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INVESTING IN CLEAN AGRICULTURE:

HOW CALIFORNIA CAN STRENGTHEN AGRICULTURE, REDUCE POLLUTION AND SAVE MONEY

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Editor: Nicholas L. Cain
Designer: Bryan Kring, Gas Tank Graphix, Oakland, California
Copy Editor: Joe Sadusky, Gas Tank Graphix, Oakland, California

Pacific Institute for Studies in Development, Environment, and Security
654 13th Street
Preservation Park
Oakland, California 94612

Tel: 510-251-1600
Fax: 510-251-2203

PACIFIC INSTITUTE

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ABOUT THE AUTHOR

Gary Wolff, P.E., Ph.D., is the principal economist and engineer for the Pacific Institute. Dr. Wolff is an expert in the economics and engineering of the water sector, including conservation, end-use efficiency, privatization, and incentive policies. His work encompasses water, wastewater, and storm-water issues. More generally, he maintains an active interest in all public policies and engineering technologies that lead to better management of natural resources and pollution. More information about his work is available from the Pacific Institute's website at *http://www.pacinst.org/about_us/staff_board/wolff/.*

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

GLOBAL COMPETITION, suburban encroachment, tighter regulations, and rising input costs are making farming in California more difficult and often less profitable. At the same time, pesticide pollution from farming is causing significant harm to California's surface and groundwater, air quality, and to human health. But there is a way to address these problems that helps farmers and protects the public: raise the pesticide mill fee and use revenues to encourage voluntary changes in on-farm practices.

The California Performance Review is causing state leaders to consider significant reform. A system that encourages farmers to "go beyond compliance" will make future regulation of agricultural runoff and air emissions simpler, less costly, and more effective.

Pesticide regulation in California has focused almost exclusively on safe standards for use. But safe standards are only one way to reduce the harms and risks of pesticide use. Policies that cost-effectively reduce total use are also possible, and have been used successfully to reduce pesticide use from 20-75% in Iowa, Denmark, and Sweden. Even modest reductions (e.g., 10%) achieved voluntarily by farmers would be a significant accomplishment with many benefits for the environment, farmers, and human health.

This report evaluates a policy of temporarily increasing the existing pesticide fee by 79 mills (7.9% of the wholesale cost of pesticides, for three years), with rebate of most revenue to participating farmers. The remainder would be spent to train participating farmers in voluntary sustainable farming techniques, and to provide insurance against the risk of crop loss from alternative practices. This policy would:

- Help farmers respond proactively to the more stringent water and air quality regulations that are inevitable as urban populations expand into farm areas (misperceptions of the risk of alternative practices are common and are a major impediment to adoption of cost-effective practices that are available today)

> Even modest reductions in pesticide use—achieved voluntarily by farmers—would have many benefits for the environment, farmers, and human health.

- Reduce pesticide pollution and the environmental and health harms it causes
- In the long run, save the state and local governments money by reducing future health, regulatory, and clean-up costs that are often borne by taxpayers.

Because urban users of pesticides pay about 50% of the pesticide mill fee, a system that spends additional mill fee revenue to encourage change in the farm sector does not create a net burden on farmers. In fact, it would bring about $60 million per year into the farm sector from the urban sector. This is fair and desirable for urban users[1] since many of the environmental and health harms of excess pesticide use on farms are now borne by downstream urban dwellers. By temporarily increasing the mill fee statewide and using revenue to support farmers who voluntarily clean up their farm practices, urban dwellers and farmers would be working together to solve many problems — economic, environmental, and medical — that will cost much more to ignore or to "solve" through litigation and the usual political battles.

1 Some sellers of consumer pesticides have threatened to litigate over what they perceive as an existing "subsidy" from urban to agricultural pesticide users. They believe current California Department of Pesticide Regulation spending benefits farmers at the expense of urban pesticide sellers and users. An alternative policy – discussed toward the end of this report – that would be less offensive to these parties is a higher mill fee on agricultural pesticides only, and a water source protection fee levied on non-agricultural water consumers.

INTRODUCTION

CALIFORNIA'S AGRICULTURAL SECTOR IS impressive. It produces a very wide range of fruit, vegetable, nut, and row crops, as well as meat, dairy products, and horticultural products like cut flowers and landscape plants. Annual gross revenue is about $28 billion (DOF, 2003),[2] almost 50% more than the combined output of the second- and third-largest producing states (Texas and Iowa). On the other hand, unintentional by-products of farming like air and water pollution are a significant financial burden for current and future generations of Californians that should be "netted against" farm sector output in a complete and rational accounting system.

According to the work of others cited throughout this document, maintaining a strong agricultural sector while reducing the unintended consequences of farming requires a transition to sustainable agriculture.[3] The 1990 U.S. Farm Bill defined sustainable agriculture as "an integrated system of plant and animal production practices that will, over the long term: satisfy human food and fiber needs; enhance environmental quality and the natural resource base upon which the agricultural economy depends; … integrate where appropriate, natural biological cycles and controls; sustain the economic viability of farm operations; and enhance the quality of life for farmers and society as a whole."

This is not a radical definition or a call for the end of farming, as we know it.[4] It is in our opinion the only way to escape long-term social forces that could be very detrimental to farms and farmers and food security.[5] These forces — global competition, suburban encroachment, tighter regulations, and rising input costs — are making farming in California more difficult and less profitable. A "business as usual" future likely involves fewer farms and farm acreage,[6] water sold or transferred to cities, less business for rural merchants, and fewer jobs for farm workers.

Sustainable agriculture is the only way to escape long-term social forces that could be very detrimental to farms and farmers.

The combination of these pressures has and will continue to lead toward higher value-added commodities that under conventional practices use considerably more pesticides per acre, as described in the next section.

Global competition is here to stay, and tighter regulations are appropriate. Pollutants in storm runoff from farms affect the water supply of at least 20 million Californians and are harmful to other parts of the California economy (e.g., fishing and recreation), groundwater is often being extracted faster than nature can recharge it, and air quality in some farming areas is now worse than in urban areas.[7] Environmentalists and regulators are not driving farmers off the land; underlying social trends like rapid population growth, urbanization, and global competition are, and they aren't going to stop.

2 This is about 2% of annual economic output in California.

3 Parts of the transition have begun. Swezey and Broome (2000) say "alternative farming systems could comprise at least 20% and as much as 60% of all California cropland in production by 2025." But what could be and what will be are obviously different.

4 Committees of the National Research Council composed of leading agriculturalists in academia, business, government, and the nonprofit sector have twice made similar recommendations (NRC, 1989 and 1996).

5 Food security refers to sufficient production of food to support the local population in an extended crisis, e.g., a war that disrupts regional or international trade.

