage in the county has also remained essentially constant throughout the last ten years, at roughly 12,000 acres. In part, the continued importance of fresh and processed vegetables in the area reflects increasing consumer demand throughout the U.S. Per capita consumption of fresh fruits and vegetables is now 50% greater throughout the nation than it was twenty years ago.

While garlic is Santa Clara County's best known vegetable crop, mushrooms are the single most important category of vegetable production. The annual tonnage of mushrooms now grown in the county is 50% larger than it was a decade ago, reflecting the expansion of the industry throughout the Central Coast of California.

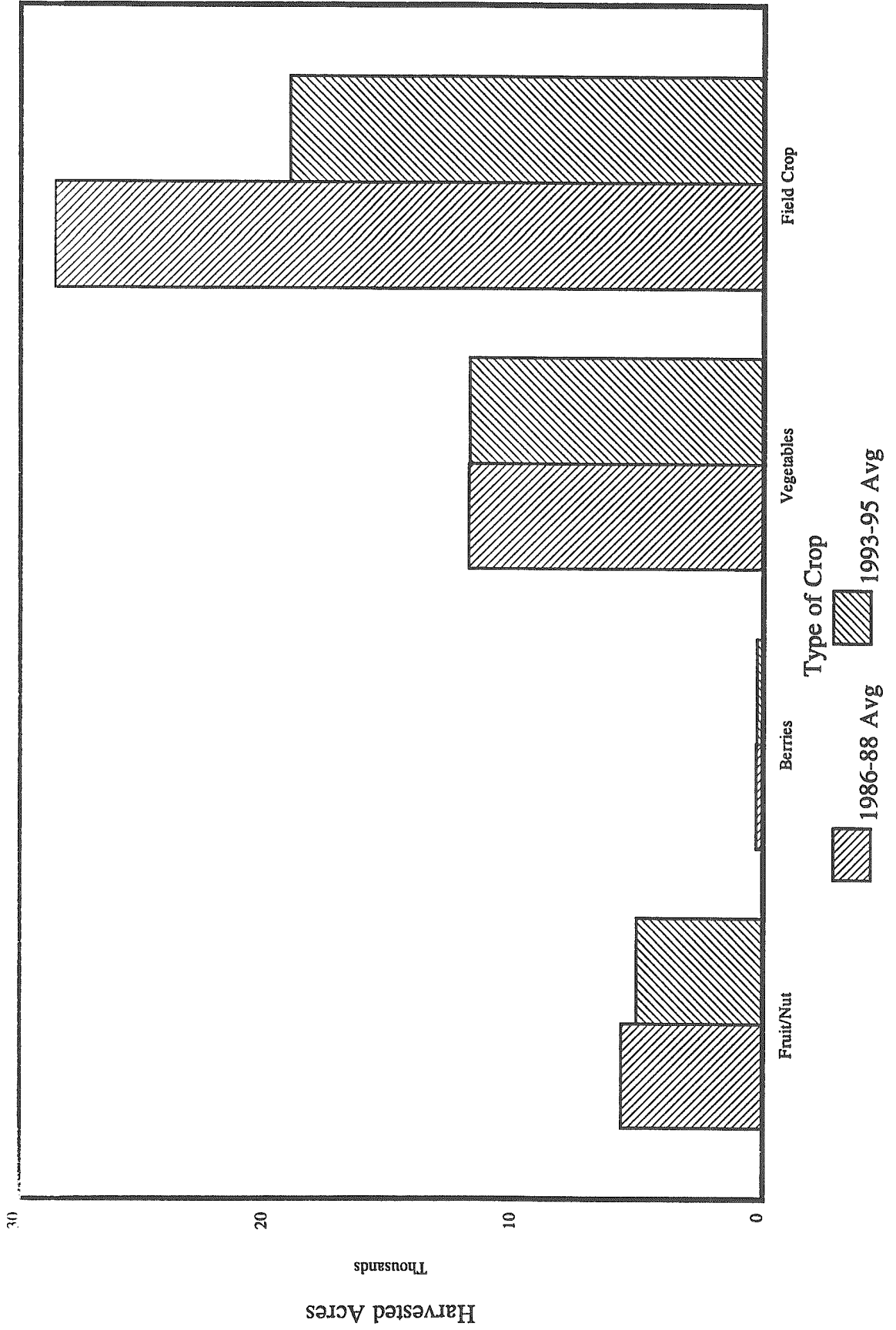
As summarized in Figure 2, vegetable harvested acreage is essentially unchanged over the past ten years, as is the case for the relatively small acreage of berry crops grown in the county. But field crops (exclusive of range) have declined sharply, and fruit and nut crop acreage is also down.

Taken together, the various categories of crop production that account for some 86% of Santa Clara County's agriculture - tree fruit and grapes, vegetables, nursery crops and cut flowers - all share the important characteristic that they require a large amount of hand labor. A single acre of strawberries requires more than 1,000 hours of labor, and one acre of cherries requires about 250 hours of labor. Comparable figures for mushrooms and ornamental horticultural crops are not accurately known but are believed to be even larger on a per acre basis.

Santa Clara County agriculture is regarded as "labor intensive" because of the very large hand labor requirements, both on a per-acre basis and as the single largest component of farm production costs. According to the *Census of Agriculture*, in 1992, Hired and Contract Labor Expenses on farms in the county amounted to \$42.7 million, out of total production expenses of \$103.1 million. Thus, labor expenses were 41% of all production costs. They were also greater than any other category of expense by a very large margin.

In contrast, for all of California agriculture, labor expense is 28% of all expenses. Even in neighboring Monterey County, well known for its dependence on hired labor, county-wide farm labor costs amount to 41% of total farm costs, the same fraction as in Santa Clara County.

FIGURE 2
 Change in Santa Clara County Harvested Acres
 3-Year Averages, Annual Crop Reports



The number of persons employed in Santa Clara County agriculture is not accurately known. But on an annual average basis, farm employment is slightly more than 5,000. As shown in Figure 3, employment at the peak of the harvest season reaches nearly 6,900 (July-August) but is as low as 3,300 during the winter months.

Each type of crop grown in the county has labor requirements that result in temporal patterns of labor demand that differ somewhat from the pattern described above. For example, berry harvest employments reaches a peak of a little under 400 workers in May, while tree fruit employment peaks at about 400 workers in June and the highest level of employment in vegetable production is about 1,000 during August.

Figure 4 shows the variation of farm employment by industry of employer. Farm labor contractor and packing firm employment in fruit or vegetable production is included in the category "Other" because these employers are not farm operators.

The agricultural sector with the largest reported employment is Nursery Crops, including both ornamental floriculture and food crops grown under cover, as in greenhouses or other enclosures (mushroom producer employment is reported as part of this category). Annual average employment is 1,000 in ornamental crops and a little over 500 in mushrooms, with no significant variation during the course of the year. Studies of nursery production workers have shown that much of this type of work is performed on a steady, year-round basis.