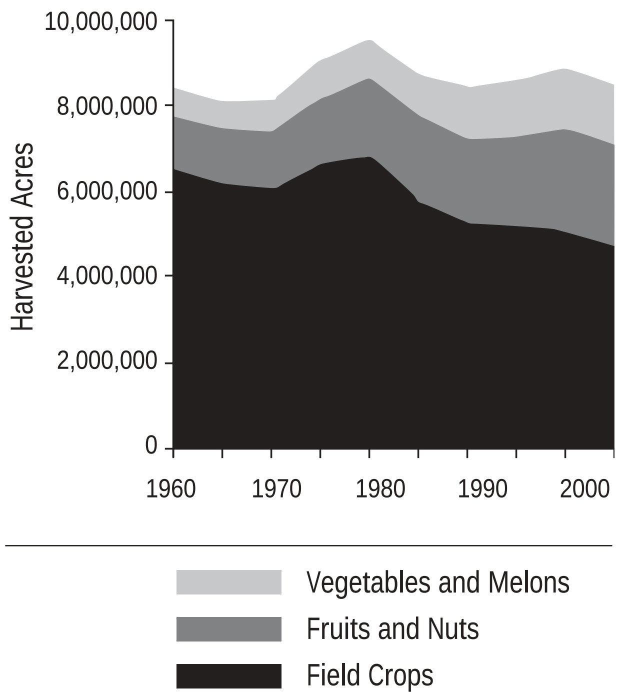
6 The US Census of Agriculture (2002 and 1997) shows about a 10% decline in farm acreage in California in the last 15 years (about 27.6 million acres in 2002 versus about 30.6 million acres in 1987). Total harvested acreage (see Figure 1), however, has not declined noticeably since 1960, which suggests that either non-cropland farms (e.g., ranches) are being consumed by urban sprawl or that non-crop farmland uses are converted to crops as croplands near urban centers are consumed by sprawl.

7 Kegley, et. al. (2003) and Kegley, et. al. (1999) summarize current science and data on air quality and ecological impacts of pesticide use in California.

TAKING THE LONG VIEW:
CALIFORNIA FARMS AND EFFICIENCY

If we want to maintain the strength of the California farm sector in the long run, we need to get past the usual political divides and ask what is needed to achieve sustainable agriculture as defined in the Farm Bill. In the long run, California agriculture must use more information and knowledge and less of nearly every other input (e.g., land, water, pesticides, fuels). We are already part of the "Fruitful Rim" region identified by the USDA as producing 22% of US agricultural production on only 8% of cropland.[8] And the historical trend toward high value-added commodities like fruits, nuts, vegetables, and melons (Figure 1) will likely continue.

Figure 1: Harvested Acres by Crop Category in California, 1960-2002[9]



This trend has increased pesticide use per average acre, because higher value-added crops use pesticides more intensively (Table 1). Unless we widely implement the best available clean production practices, the natural response of farmers to global competition and other pressures (i.e., to intensify production and use more pesticides) will lead to a head-on collision with the natural response of a larger and more affluent California population (i.e., to protect water and air quality). Taking the long view means recognizing and solving this conflict before it becomes a political crisis.

Table 1: Pesticide Intensity and Gross Revenue per Acre in California

	Pounds of Pesticides/Acre[1]	Gross Revenue/Acre[2]
Row Crops	7.13	$ 640
Fruits and Nuts	51.25	$2,936
Vegetables and Melons	21.24	$4,856

Notes: (1) From Kegley, et.al. (2000), using 1998 data
(2) Estimate by author, using 2000 data from the DOF (2003)

Another important trend in California is the budget crisis and the way it is affecting government programs. Even after Proposition 58 bond revenues of $15 billion are used in fiscal year 2004-2005, billions of dollars of deficits are projected for later fiscal years. Actions that help the budget not just this year or even next, but in the long-term, are needed. That is why the California Performance Review has been undertaken, and the Governor has made some administrative decisions with significant potential to create long-term savings.[10] Farm policies in California need to be reformed based on the long view. We need policy innovations in regulation, not just belt-tightening accompanied by promises to eliminate inefficiency in the state bureaucracy. This report focuses on pesticide policy, but places it in the context of other, broader policy issues such as water and air quality protection, long-term control of health care costs, and crop production risk management.

8 See www.usda.gov/emphases/harmony/issues/resourceregions/resourceregions.htm.

9 Data faxed by Gary Nelson, California Agricultural Statistics Service, "Principal Crops: Harvested Acres, California, 1950-Present (June 2004)."

10 For example, the Governor appointed Jeanne Woodford to run the California Department of Corrections. She has created programs at San Quentin that seem to reduce recidivism at little state expense. Since it costs on average $31,000 per year to house a prisoner, and two-thirds of those released return to prison within 18 months (twice the national average rate), policies that reduce the number of prisoners who return are very helpful to the state budget, in the long term (The New York Times Magazine, March 14, 2004).

PESTICIDE REGULATION:
SAFE STANDARDS VERSUS USE-REDUCTION

CALIFORNIA'S PESTICIDE REGULATORY structure is based almost exclusively on safe standards policies.[11] Safe standards policies aim to make pesticide use safe by training and licensing those who handle pesticides, by controlling when and where and under what conditions (e.g., not immediately before rain) pesticides can be applied, and by informing people when pesticides are being used so they can take appropriate action to avoid exposure if they are particularly vulnerable to or concerned about exposure. Safe standards regulation is necessary and important, but it is not the only way to manage the risks from pesticide use.

For example, a car with airbags costs more than one without, but the airbags reduce the risk of injury. Driving less would also reduce the risk of death or injury from a car accident, and might save money as well. In fact, insurance companies charge more to drivers who drive more miles. This example doesn't mean that driving less is better than an airbag. They are complementary ways of reducing risk: both are useful.[12]

We also know from the history of toxicology and other sciences related to public health that today's safe standards are often found to be unsafe at a later time. For example, organophosphate (OP) pesticide toxicity has been the focus of regulatory efforts for the past decade, with some notable successes such as phasing out the use of these compounds in urban areas. Recently, however, we have begun to learn that one category of substitutes for OP compounds — pyrethroids — that were believed to be less toxic may have different, but equally damaging toxicity characteristics.

Use reduction — when it is cost-effective — is a tool that complements safe standards by also reducing risk. Rather than assuming that safe standards are always safe, it is smart to reduce use and exposure to potentially harmful substances or activities when alternatives exist. We know from experience in several countries and states (Box 1) that large percentage decreases in pesticide use can be achieved cost-effectively.

Box 1: Pesticide Use Reduction Experience Outside California

Denmark has a pesticide charge that is tiered from 3% to 35% of the retail sales price of the pesticide. Most categories of pesticides are subject to a 25% or 35% rate. Microbiological plant protection products are subject to the 3% charge. The Danish objective — established in the 1986 National Pesticide Action Plan — was to reduce pesticide use by half by 1997. The target was exceeded, with an actual decline from 1985 to 2001 of 59% (Ministry of the Environment, 2001). The Danish system included reduction of the property tax on agricultural property to offset the burden of the higher pesticide charge.

Sweden has specific charges — that is, a specified "dollar" amount per kilogram of active ingredient. The equivalent percentage rate of the Swedish charge was about 30% of retail price in 1990. Pesticide use declined by 65% between 1986 and 1993, and was on target to achieve the national goal of 75% decline (Pettersson, 1997). About 3/4 of the reduction through 1993 (3/4 of 65%, or about 48% of initial use) resulted from a decline in pesticide use on cultivated lands.