The *Census of Agriculture* reported that 438 farms in the county directly hired employees during 1992, in reasonable agreement with the annual average number of such employers (400) reported by the California Department of Employment in the same year. The *Census* reported that 193 operations hired farm labor contractors to perform jobs on their places, some of which also directly hire farm workers. Overall, the total farm labor contractor expense reported by Santa Clara County farm operators was quite small in 1992 (\$4.0 million) as compared with direct-hire labor expense (\$38.7 million).

The adjacent Central Coast counties (Alameda, Monterey, San Benito, San Mateo, Santa Cruz) produce crops that, in each case, are quite similar to some specific crops grown in Santa Clara County. However, both Monterey and Santa Cruz Counties have much higher levels of overall production and on-farm employment. In Alameda, San Benito and San Mateo

FIGURE 3
Santa Clara County Farm Employment
Monthly Employment, EDD Report 882-A, 1992

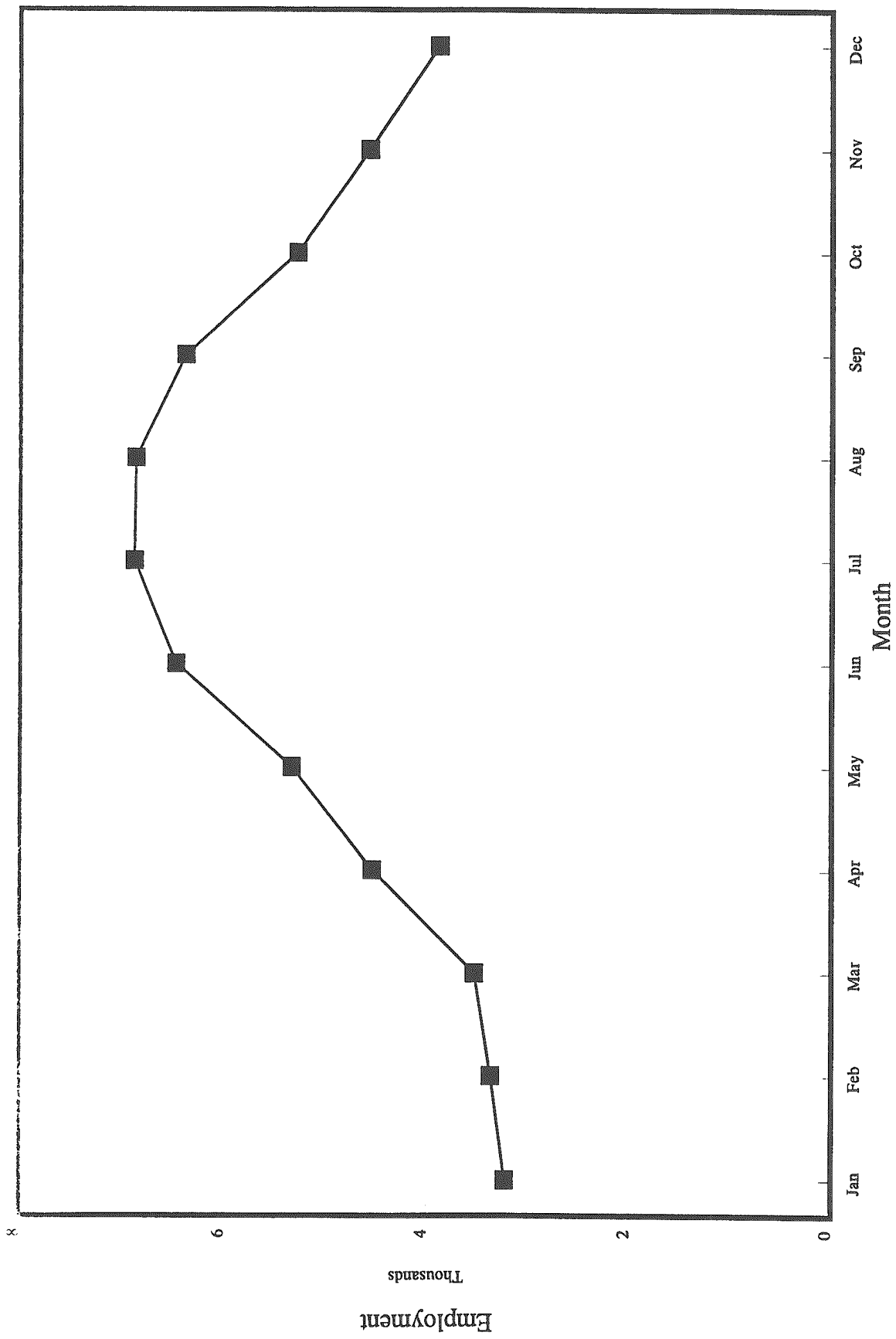
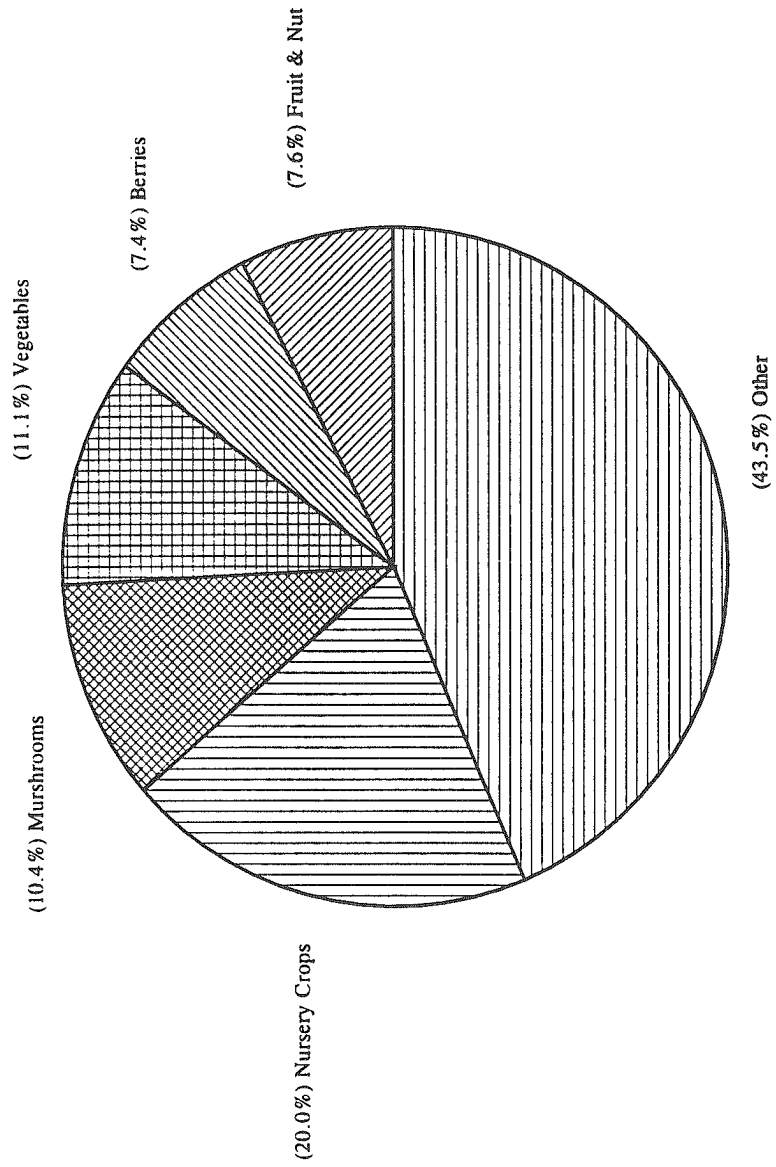


FIGURE 4
Farm Employment, by Industry of Employer
Annual Average, EDD Report 882-A, 1992



Counties agricultural production is smaller than in Santa Clara County, and, in two of them, nursery crops are the leading commodity group..

Santa Clara County also borders Stanislaus and Merced Counties, sharing a vast area of interior coastal range. These hilly and mountainous areas are well-known for the high quality of grasses and fodder for free-ranging livestock. About 215,000 acres of this area is located within the county itself. Few hired farm workers are employed by these livestock operations.

Pesticide Use in Santa Clara County

According to the California Department of Pesticide Regulation, about 800,000 pounds of pesticides were reportedly applied in Santa Clara County in 1994. The total amount of annual reported pesticide use in the county has been increasing somewhat in recent years. This is illustrated in Figure 5, which shows the county-wide totals for 1990-94. As indicated in the figure, total reported pesticide use in the county increased by one-fourth during the five years.

Both agricultural and non-agricultural pesticide use have increased in this period, where the term "agricultural pesticide use" herein refers to pesticides used on a farm to produce an agricultural commodity for sale. The majority (54%) of this increase was for non-agricultural purposes.

It is not possible to compare total annual reported pesticide use prior to January 1, 1990 with the data in Figure 5. Before that date state law did not require reports concerning unrestricted chemical use from "private applicators" (those who apply their own pesticides). Today, however, "full-use" reporting is required in the state.

Table 1 presents summary data for reported 1994 agricultural pesticide use in Santa Clara and all adjacent counties. Total reported pesticide use in California amounted to some 200 million pounds in that year. Thus, Santa Clara County's agricultural pesticide use was less than one-half of one percent of the state total. The county's extremely small share of the amount used in the state in part reflects the fact that agricultural production amounts to somewhat less than 1% that for all of California.

Finally, the relative amounts of agricultural pesticide use in all eight counties shown in Table 1 tracks rather closely the relative levels of crop production in these counties. Essentially, this indicates that the level of agricultural activity is the most important single indicator of the total amount of pesticide use in a given county.

Table 1 also demonstrates how the county's pesticide use is very much smaller than is reported for major agricultural counties, such as Merced, Monterey and Stanislaus. Even Santa Cruz County's pesticide use greatly exceeds that of Santa Clara County being six times larger.

FIGURE 5
Pesticide Use in Santa Clara County, by Year
California DPR, Active Ingredients, Pounds

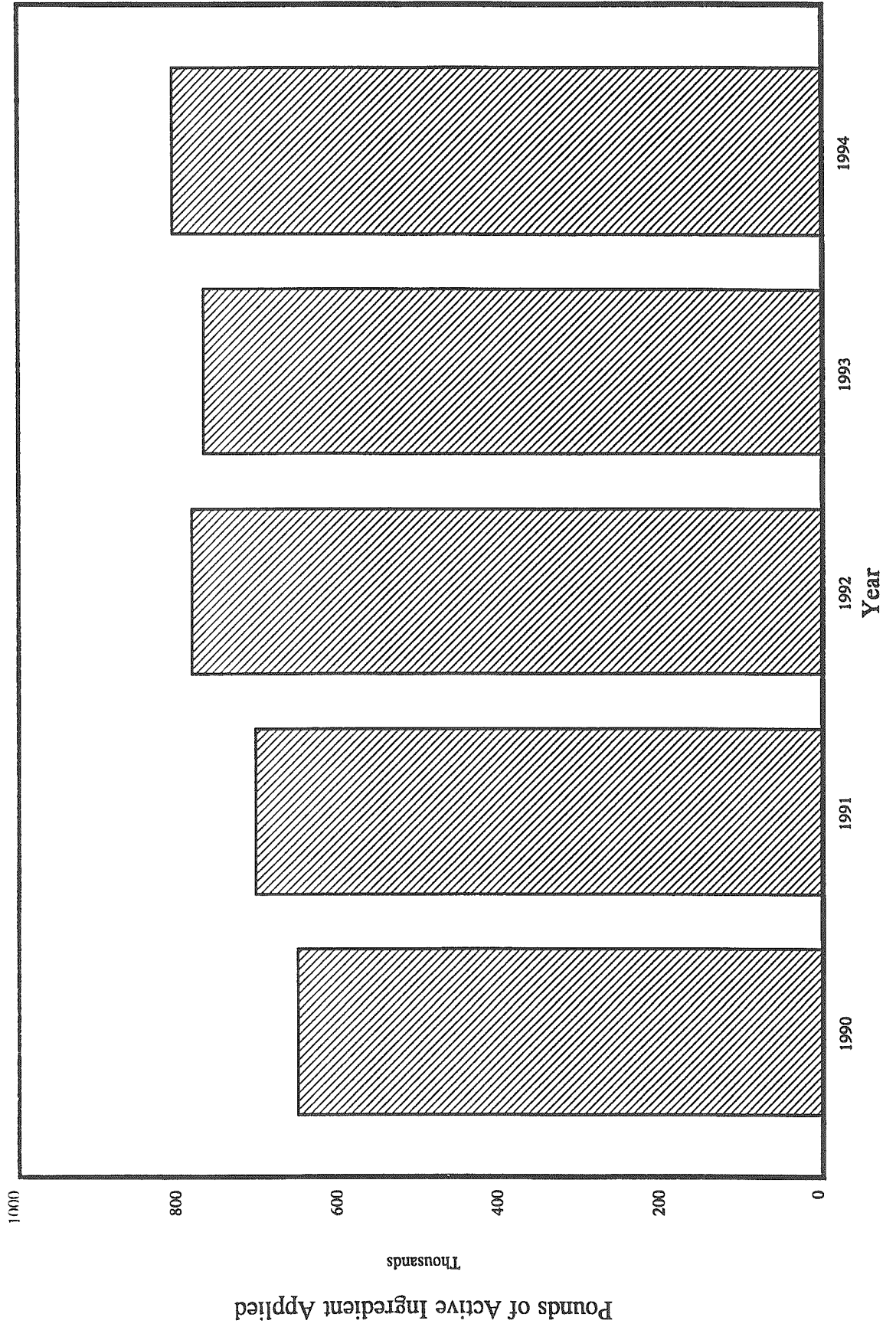


Table 1
Agricultural Pesticide Use in Santa Clara and Adjacent Counties, 1994

County	Pesticide Use, Ingredients (lbs.)
Alameda	152,478
Merced	8,276,269
Monterey	9,039,923
San Benito	588,157
San Mateo	121,465
Santa Clara	296,924
Santa Cruz	1,824,236
Stanislaus	6,804,211