The state of Iowa — the third-largest agricultural state in the US — made a commitment to sustainable agriculture starting with the passage of Iowa's Groundwater Protection Act in 1987. There were two university centers and 22 programs supported by pesticide and nitrogen fertilizer fees. Total pesticide use on corn and soybeans was rising prior to 1985, but declined from 1985 to 1990 and from 1990 to 1995. For example, intensity of use per harvested acre of corn declined by about 23% from 1990 to 1995, from 1.07 to 0.82 pounds of active ingredient (Hartzler, Wintersteen, and Pringnitz 1997).

11 This was less true prior to the budget crisis, although even then less than 2% of the Department of Pesticide Regulation budget was explicitly for use reduction activities.

12 Sunding and Zivin (2002) compare the efficiency of occupational safety regulations versus taxes or bans with respect to pesticide poisoning of lettuce farm workers in California. Not surprisingly, protective clothing and closed cab regulations are the lowest-cost way to achieve reductions in poisonings. After all, these tools directly reduce human exposure. Their work provides a model, however, within which one can see that safe standards regulations have the side benefit of reducing total pesticide use and ambient contamination (because regulations make pesticide use more expensive), while a pesticide tax also reduces human exposure because it reduces total use. If a single objective exists, a single policy might be best. When multiple objectives exist (in this case, to reduce both human exposure and ambient contamination), multiple policies that reinforce one another are often best.

The Multiple Benefits of Pesticide Use Reduction

Pesticide use reduction has multiple benefits. It can strengthen the financial bottom line for California commodity growers while reducing water pollution. And it can be implemented in a voluntary way that "goes beyond compliance" in order to reduce the cost and severity of inevitable, future water quality regulations for agricultural runoff.

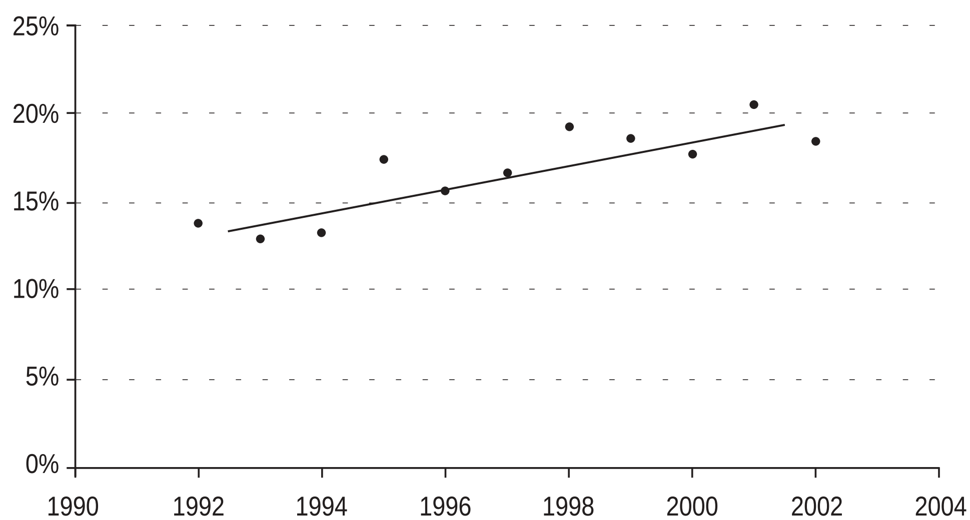
Spending on pesticides as a percent of net income has grown steadily in the last decade (Figure 2). The trend has made profitability more difficult to attain. A trend like that cannot be sustained for inputs. Controlling costs through more efficient use of inputs is necessary for California's farm sector to thrive. Pesticide use reduction policies that lead to wider adoption of cost-effective pest management practices can help to increase net income for California farmers.

Pesticide use reduction would also reduce environmental impacts. Agricultural runoff has been exempt, historically, from water quality regulation. An intense regulatory and legal battle is now underway over future regulation of agricultural runoff. Recent actions of the Central Valley Regional Water Quality Control Board and the State Water Resources Control Board with regard to this issue will be challenged in court. The debate is no longer about whether farm runoff will be regulated; it is now about the details of future regulation. Pesticide use reduction policies could make future regulation of agricultural runoff simpler, less costly, and more effective.

> Pesticide policies can help increase net income for farmers while reducing environmental impacts.

Pesticide use reduction can also help with state and local budget problems, eventually. A credible nationwide estimate of the costs of pesticide use

Figure 2: Pesticide Expenditures as a Percent of Net Farm Income in California[14]



13 A credible statewide analysis of these costs has not been performed in California. Numerous studies, however, confirm the environmental and health damages caused by pesticide use, although these damages are expressed in physical rather than economic terms. See for example, Solomon (2000).

14 Data from DOF (2003 and 2000).

(Pimentel, 1997) found there are two dollars of cost to society for each dollar spent by farmers to purchase pesticides. These "external costs" include medical expenses and harms to businesses that depend on natural systems (e.g., fishing, recreation, and tourism). Since Californian's spend about $1.7 billion per year for pesticides, external costs are possibly in excess of $3 billion per year.[13]

Realistically, these external costs cannot be fully internalized by increasing pesticide prices. One would need to double or triple the price of pesticides, which is neither economically nor politically feasible. Furthermore, it is not possible to conclusively connect

> How large is the opportunity to cost-effectively reduce pesticide use in California agriculture?

Box 2: Pesticide Use and Government Budgets: Potential Impacts

Health care spending among those aged 0-64 in California is about $62 billion per year (Kominski and Roby, 2004). Medi-Cal expenditures are budgeted at $33 billion in fiscal year 2004-05 (DOF, 2004). County government spends about $5.3 billion each year on health related services (CICG, 2003). And hospitals and safety net clinics in California spend over $3 billion per year caring for the uninsured (Kominski and Roby, 2004). More than half of the nearly 10 million emergency room visits each year (CCIG, 2003) are for non-urgent services that cost six times more to provide in this way than through a doctor's office. Asthma, especially in children, has risen dramatically in California. Asthma hospitalizations cost $480 million in California in 2000, with about a third of these stays paid through Medi-Cal (Department of Health Services Strategic Plan for Asthma). Dr. David Pepper, director of the Asthma Education and Management Program at the Fresno University of California Medical Center, says outpatient costs for treating asthma are about $1,000 per patient per year (personal communication, Susan Kegley).

How much of these expenditures is pesticide-related? We don't know with certainty. But numerous reputable, peer-reviewed studies support the link between pesticide exposure and human health problems (Solomon, 2000). And numerous pesticides are known causes or contributors to asthma. See, for example, the Association of Occupational and Environmental Health Clinics on-line look up system (*http://www.aoec.org/aoeccode.htm*).

Monitoring data on pesticides in California's water supplies or air (from spray drift) is far from comprehensive. But the little we know suggests strongly that exposure and consequent health costs are significant. For example, a study by the US Geological Survey (1998) of domestic groundwater wells in the San Joaquin-Tulare Basin found at least one pesticide in 59 of 100 samples, and at least three pesticides in 29 samples. California Department of Health Services records showed 79 sites in Tulare County, 40 in Fresno County, 25 in Orange County, and 20 in Los Angeles County as containing pesticides at levels that exceeded EPA cancer levels (Heavner, 1999).