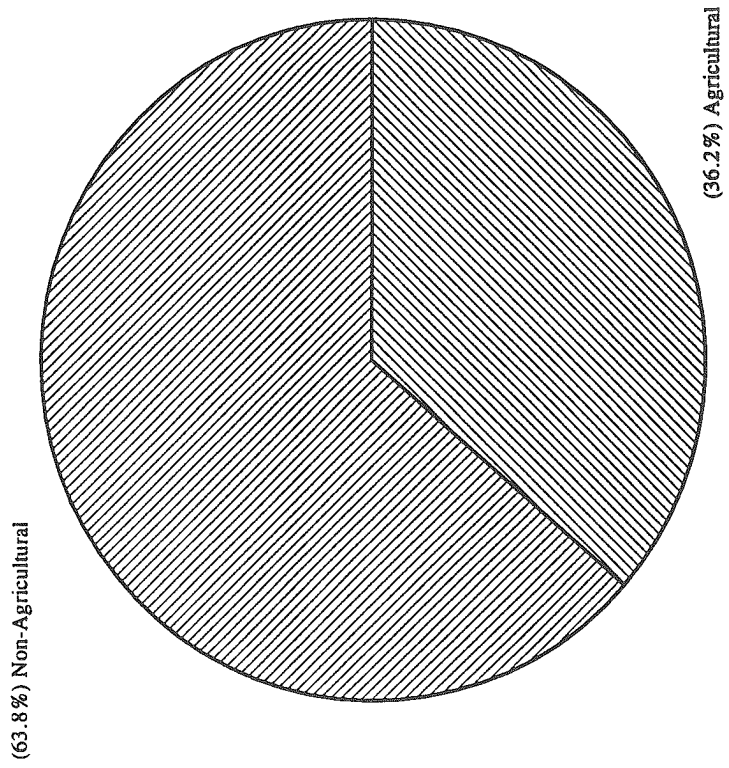
A second factor contributing to the relatively low pesticide use in the county is that it has a mix of crops that include some that require little or no pesticide use. In contrast, crops such as strawberries that require a very large amount of chemicals for pest control purposes on a per-acre basis are far less important in the county than is the case for adjacent counties.

The most important single fact about reported pesticide use in Santa Clara County is that the **majority** is used for non-agricultural purposes. This is shown in Figure 6, which indicates the relative shares of pesticide use for agricultural and non-agricultural purposes in 1994. Major non-agricultural uses include treatment of structures such as residences or warehouses to control insects and rodents, applications of herbicides to areas adjacent to roadways, and use of pesticides in open space such as golf courses, parks and vacant fields.

While there has been some variation in the fractions of county pesticide use for agricultural vs. non-agricultural purposes over the years, it has always been in the range of roughly 33-40% vs. 67-60%, respectively, in the years since full-use reporting began in 1990. Thus, the data for 1994 shown in Figure 6 is not an anomaly. Rather, it is representative of the pattern of use for all years of the 1990s.

That the majority of reported pesticide use is for non-agricultural purposes is actually quite representative of California's urbanized counties. Home or garden applications of

FIGURE 6
Type of Pesticide Use, Santa Clara County, 1994
Reported Pesticide Use, Pounds



agricultural chemicals purchased in hardware or retail nursery outlets, as well as chemicals used for many cleaning or disinfectant purposes, such as in hotels, is not regulated or reported under California pesticide laws. On the other hand, a large share of reported pesticide illnesses in the state result from these types of chemical applications.

Figure 7 shows the amount of active ingredients used in each major type of non-agriculture pesticide use. Clearly, structural pest control is the most important category of use in the county and, as shown later, more important than **the total of all agricultural pesticide use**.

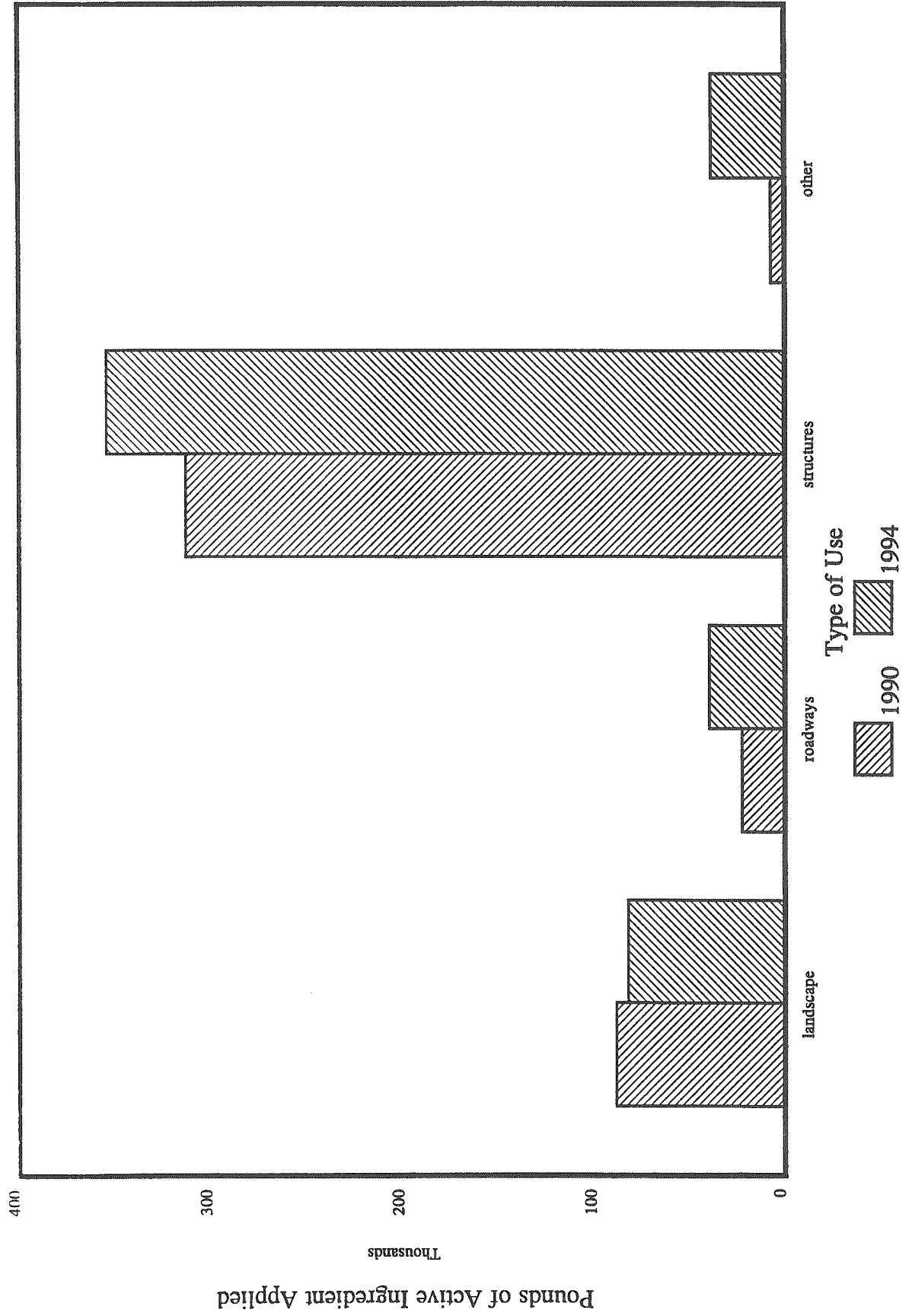
Based on the finding that most pesticide use in the county is actually urban or urban-oriented, the greatest potential health risk to workers from occupational pesticide exposure is likely to be found in these settings, not in agriculture. It is well-established that those persons at highest risk of injury or illness from exposure to pesticides are applicators and mixer/loaders.