Every honest review of the evidence concludes that there are substantial costs associated with pesticide use other than the cost of purchase. The size of those costs is the only question. Suppose, for comparison with the policies suggested in this report, that 1% of the health costs above were pesticide-related. This would amount to $620 million per year of total health care spending for Californians aged 0-64; $330 million per year of Medi-Cal expenses; $53 million per year of county spending for health care; or $30 million per year of emergency room expenses. Even the least of these is significantly more over time than the cost of the policies discussed in this report ($31 million per year, for only three years; see subsequent discussion). The potential health benefits alone justify serious consideration of innovations in pesticide policy in California.

Some of the other impacts that may affect government budgets are emergency response costs, monitoring costs, loss of fish and birds and associated license revenues, and loss of beneficial insects and pollinators (which reduce crop income, and thus income and sales tax revenues). A comprehensive examination of the potential budget implications of reduced pesticide use in California has not been done, but would be worthwhile, perhaps as part of the annual budget process.

pesticide use with line item budget expenditures. But we can recognize that the social costs of pesticide use will decline if pesticide use declines, and that some of these social costs are paid for via government budgets. Some examples of the possible magnitude of budgetary impacts are provided in Box 2. Like the prison recidivism example in footnote 10, there are policy choices that have long-term impacts on budgets, even though quantifying those impacts is not possible at present.

Opportunities for Change, Opportunities for Profit

All farmers can reduce pesticide use, but doing so is economically desirable from their perspective only when the net reduction in expenses plus price premiums for products is greater than the value of losses in yield. A large body of peer-reviewed research based on field trials shows that lower pesticide input practices — including but not limited to organic practices — can be as or even more profitable than business as usual.[15]

For example, Zalom (1997) provides historical examples of integrated pest management (IPM) techniques to reduce insecticide use in fruit crops that were very beneficial economically. These include control of red scale on citrus in California that costs 80% less than similar levels of control using organophosphate chemicals alone, control of spider mites in orchards for 50-66% less than that of previous practices, and annual returns on investment from IPM research for almonds of between 500 and 600%.

Research at the University of California at Davis demonstrated this point for other crops in the California setting (Klonsky and Livingston, 1994). The Davis researchers compared four cropping systems over four years for five crops: tomatoes, safflower, corn, winter grains, and beans. At premium prices for organic products, the organic system was significantly more profitable for tomatoes, corn, and beans. At conventional prices for all products, corn was most profitable in a low-input system[16], and beans were still most profitable in the organic system. Winter grains were profitable only in the low-input system; that is, conventional and organic practices for growing winter grain created net losses.

> Even if the potential for cost-effective reductions in pesticide use is large, uncertainty about new technologies and practices is a very real obstacle to change.

The challenge to California farmers is nicely stated in a pamphlet prepared by Iowa State University: "Eight Ways to Reduce Pesticide Use" (Wintersteen, et. al., 1999). The pamphlet provides examples of reductions in pesticide use that increased profits on Iowa farms, and summarizes the theme that runs through the success stories:

> Profit margins vary widely in farming. The key is to think in terms of net return, rather than maximizing yield. For example, a $5,000 insecticide application that results in a $3,500 increase in yield amounts to a $1,500 loss in profits. When commodity prices change, farm input use has to be reconsidered. Because prices vary over time, it is important to reevaluate pest management at least yearly. … Using a $50 sledgehammer when a $5 hammer will do is unnecessary and unprofitable. It takes an independent manger to use a hammer when the neighbors are using sledgehammers, but a profitable balance sheet is persuasive in the end. (p. 1)

15 In addition to the examples provided in the text, see Reichelderfer (1981 and 1985); Cate and Hinkle (1993); Ikerd, Monson, and Van Dyne (1993); Diebel, Williams, and Llewelyn (1995); Hanson, Lichtenberg, and Peters (1997); Schillhorn van Veen, et. al. (1997); Srivastava, Smith and Forno (1999); USDA (2001); and www.sustainablecotton.org/BASIC.

16 Low input is less than common practice, but not organic. See Klonsky and Livingston (1994) for details.

Maximizing net return is more information-intensive than maximizing yield. It requires that applications of chemical controls be made based on factors other than time of year or stage of crop development or contract requirements that say one has to spray at specified intervals (e.g., every month). Maximizing return requires that controls should be used when monitoring or other site-specific knowledge indicates that a pest is present or will soon be present at levels that will cost the farmer more in lost yield than the cost of control. Farmers who don't have this knowledge will tend to overuse pesticides. For example, several studies show that farmers who depend on the advice of pest advisors who also sell pesticides use 25-50% more pesticides than farmers who do not (Box 3).[17]

> If we want to maintain the strength of the California farm sector in the long run, we need to get past the usual political divides.

Box 3: Pesticide Overuse and Knowledge

Robert Van den Bosch (1978), one of the entomologists who helped to invent the techniques we now call Integrated Pest Management (IPM), believed that pest control advisors should be prohibited from having a financial interest in the sale of pesticides, just as medical doctors are licensed separately from pharmacists because an inherent conflict of interest exists between the function of prescribing medicines and selling them.

His concerns have been supported by empirical studies such as those of Hall (1977), Burrows (1983), Hall and Duncan (1984), and Wiebers, et. al. (2002). The first three studies found that farmers who depended on advice from independent pest management consultants used about 50% less pesticides, experienced slight reductions in yield, and were as profitable as farmers who relied on pesticide salesmen for advice. The last study found that tomato growers who relied on their own judgment spent 26% less (saving about $5.5 per acre) than growers who relied on the advice of pest advisors who also sell pesticides.

The study on tomatoes looked only at spending on insecticides to control fruit and army worm damage in late-season processing tomatoes in California. This study is particularly relevant because the IPM Group of the University of California (1998) has developed procedures for control of these pests that significantly reduce late-season insecticide use without a corresponding increase in worm damage.

The study shows that superior practices are not always adopted, and helps explain why that is so. One reason is incomplete growers' knowledge, both actual and as perceived by pesticide salesmen.

Nearly two decades ago, Pingali and Carlson (1985) showed that the level of fungicide and insecticide use is dependent on knowledge by growers. Weibers et. al. (2002) also find that "More pesticides are suggested for use on fields where growers are perceived to be less informed … Therefore, increasing the perception of grower education through improved training would help to reduce chemical pesticide use. Furthermore, such training is likely to increase the profitability of farmers …" (p. 97)

17 Hall and Moffitt (2002) report that the Director of the California Department of Food and Agriculture worked with the California legislature in 1980-1981 on a policy to summarize the already-required written reports of pest control advisors by commodity and to offer the summaries to growers to aid in their choice of advisors. A bill to this effect was introduced but defeated.

How Much Pesticide Use Reduction Is Cost-Effective?

How large is the opportunity to cost-effectively reduce pesticide use in California agriculture? We know the technical opportunity is large. For example, Zalom (1997) estimated that pesticide use for five crops in California (apples, grapes, oranges, pears, peaches) could be reduced from 10.4% (oranges) to 22.6% (apples) if IPM techniques were fully applied to all acres of these crops. He estimated a further reduction in use of approximately 33% was possible if the most efficient application technology were used. The total reduction potential amounted to 40-50% of use. This estimate, and others (Box 4), shows that although some California farmers have implemented resource-efficient, knowledge-intensive pest management practices,[18] there are still many technical opportunities to reduce pesticide use.

But how much of this is cost-effective to implement? We know that some is, as the studies and examples in the previous section demonstrate. But we do not have a comprehensive statewide estimate of the cost-effective potential for use reduction. We attempted to perform that assessment for some of the most pesticide intensive crops in California.[19] Unfortunately, the attempt was not successful because sufficient pesticide price data were not available. Fortunately, the data are available in principle. Appendix A describes the approach we took to answering this very important question, the data problem we faced, and how it could be overcome by a relatively small commitment of staff resources at the California Department of Pesticide Regulation (DPR).

Perceptions of Risk and Barriers to Change

Even if the potential for cost-effective reductions in pesticide use is large, uncertainty about new technologies and practices is a very real obstacle to change. Risk-averse farmers will give up some profit in order to reduce the variability of net returns from farming (Headly, 1985; Tisdell et. al., 1984). Bosch and Pease (2000) provide a thorough discussion and reference list for this issue.

Box 4: Some Examples of the Technical Potential for Use Reduction

The Biologically Integrate Farming Systems (BIFS) Program of the University of California Sustainable Agricultural Research and Education Program (SAREP) was established in 1994. It was modeled on an almond project that SAREP participated in created by the Community Alliance With Family Farmers. That project found that almond yields from organic orchards could be comparable with those from conventional orchards. At least nine BIFS projects in nine different farming systems have been funded since 1995.

For example, a wine grape BIFS project involving 43 growers and 2,370 acres used intensive monitoring of weeds, pests, and beneficial insects to obtain a reduction in the proportion of BIFS vineyards sprayed for mites or leafhoppers from 54% in 1996 to 28% in 1998. The percentage of acreage treated with pre-emergence herbicides declined from 70% to 59%. Similarly, a BIFS prune project involving 877 experimental acres farmed by 33 prune growers found that growers could eliminate wintertime sprays of diazinon — an organophosphate insecticide routinely found in California rivers — without adverse effects on farming operations. And a BIFS apple project found that pheromone mating disruption for coddling moth on 311 acres in 11 apple orchards allowed a reduction in use of organophosphates and carbamates of 59% and 92%, respectively. (Personal communication with Marco Barzman, SAREP coordinator, and *www.sarep.ucdavis.edu*).

Fernandez-Cornejo et. al. (1994) found that farmers who adopted IPM practices were less risk averse than farmers who did not adopt. This is consistent with a belief that IPM practices are more risky than conventional practices. But Hanemann and Farnsworth (1981) found that this belief existed primarily among farmers who had not used IPM; farmers familiar with IPM techniques believed they involved less risk than conventional practices. Hence the perception of risk is as important as the reality. Wiebers et. al. (2002) conclude: “Improved training could also change the current perception of many growers that IPM qualitative techniques are risk increasing. This would lead to increased IPM adoption and lower chemical pesticide use.”

18 Some growers have taken significant steps toward lower pesticide use practices. For example, Tanimura and Antle (the nation’s largest independent lettuce producer), Driscoll (strawberries), Dole (almonds), Paramount Farms (citrus), Pavitch family farms (table grapes and raisins), and Fetzer, Frog’s Leap, and Frey Vineyards (wine) use all or some of their acreage for organic production of premium products (Holmes, et. al., 2001). And Robert Mondavi and Gallo vineyards have reduced chemical inputs to cut expenses and reduce liability.

19 Data on intensity of pesticide use by commodity are presented in Table 2 later in this report.

Federal crop insurance requirements have reinforced the misperception that all lower pesticide use practices are more risky. The requirements deny payment of claims to farmers who do not implement all available measures to prevent losses. This can force farmers to spray when they would not do so otherwise.

Commencing in 2003, however, the US Risk Management Agency (RMA) waived this requirement for growers who pay a 5% surcharge on their crop insurance premiums (e.g., organic growers). Unfortunately, by imposing a surcharge, the RMA is demonstrating that it believes that growers who are cautious in their use of pesticides have a greater chance of damage from pests than conventional growers. This is demonstrably untrue for some commodities in some locations.

Factually, lower pesticide use practices can be more or less risky than higher use practices depending on the practice, the crop, its location, soil type, and other issues. Public policy that corrects inaccurate perceptions of risk through farmer education and on-farm demonstrations is likely to increase farm profits and have the socially desirable side effect of reducing pesticide use.

Programs Versus Incentives

Prior to the current budget crisis, the California Department of Pesticide Regulation's (DPR) pest management alliances (PMAs) and other state programs (e.g., UC SAREP and IPM, etc.) helped farmers to control pests with fewer pesticide inputs. These efforts were not just good for the environment; they also made economic sense. We believe that restoration to previous budget levels, or increased budgets for these programs, would generate net benefits for growers, the environment, and future state budgets.

Given the political situation at present, however, this report does not focus on new programs or restoration of previous funding levels of existing programs. Our focus is on a policy innovation that might be adopted this year or next.[20]

Incentives motivate people. The programs mentioned do not create motivation, but assist those who are motivated to make changes. In the long run, both are valuable parts of any solution. But the incentive part of the solution is weak in California, and the possibility of restoring budgets for these programs right now is low. In our opinion, the best action now is to convince the farm community that pesticide use reduction is worthwhile, and to motivate farmers to reduce use. This is a "beyond compliance" regulatory approach. It urges the agricultural community to do more than is required by regulations — today — because going beyond compliance benefits farmers in the long run.

There are few, if any, in the farm community who believe that regulation of agricultural runoff will not increase in the future. And there are many who believe that increases in the mill fee are inevitable. The pressure to regulate pesticides and agricultural runoff is not being driven by environmentalists who can be defeated in the legislature or the courts. Future regulations that will affect farmers are being driven by population growth, suburban sprawl into farm communities, and increased urban affluence and associated public concerns about the healthiness of food and water. Ultimately, these social trends will force California's farmers to adopt cleaner practices, go out of business, or operate only in the most remote parts of the state. Going "beyond compliance" now will make future water quality regulations simpler and less costly to implement.

20 Prior to the budget crisis, Wolff (2002) recommended a higher mill fee that would both eliminate the need for General Fund support for DPR and restore and expand programs that directly promote sustainable agriculture. The first outcome has occurred: DPR no longer depends on General Fund support.

OUR RECOMMENDATION

INCREASING THE PESTICIDE MILL FEE without a financial offset to the farm sector may not be politically feasible. The 21 mill fee[21] authorization that resulted from the fiscal year 2003-2004 budget negotiations shows how far away we are, politically, from the mill fees of 45 and 27 recommended by Senate and Assembly committees, respectively. Pesticide manufacturers and their sales associates were able to derail these recommendations by arguing that the proposal would increase costs for farmers and urban pesticide users.

Several countries, however, have overcome similar political hurdles by rebating revenue from environmental or resource use fees in a way that offsets the average burden of the increased fee.[22] A "refunded emissions payment" (Sterner, 1998) or "feebate" structure can create large incentives without burdening the economic sector paying the fees. This approach may convince farmers that the increased fee will not burden them. In fact, because California's mill fee applies to all pesticide use, not just agricultural use, this structure can return perhaps $2 to growers as a group for each $1 of additional fee.[23, 24] An alternative policy that exempts nonagricultural pesticide sales but has similar payments to farmers is described later in this report.