CIRS has reviewed summaries of pesticide use reports filed in Santa Clara County for the five-year period 1990-94 as well as all individual pesticide use reports filed in 1994. In general, this review of agricultural pesticide use in Santa Clara County indicates that it was quite similar to customary practices found throughout the state, given the types of commodities being produced.

During 1994, 472 producers of agricultural commodities in the county obtained permits to apply restricted materials or an operator identification permit for the exclusive use of unrestricted materials. This can be compared with the county-wide total of roughly 1,000 farms identified in the *Census of Agriculture* in 1992, which suggests that slightly less than half of the county's farm operators expected to apply pesticides in 1994.

In this context it is worth noting that the 1987 census found about 1,300 farms in the county. Hence, some 300 farms ended their operations in the five subsequent years. If that trend continued into 1994, one might expect as few as 880 farms in the county in 1994. If so, then about 53% of the county's farms obtained a permit because they expected to need to apply pesticides on their places. No matter which estimate is used, we conclude that about one-half of the county's farms needed to obtain a permit in 1994 to enable them to apply pesticides.

FIGURE 7
 Non-Agricultural Pesticide Use, Santa Clara County



This finding is fully consistent with the *Census of Agriculture* finding that in 1992 some 492 Santa Clara County farms reported agricultural chemical expenses, or roughly 46% of all farms in the county. This fraction is very close to the estimate we have made for 1994, albeit one that relies on an extrapolation as to the number of farms in 1994.

Therefore, by two independent measures, roughly one-half of Santa Clara County farms apply for a permit to use pesticides in a given year. This is an important observation in reviewing the possibility of farm worker occupational exposure.

Reports by farmers under the California Organic Foods Act indicate that only ten farms in Santa Clara County were producing agricultural commodities that they wished to market as organically grown. Thus, only a handful of farms produce commodities following cultivation practices that are considered organic.

Nearly as many non-agricultural pesticide users obtained a pesticide permit. This category of permit holders includes government agencies, such as park or recreation districts, schools, city or county street departments, golf courses, cemeteries or landscape businesses, among others. Following the previous discussion of the types of pesticide use in the county, this group include the permit holders who are responsible for the majority of reported pesticide use in the county.

Agricultural Pesticide Use in Santa Clara County

As described above, 472 farms in Santa Clara County obtained a permit for the use of pesticides for agricultural production purposes in 1994. Most pesticide use on these farms consisted of unrestricted (least hazardous) materials.

California recognizes two types of pesticides: restricted, which are the most hazardous to the environment or human health, and unrestricted, which are the least hazardous. At present, there are a little more than five dozen chemical active ingredients which are defined as restricted, either by state or federal standards. Hundreds of additional materials are unrestricted under existing guidelines.

Figure 8 shows the proportions of restricted and unrestricted materials applied on farms in the county in 1994. A majority of the chemical active ingredients, measured in pounds, were unrestricted materials. Just under 45% were restricted materials.

Figure 9 shows the ten top pesticides, according to active ingredient measured in pounds, used in the county in 1994. Taken together, these ten materials account for three-fourths of all agricultural pesticide use (pounds applied) in the county. In 1994, seven of the ten materials shown in the figure were unrestricted materials and three were restricted.

The leading chemical used on Santa Clara County farms is sulfur. Sulfur is a naturally occurring chemical element and, because it is not a synthetic chemical, is legal for use in organic food production under state law. It is rather ironic that the leading chemical used in agriculture in the county is an “organically allowed” material. But it is also the case in the state as a whole that sulfur is the leading chemical used in agricultural production.

There were 238 applications of sulfur for agricultural production purposes in the county during 1994. By far, the largest share of sulfur use, measured in pounds, was in the county’s vineyards.

The second most important chemical shown in Figure 9, based on pounds applied, is metam-sodium. This is an extremely hazardous chemical, and is registered for use in the state as a restricted material (Category I, label “Danger”). It is widely used in California as a soil disinfectant to control soil fungi, nematodes, soil insects and germinating weeds.