Here's how it might work. First, increase the mill fee on all pesticides from 2.1% to 10% of wholesale prices (i.e., from 21 to 100 mills), effective one year after legislation is adopted. The surcharge of 7.9% above the current level would sunset automatically four years after legislation is adopted (i.e., it would be in effect for only three years). This surcharge would probably raise $126 – $138 Million of additional revenue in its first year.[25]

> Going "beyond compliance" now will make future water quality regulations simpler and less costly to implement.

Second, rebate most revenue (75-80%) to participating farmers as a percentage of gross revenue from crop sales, payable after income tax returns for the previous year are submitted. The actual percentage of gross revenue a farmer receives would depend on how much revenue is raised each year, and how many farmers participate that year.

Participation each year would require only two actions by a farmer. First, they would need to attend an on-farm water quality and pest management course modeled on the water quality courses offered through the Farm Bureaus in the central coast region of the state (see *http://groups/ucanr.org/signup/index.cfm* for details). El Dorado County is exploring a similar program, and the Central Valley Regional Water Quality Control Board is considering the possibility of using this type of course as a component in future agricultural runoff regulations. Our recommendation, however, has no regulatory component. It would be a voluntary program to see how much improvement participating farmers can achieve, and how many are willing to participate. Farmers have reportedly responded very positively to

21 A mill is 1/10 of a percent, so 21 mills is 2.1%. California's fee on pesticides at their first point of sale within the state (in essence, a markup on wholesale rather than retail prices) has a long history. See DPR (2003) for a thorough discussion.

22 Hall et. al. (1989) consider a wide range of policy options for pesticide-related problems and argue that pesticide fees or subsidies for low input or organic farming are the best options overall, but due to competitiveness concerns have lower political feasibility. Rebating revenues appropriately is a policy variation developed in the 1990s specifically to overcome the competitiveness objection.

23 DPR (2003) reports that about 50% of current pesticide fee revenues are from agricultural products. The definition of agriculture used to obtain this estimate, however, may include revenues from sources other than production agriculture. Consequently, the 2:1 ratio is approximate, and might be too small.

24 Without the urban contribution that makes net gains for farmers possible, farmers are unlikely to support a fee increase with rebate unless this policy is the "lesser of policy evils." Despite their rhetoric about the advantages of market-based tools for environmental protection, industry groups rarely support these tools if a fee increase is involved. See Wolff (2000) for a lengthier discussion. Fortunately, in this case, a net gain is possible and "worse evils," in the form of future regulation of farm runoff, exist to motivate the farm community to try this policy approach.

25 DPR (2003) states that each mill raises about $1.6 million; hence 79 additional mills would raise about $126 million. Calculations by the author, however, using actual revenue since 1998, suggest that each mill might yield $1.7 million or so; hence 79 mills might raise about $138 million at first.

the central coast program (personal communication, Jenny Derry, Executive Director, Santa Clara County Farm Bureau).

In these courses, farmers learn how to reduce polluted runoff from their farms using a variety of techniques, including but not limited to lower pesticide application rates. The course curriculum would need to be reviewed by a wide range of stakeholders to be sure the full range of options are presented, impartially. Farmers who take these types of courses also create a confidential plan for their own farm, which they are expected to implement voluntarily after completing the course. Farmers would need to attend the course in each year they seek a rebate. Courses after the first year would need to be designed as site visits to see in the field what other farmers are doing, and to discuss with other farmers and various experts implementation obstacles and solutions.

Second, each participating farmer would need to fill out a one-page form — perhaps integrated with their income tax filing each year — providing the information required to issue a rebate check.

Not all revenue would be rebated, because there are a few other expenses needed to make this program work. One is administrative overhead. Based on Swedish experience with a similar system for reducing emissions of nitrogen oxides from electric power plants, overhead would consume less than 1% of revenue. The mill fee and income tax systems already exist; this policy would not require new bureaucracies.

A more significant expense is payment for the on-farm courses. Based on experience in the central coast region — where the Farm Bureaus have worked in collaboration with UC Agricultural Extension staff — one could offer yearly courses to all farmers in California for $15 million per year or less.

Finally, it will cost up to another $15 million per year to eliminate the perverse incentive in the federal crop insurance program mentioned above. Currently, farmers are required to pay a 5% surcharge on their insurance premiums to avoid rejection of claims because a farmer did not use “all available means” to protect the crop. It would be desirable for the state to pay the 5% “organic” surcharge for all participating farmers. This helps to offset the perception of risk

Most California farmers will get back more money in rebates than they pay in higher mill fees.

associated with lower pesticide use practices. It would also help the U.S. Risk Management Agency to obtain data on the frequency and size of claims as a function of pesticide use practices.

Impacts on Growers

We evaluated the impacts of the fee and rebate proposal on the costs and returns from growing selected commodities (Table 2), assuming 80% of farmers participate. When cost and return study data from UC agricultural extension were available, we evaluated the most pesticide-intensive commodities identified by Kegley et. al. (2000). We also evaluated selected commodities with lower pesticide intensity. Seventeen of 22 (77%) of the commodities evaluated are estimated to receive more money in rebates than they would pay in additional mill fee. Since the 22 crops evaluated are skewed toward the most pesticide-intensive crops, the list shows that most California farmers will get back more money in rebates than they pay in higher mill fees.

Net benefit after rebate (furthest column to the right) reflects a rebate of 0.64% of gross income (second column from the left) less the additional mill fee (second column from the right). Gross income and pre-reform pesticide costs per acre are from University of California cost and return studies located at *http://www.agecon.ucdavis.edu/outreach/crop/cost.htm*. The rebate per acre was estimated as total revenue of $132 million less other costs ($15 million insurance premium, $15 million of course costs, about $1 million for administration), divided

Table 2: Financial Benefit by Commodity Type, per Acre per Year (ranked by intensity of pesticide use)

Commodity	Intensity of Use[26] (lbs/ac/yr)	Gross Income ($/ac/yr)	Pre-Reform Pesticide Cost ($/ac/yr)	Additional Mill Fee ($/ac/yr)	Net Benefit After Rebate ($/ac/yr)
Strawberries, Conventional	140.27	$30,648	$1,562	$120.88	$74
Strawberries, Organic	Not Available	$31,875	$628	$48.59	$154
Pears	119.72	$5,682	$784	$60.70	-$25
Carrots	82.44	$2,106	$221	$17.10	-$4
Lemons	63.15	$6,840	$290	$22.44	$21
Grapes, Table and Raisin	53.85	$2,550	$70	$5.42	$11
Peaches	53.80	$4,620	$198	$15.32	$14
Nectarines	49.59	$8,400	$347	$26.85	$27
Grapes, Wine	47.51	$5,650	$193	$14.93	$21
Watermelon	47.28	$5,515	$335	$25.92	$9
Tomatoes, Processing	36.37	$1,802	$115	$8.89	$3
Tomatoes, Fresh	25.18	$5,720	$132	$10.21	$26
Almonds	20.88	$2,527	$268	$62.21	-$5
Walnuts	11.66	$3,348	$187	$14.47	$7
Rice	11.35	$640	$29	$2.24	$2
Olives, Table	11.07	$2,125	$150	$11.61	$2
Melons	9.82	$3,140	$235	$18.18	$2
Cotton, Pima	9.30	$1,035	$224	$17.33	-$11
Corn	4.85	$506	$13	$1.01	$2
Wheat	0.92	$320	$3	$0.23	$2
Pasture	0.45	$144	$7	$0.53	$0
Alfalfa	0.24	$666	$64	$4.98	-$1

by 80% of $19.7 billion of crop revenue in 2002 (DOF, 2003), times gross income per acre. This is a rebate of 0.64% of gross income for the 80% of farmers assumed to participate.

The five crops estimated to have negative benefits have low market value relative to the amount they spend on pesticides. For example, pesticides are reported to be nearly 22% of the gross income of cotton and nearly 14% of the gross income of pears. The dividing line, in this respect, is 8.2% of gross income. That is, any farmer who spends less than 8.2% of gross income on pesticides in any year of the program and participates in the water quality and pest management course would receive a rebate check larger than the additional mill fee he or she would pay in that year. Since California farmers in 2002 spent about 5.3% of gross farm income on pesticides on average (DOF, 2003), most farmers will benefit financially from the policy.

Overall, the system would have minimal or positive financial impact on the vast majority of California growers. This is possible because urban pesticide users would pay around half of the increase in mill fee but would not receive rebates. But urban users would benefit from fewer pesticides in their water supplies and healthier natural systems throughout the state. These in turn create benefits such as clean drinking water, safe recreation, and stronger fishing and tourism industries, which have positive health and economic ripple effects for urban users.

The impacts in Table 2 were calculated assuming that farmers do not change their pesticide use practices. This is a reasonable starting point for analysis and also illustrates impacts on an "average" grower when pesticide use declines. However, pesticide use may decline under the policy, reducing revenue from the additional mill fee and the rebate

26 Pesticide use data from DPR (2002); acres planted by commodity in 2002 from DOF (2003).

payments.[27] These changes will approximately offset one another for a grower whose pesticide spending declines equal to the statewide average decline. Growers who reduce pesticide spending by more than average will do better financially than shown in the table; those who reduce pesticide spending less will do less well.

An Alternative Policy

As noted previously, some sellers of pesticides have suggested they will sue the DPR because they believe too much of current mill fee revenue is used to deliver services that primarily benefit agriculture. A law to increase the mill fee for all users but primarily spend it to initiate change in the agricultural sector might be challenged in court. There are three ways this concern might play out over time. First, 2/3 majorities in both the State Assembly and Senate could authorize the increased mill fee, which would make a legal challenge impossible. The basis for a challenge to the current or future mill fee is that it is not a fee, but a tax requiring approval by a supermajority.

Second, if majorities in the Assembly and Senate, but not supermajorities, approved a policy such as that above, legal challenges to it may fail. The California Supreme Court Sinclair Paint Decision (see Box 5) is clear that fees do not have to be levied in proportion to the benefits received by those who pay them. They can be levied as a general exercise of the police powers of the state, in order to regulate one or more harms associated with use of a product. Spending supported by the fee must have a reasonable "nexus" with the activity upon which the fee is levied. Action to reduce pesticide pollution of surface, ground, and drinking water in the state seems to have a reasonable nexus with the activity of pesticide use. Nothing in the case law suggests that a fee on one class of regulated parties (e.g., urban pesticide users) fails to have a reasonable nexus with spending to change the behavior of another class of regulated users (e.g., farmers). Since at least 20 million urban Californians obtain drinking water from sources affected by agricultural runoff, actions of these classes of regulated parties are not at all independent.

Box 5: The Sinclair Paint Decision

The California Legislature enacted the Childhood Lead Poisoning Prevention Act of 1991 (the Act) by a simple majority. The Act provided evaluation, screening, and medically necessary follow-up services for children who were deemed potential victims of lead poisoning. The Act's program was entirely supported by fees assessed on manufacturers or other persons contributing to environmental lead contamination. Those persons able to show that their industry did not contribute to environmental lead contamination, or that their lead-containing product does not and did not "result in quantifiably persistent environmental lead contamination," are exempt from paying the fees.

The Sinclair Paint Company challenged the Act on the ground that these fees were in legal effect taxes required to be enacted by a two-thirds vote of the Legislature. The California Supreme Court ruled unanimously against the Sinclair Paint Company in June of 1997 (Opinion No. S054115). They cited case law that "clearly indicates that the police power is broad enough to include mandatory remedial measures to mitigate the past, present, or future adverse impact of the fee payer's operations, at least where, as here, the measure requires a causal connection or nexus between the product and its adverse effects." They further noted that Sinclair should be permitted to attempt to prove at (a subsequent) trial that the amount of fees exceeded the reasonable cost of providing the protective services for which the fees were charged, or to try to show that no clear nexus exists between its products and childhood lead poisoning, or that the amount of the fees bore no reasonable relationship to the social or economic "burdens" its operations generated. Sinclair, however, apparently did not pursue the matter further.

Third, one could address the threat of litigation over a higher mill fee by implementing an alternative but similar policy. One could exempt urban pesticide users from the higher mill fee and raise the funds lost

27 One way of estimating the reduction in use that will result from an increase in pesticide price is to assume that price elasticities estimated in other situations apply here. For example, McIntosh and Williams (1992) and Capalbo and Vo (1998) estimated that the elasticity of pesticide use in agriculture was between -0.1 and -0.5. These numbers imply that the 79 mill increase in fee proposed would lead to a reduction in pesticide use somewhere between about 0.8% and 4%. But such estimates are crude because they do not account for the message, if any, that accompanies the price change. For example, the increase in mill fee from 9 to 22 in 1993 did not lead to any measurable decline in pesticide use, possibly because the fee increase was for purely administrative purposes and not part of an effort to encourage use reduction. Opposite examples are those in Denmark, Sweden, and Iowa described in Box 1, where use reductions were much larger than these elasticities would suggest, probably because fee increases were part of widely publicized attempts to encourage use reduction.

28 The Chemical Specialty Manufacturers Association has been particularly vocal on this topic.

by the exemption with a very small source water fee on nonagricultural water use. Spending would be the same under the alternative policy, and the impacts on farmers discussed above would also be the same.

Raising $60–$65 million with a nonagricultural source water fee would require a fee rate of about $0.02 per hundred cubic feet (ccf),[29] or a surcharge of 1–2% on retail water sales in California, depending on local water rates.[30] It amounts to about $1.84 per Californian per year, including not just direct payment to one's water utility, but indirect payment for all of the fees that would be borne by businesses (assuming retail prices were to increase to compensate businesses for the higher cost of water). Less than $2 per person per year, for the three years of the program (less than $6 per person total), is an extremely reasonable amount given the potential long-term health and environmental benefits of cleaner agricultural runoff.

Of course administrative expenses for the alternative policy would be larger than the simpler policy that does not exempt urban pesticide users. Water utilities would need to collect the nonagricultural source water fee and transfer it to state government. But a doubling of administrative cost (i.e., from $1 million per year to $2 million) would create an additional burden of only $0.03 per person per year (i.e., $1.87 rather than $1.84).

Why Act Now?

California's budget crisis demands that we take the long view and look at the big picture, not just this year's spending and tax plans. We desperately need to find ways to reduce spending without cutting services, or to reduce the need for services, even if these actions take years to bear fruit.