There were only 33 individual applications of metam-sodium for agricultural

FIGURE 8

Agricultural Pesticide Use, Type of Chemical, 1994

Reported Pesticide Use, Pounds

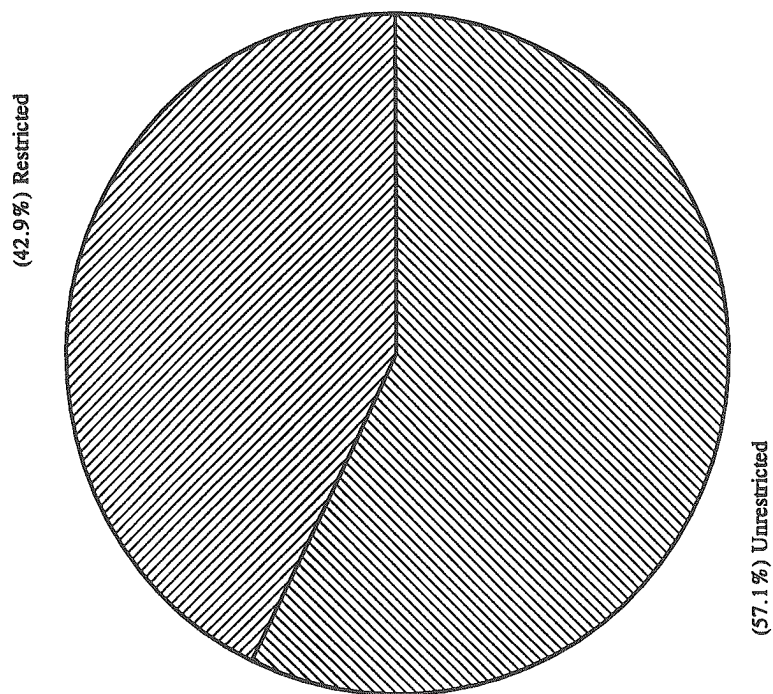
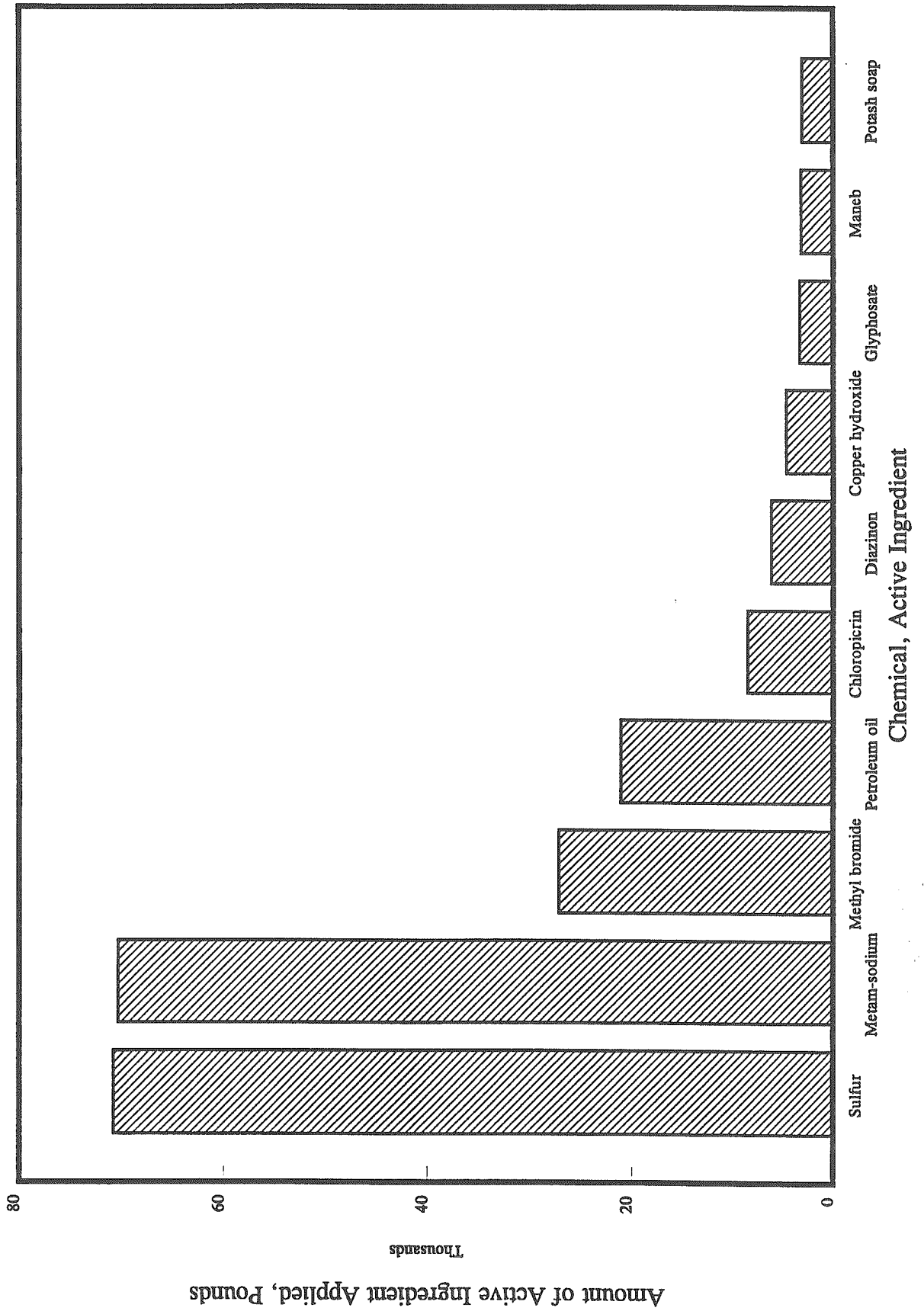


FIGURE 9

Agricultural Pesticide Use, Ten Leading Chemicals



production purposes in Santa Clara County in 1994, six of which were by a single farming operation. Thus, it was utilized by only a very few farmers in the county.

The third ranking chemical used for agricultural production purposes in Santa Clara County is methyl bromide, a dangerous restricted material widely applied as a soil fungicide. Its is especially important in the production of strawberries and for the establishment of new plantings of vineyards or tree orchards.

There were 19 individual applications of methyl bromide in Santa Clara County in 1994. As was the case for metam-sodium its use is limited to only a very few farmers.

Fourth in importance in the county is petroleum oil, an unrestricted material that is primarily used for weed or insect control. It is often used as a dormant spray in orchards. The Bay Area Air Quality Control Board restrictions forbid the use of petroleum oil for weed control purposes in Santa Clara County.

Chloropicrin, fifth in importance, is a restricted material that is normally mixed with methyl bromide when the latter is used as soil fumigant. Chloropicrin is also a soil fumigant that can cause irritation to the eyes, somewhat like tear gas. For that reason the material is often mixed with colorless, odorless chemicals to serve as a warning agent.

There were only 14 applications of chloropicrin in the county in 1994, all of which were mixes with methyl bromide. Thus, the utilization of this material was quite limited.

Sixth among the ten leading chemicals in the county is diazinon, an unrestricted material in 1994 that is an important insecticide. It is also widely used by home gardeners and other homeowners for control of a variety of insect pests, including fleas. By 1996 this material was reclassified as a restricted material.

There were 1,248 applications of diazinon by county farmers in 1994. This is the material among the top ten that is used by the largest number of Santa Clara County farmers. Though it accounted for only 2% of all agricultural pesticide use in the county (as measured by pounds applied), this material alone accounted for nearly half of all of the individual applications of the ten leading chemicals utilized in agriculture.

The remaining four among the top ten chemicals used on county farm lands are all unrestricted materials, and their usage is quite limited. Copper hydroxide is the most widely used of these (462 applications).

There are several other important pesticides that are widely used on farms in the county, but the amount of use, county-wide, is smaller than 3,000 pounds for each of them. Chief among these are carbaryl (1,865 pounds), fonofos (1,729 pounds), chlopyrifos (2,464 pounds), methomyl (2,925 pounds) and propyzamide (1,798 pounds).

CIRS also examined pesticide use in 1994 for each farm in the county, based on individual pesticide use reports. The most important result of that analysis is that just 379 farms reported pesticide use. This is a surprising finding: some 472 farms went to the trouble to obtain pesticide permits in 1994 but just 379 reported using the chemicals allowed under their permit. If correct, then pesticide usage on county farms is much smaller than was suggested in the 1992 *Census of Agriculture* where, as noted above, some 492 farms reported agricultural chemicals expenses.

CIRS referred the original pesticide use report data on which this finding is based to Santa Clara County Agriculture Department staff for additional review. The staff were extremely helpful in identifying each farm reporting pesticide use in 1994. This staff review identified about 135 farms in the final list of 472 which had obtained permits.

In addition, the CIRS review found that the median number of pesticide applications among all farms reporting pesticide use in 1994 was just 8 for the entire year, and the median number of pounds of pesticide applied (active ingredient) was only 25 pounds. This is a rather small number of applications and pounds of chemicals as compared with agriculture use in the state as a whole.

The average number of applications and of pounds of active ingredient applied are much larger: 51 applications, and 767 pounds. That the average is much larger than the median for both number of applications and pounds applied means that a very few of the farms account for most of the applications and of chemicals applied. In fact, the ten largest Santa Clara County farm users of agricultural chemicals in 1994, based on individual use reports, accounted for two-thirds of the pounds applied in the county.

We conclude that a very few farms are responsible for nearly all of the county's farm pesticide usage. By implication, overall worker exposure to risk associated with pesticide exposure is also concentrated on these same farms.

Farm Worker Occupational Exposure to Pesticide Hazards in Santa Clara County

We next identify those pesticides that present the greatest risk to health for farm workers in Santa Clara County. In so doing we consider both materials that are associated with the highest reported rate of injury among all farm workers in the state as well as those associated with the highest number of injuries.

Dr. William S. Pease et al (School of Public Health, University of California, Berkeley) have identified eight agricultural pesticides as having the highest hazard for occupational injury and illness. Pease et al define "high hazard" in terms of the number of reported injuries and illnesses per million pounds of applied active ingredients. The eight are sodium hypochlorate, aluminum phosphide, phosalone, triadimefon, chlorine, glyphosate, chlorpyrifos and methyl bromide.

Of the eight, just four are used in Santa Clara County agriculture. One of these four (aluminum phosphide) was used for only 9 farm applications in the county during 1994, totaling an aggregate of 17 pounds. For that reason it is not considered here. Hence, only three of the eight high-hazard pesticides are used widely enough in the county to warrant careful review: glyphosate, chlorpyrifos and methyl bromide.

In addition to these three we also consider metam-sodium and methomyl because they rank among the top ten pesticides in the number of reported occupational pesticide illnesses among all agricultural workers in the state during the past decade.

Finally, we add sulfur and diazinon to this group. Diazinon was an unrestricted material in 1994, ranking among the top ten in the county's agriculture and accounts for half of all of the number of applications among the top ten. Sulfur is the most heavily used chemical in county agriculture and is associated with more farm worker pesticide illnesses on a statewide basis than any other material.

Thus, there are seven pesticides to be considered in this report in detail: chlorpyrifos, diazinon, glyphosate, metam-sodium, methomyl, methyl bromide and sulfur. This does not mean that other materials are not hazardous. Rather, using established injury rates and consideration of the amount of each chemical used in the county, these are the materials that should be the focus of greatest concern.

We next calculate an expected annual worker injury rate using published injury rates per million pounds of applied material for each of these seven chemicals (see Pease et al). This method of computation is based on the hypothesis that pounds of chemical applied is a surrogate for worker exposure. Using the known levels of use of these chemicals on the county's farms during 1994 it would be expected that less than one occupational injury or illness would occur in an average year. By far, the largest contribution to this illness incidence would be attributable to metam-sodium, mainly because of the relatively large amount used in the county. The details of the computation are shown in Table 2.

Table 2
Expected Farm Worker Pesticide Injuries, Santa Clara County

Chemical	Injury Rate (per million pounds)	County Use	Injuries/Year
chlopyrifos	14.28	2,464	0.0352
diazinon	1.70	6,247	0.0107
glyphosate	38.77	3,384	0.1312
metam-sodium	6.74	70,332	0.4740
methomyl	21.10	2,925	0.0617
methyl bromide	1.30	23,067	0.0300
sulfur	2.70	70,809	0.1905

Sulfur, the chemical that is permitted under organic food production laws, is associated with more worker injuries in California than any chemical but this is so because so much is used in the state. In Santa Clara County, the 1994 reported use implies just 0.19 worker illnesses per year, on average.

We have also calculated the expected annual rate of farm worker occupational pesticide illness and injury taking account of the next ten most highly used chemicals (twenty

chemicals in all). The expected injury rate is calculated to be just 1.03 per year.

These low numbers of expected farm worker injuries due to pesticide exposure are based on the actual levels of pesticide use in the county and known rates of injury per million pounds applied. However, this does not mean that the county is somehow immune to worker injury. Rather, it is simply a statement that the levels of farm worker exposure to pesticide hazards are relatively low in Santa Clara County.

Since metam-sodium contributes the majority of the occupational health risk, nearly five times greater than for glyphosate, we examine the location and timing of applications of this material as reported in 1994. This was accomplished by examining all applications of metam-sodium in the county in detail.

First, all of the applications of metam-sodium for agricultural production purposes were found to occur on just three sizeable vegetable farms in the county. The soils were treated for plantings of peppers, tomatoes and beans. Even other plots operated by the same three farmers where these crops were being grown did not require this chemical treatment. Since all other producers of these commodities in the county, including farms directly adjacent to these three, did not use this chemical for their plantings of the same commodities, it may be that a localized soil problem was the reason for choosing metam-sodium treatment.

Second, the applications were localized to a small region near Gilroy at the south end of the county. A maximum of seven miles separated the most distant of these locations.

Third, the timing of these chemical treatments was confined to March (10 applications), April and May. The low level of field worker activity in the county during March suggests that the main concern for field worker safety would be centered on the April-

May period when hoeing and thinning labor is needed in some vegetable fields.

Finally, Santa Clara County Agriculture Department staff informed CIRS that, as a specific condition imposed at the county level, all applications of metam-sodium require the use of tarpaulins covering the ground to confine the volatile material. This is a local condition of use that is more restrictive than for metam-sodium applications in other regions of the state. By restricting applications of this material in this manner it is expected that both farm labor and neighboring residents will be afforded additional protection.

Another material of some concern is diazinon. The reason for the concern is not the quantity of use in agricultural production in the county - it is actually quite small - but instead the fact that its use is so widespread. There were more than 1,200 individual applications of diazinon for agricultural production purposes during 1994 alone.

In this context there are some questions about measuring exposure to hazardous materials solely in terms of quantity applied. It is the author's view that pounds of chemical applied is, by itself, not a fully satisfactory measure of worker exposure to risk. The computations of expected numbers of occupational pesticide illnesses and injuries described above in this report have been based exclusively on the use of pounds of chemical applied as a surrogate for worker exposure (cf. Pease et al). But if the amount of chemical applied is small and the number of individual applications is large, as is the case for diazinon, then the opportunity for worker exposure might actually be quite significant. Therefore, some attention must be given to hazardous materials which are applied by large numbers of growers even if the total county-wide amount is relatively small. It is for this reason that diazinon was included for consideration in estimating the likely number of farm worker pesticide illnesses.

Pesticide Illnesses in Santa Clara County

Pesticide illness reports reflect incidents in which an individual becomes ill or is injured and the possible causes include exposure to pesticides registered for use in California. Occupational illnesses or injuries comprise only a portion of these incidents, i.e., those in which the injury was a result of on-the-job exposure. In either case, occupational or non-occupational illness or injury, it is only those incidents that are reported that form the basis of assessments of the risk to health presented by exposure to these materials.

One of the most difficult aspects of attempting an epidemiological analysis of pesticide illnesses and injuries is that unreported incidents are, by definition, excluded from consideration. Thus, if an individual chooses not to report an incident, or if the illness or injury is not properly diagnosed, the case will go unreported.

We consider here only reported incidents. Inferences about the magnitude or seriousness of unreported pesticide injury or illness cases is outside the scope of this report, although, as in a wide variety of matters pertaining to health status, opportunities for speculation, whether well-informed or not, abound.

A review of Doctor's First Reports of pesticide illnesses in Santa Clara County for the period 1991-94 indicates an average of fewer than 100 incidents per year. In 1994, the most recent year covered by this report, there were 88 such reports.

More than 95% of reported cases of pesticide illness in Santa Clara County in the period 1991-94 were associated with non-agricultural exposures (364 out of 382 case reports). While many of this type of case are associated with non-agricultural pesticide use, a

significant share are associated with non-commercial pesticide use, as in home or garden use.

Cases of children made sick by accidental exposure to chemicals in the home are typical of the incidents of illnesses associated with non-commercial pesticide use. Thus, the existence and number of these types of cases reflect the substantial amount of non-commercial pesticide use in the county that is goes unreported.

Incidents of occupational illness or injury associated with commercial non-agricultural pesticide use comprise the majority of reports in the entire four year period (1991-94). They include public employees treating landscape or structures, service or maintenance workers using chemicals for cleaning purposes and food processing workers. Even health care workers made sick by fumes from cleaning solvents are reported as occupational pesticide illnesses.

Reports of occupational pesticide illnesses within agricultural production in the county are quite rare, typically amounting to fewer than a half dozen cases per year in the past decade. Most recently, the number of cases of occupational pesticide illness or injury is one or two per year.

In 1994 there were just three incidents involving pesticide use in agricultural production that resulted in worker illness or injury. One of these cases was an injury to a pilot of a plane used for aerial application of pesticides. Upon further investigation it was found that the accident was associated with the operation of the aircraft and not the application of pesticides. Both of the two remaining cases involved nursery crop workers. In these latter cases no specific chemical could be uniquely identified as causing the illness.

During 1994 the Worker Health and Safety Branch of the California Department of Pesticide Regulation reported that there were seven "agricultural" pesticide poisoning cases in

Santa Clara County. However, upon further examination we find that DPR includes food processing and cannery workers in the category agricultural and six of these cases were in a major cannery in the county. For our purposes, direct involvement in farm work and the associated occupational pesticide exposure is of particular interest. Thus, we exclude the cannery cases from our analysis.

Santa Clara County Agricultural Department staff report that there were two occupational illnesses involving farm workers in 1995, both occurred in the same incident. The crop was vegetables and the workers became ill as result of exposure to diazinon.

These findings suggest, at the present time, that the rate of reported agricultural occupational pesticide illnesses or injuries is between one and two per year. The two 1994 cases involved nursery crop workers and the two 1995 cases involved vegetable crop workers.

Therefore, the previous finding of this report, based on the actual pattern of pesticide used, that the expected level of pesticide illnesses among agricultural production workers in the county was a little larger than one per year is in good agreement with the actual reports of between one and two per year. The central tenet of epidemiology is that the number of cases will be determined by the overall level of worker exposure to risk. The agreement between the predictions of epidemiology and the actual record of cases is strong evidence that the assessed level of risk we have made is probably correct, even though the number of cases is quite so small as to be statistically unreliable.

The finding that nursery crop workers experienced half of the reported cases of farm worker pesticide illnesses in the county during 1994-95 (2 out of 4 cases) requires further discussion. Recalling the findings regarding farm employment in the county, employment in

the nursery crop industry is about 1,000 on a year-round basis. Most of these jobs are permanent, with only relatively brief periods without work, in contrast to workers in most other crop industries. Thus, nursery crop workers are likely to experience the greatest amount of risk, given their repeated exposure to pesticide applications, irrespective of how much material is applied. In contrast, most tree fruit jobs are short-term, which probably limits the number of applications to which a worker might be exposed.

Vegetable crop employment ranks next in importance in Santa Clara County and, at peak season, vegetable farmers directly hire more than 1,000 persons. The finding that half of the agricultural occupational pesticide illnesses in recent years are among vegetable workers is consistent with the level of employment and, therefore, exposure.

The two cases of farm worker pesticide illness reported in 1995 involved diazinon, an unrestricted material in 1994 that was the most widely used of the ten leading chemicals used in agriculture in the county as measured by the number of individual applications. This finding suggests that an epidemiological analysis based solely on the total pounds of each material applied may not be the best predictor of illnesses. Rather, it is necessary to take account of the number of applications as well. It is worth noting that diazinon was reclassified as a restricted material subsequent to 1994.

of restricted materials. In a number of such inspections citations have been issued for failure to comply with state pesticide safety law. County-imposed restrictions on the use of metam-sodium and on the application of pesticides using aircraft are commendable and reflect a concern for both worker health and safety as well as that of urban residents.