Simultaneously, California agriculture has been struggling to compete, and water and air quality and human health costs are rising rapidly. The solution for farmers is higher value-added commodities. This either drives the intensity of pesticide use upward, as has been occurring historically statewide, or leads to more knowledge-intensive, environmentally cleaner production, as has been occurring on some farms.

Farmers are responding in both ways. Most are following the first path, which worsens environmental and health problems. Some, but not enough, are following the second path that is more desirable for society. We need pesticide use policy that encourages and rewards, but does not require, farmers to voluntarily learn about and follow the second path. Such policy will reduce inaccurate perceptions of the risk from using fewer pesticides, and will make clear through real examples and experiences that the financial interests of farmers and sellers of pesticides are not identical. It may also induce innovations in pest management.[31]

Pesticides in farm runoff will be regulated in California. The only questions are how much, how soon, at what expense, and with what effect? Will we stumble toward the future, litigating every step of the way? Will farmers spend their time and money fighting regulations, or implementing innovative pesticide use reduction practices that improve their bottom line? Will pesticide manufacturers succeed in clouding the issue by claiming that all pesticide use is essential, when some is and some is not?

We can meet the future timidly, insisting that farmers can't afford to change and that the environmental and health consequences of trace levels of pesticides in our water and food are probably acceptable. We can continue to focus exclusively on safe standards regulation and act as if the health-related and other costs of pesticide use paid by taxpayers are beyond our control. We can continue to "solve" pesticide-related problems through litigation or lengthy bureaucratic processes.

Or we can recognize that farmers don't want to pollute, do respond to price signals, and are willing to innovate when the risk/reward ratio is reasonable. We can use economically thoughtful environmental policy to deliver those signals without financially burdening farmers. We can ask urban pesticide users (or water users) to financially support change in the farm sector because the quality of urban water, both

29 Urban water use in California is around 7 million acre-feet (af) per year (Gleick, et. al. 2003). This converts to around 3 billion ccf, the customary unit for urban water rates by volume (separate fixed fees are also typically charged each billing period). Dividing $65 million by 3 billion yields about $0.02 per ccf.

30 A comprehensive database of urban water rates by volume does not exist, but in the author's extensive experience, a reasonable range for current volumetric rates in California is $1-2 per ccf.

31 Fernandez-Cornejo and Pho (2002) show that the relative price of herbicides relative to other inputs like labor, machinery, or land from 1948 to 1994 affected the direction of technological change toward techniques that use more herbicides. Although the mill fee increase suggested here is small, it is a step toward technological developments in the opposite direction, i.e., those that use fewer herbicides.

potable and ambient, will improve. We can complement the safe standards approach with a use reduction approach that lowers the risk of water pollution and health problems. And by doing these things we can reduce the long-term, difficult-to-quantify budget burden created by pesticide overuse, while strengthening the California farm economy.

Once the courts have imposed more stringent regulations on pesticide runoff from farms, it will be far tougher and more expensive to take action. Once the California Performance Review recommendations have been adopted or rejected, significant government reforms will be a lower priority. Our proposal, which uses a temporary, higher mill fee to fund incentives for farmers who voluntarily put into place pesticide use reduction and runoff management techniques, is good for the economy, public health, and the environment. The time to act is now.

We can continue to "solve" pesticide-related problems through litigation or lengthy bureaucratic processes—or we can innovate.

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APPENDIX A:
ASSESSING THE STATEWIDE POTENTIAL TO REDUCE PESTICIDE USE AND INCREASE PROFITABILITY IN CALIFORNIA AGRICULTURE

THE PHYSICAL QUANTITIES OF ACTIVE INGREDIENTS (A.I.s) of pesticides used each year on each crop in each county in California are available through the pesticide use reporting system managed by DPR and the County Agricultural Commissioners. These quantities are reported in pounds of A.I.s. One could calculate expenditures for pesticides by commodity by county and year if one had either: 1) prices of pesticide products each year, by weight or volume, or 2) implicit prices paid by farmers for each of the reported A.I.s, by weight. The first data can be converted to prices paid for A.I.s by weight, using product formulation data that are available. This would give the second type of data. Multiplying these implicit prices for A.I.s by the reported quantities would yield wholesale expenditures on pesticides by A.I. for each commodity in each county in California.

From the expenditure data, one could assess how actual pest management practices by commodity, county, and year compare with practices recommended by unbiased, third-party experts in pest management (see below). When actual practices are significantly worse than these practices, farmers can improve profitability AND reduce pesticide use. A quantitative estimate of this potential is critical information for pesticide policy-makers in California, and is within our intellectual reach as described below.

The University of California agricultural extension service has routinely prepared cost and return studies by commodity and county for decades.[32] These studies show prospective growers of commodities in those locales the costs and returns (i.e., gross and net revenue) they are likely to experience if they grow those crops in that setting. The studies are forward-looking in that they estimate costs and returns for the coming year (to help farmers plan), but the studies are based on actual experience in past years.

One can extract from the cost and return studies the absolute dollars and the share of gross revenue that are likely to be spent on pesticides for each commodity, by county and year. These economic data reflect knowledgeable assessments of good growing practices. They may not reflect best practices, because that is not the intention of most of the studies (some cost and return studies focus on specific types of practices; e.g., organic). They also probably do not reflect average actual practices, because the agricultural advisors have not been asked to survey farmers and create averages. Instead, they are asked to tell farmers what a knowledgeable farmer’s costs and returns might reasonably be.

Consequently, a comparison of pesticide spending in the cost and return studies with actual pesticide spending, by commodity, county, and year should help us to quantify a minimum for how much cost-effective reduction in pesticide use is possible. We say “a minimum” because the cost and return studies may not represent best practices. Put another way, if the cost and return studies reflect knowledgeable practices, and if actual practice lags behind such practices, as the cited studies demonstrate, this method will quantify the size of the lag.

Unfortunately, price data were not available for all the active ingredients reported as actually used on pesticide-intensive crops in California. The industry is competitive, and pesticide costs are usually bundled by licensed pest control advisors (PCAs) with application and advice costs. Despite numerous phone and e-mail inquiries to private, governmental, academic, and nonprofit sources, the only consistent set of price data found was a summary of prices used in the agricultural extension cost and return studies (Mullen et. al., 2003). That dataset, however, covered only about 60 active ingredients of the 900 or so active ingredients registered for use in California. We couldn’t, therefore, estimate actual pesticide spending on strawberries, for example, in Monterey County in 2001 for comparison with the spending shown in the cost and return study for strawberries in Monterey County in 2001, because actual use involved more than twice as many active ingredients as shown in the cost and return study.

But in principle, the missing price data are available so long as pesticide prices don’t differ much from county to county. The DPR maintains records of mill fee receipts by active ingredient. One can tally receipts in any year and divide by the mill fee percent

32 The studies do not address every commodity in every county every year.

for that year (e.g., 1.75%) to obtain total wholesale revenue from sales of that active ingredient. Total pounds of active ingredient sold each year are tallied by DPR staff in the annual Reports of Pesticides Sold. Dividing total pounds by total revenue yields an average wholesale price for that active ingredient.[33]

DPR staff shared the raw revenue data with us for 22 of the 900 or so active ingredient subject to the pesticide mill fee in 2002 (personal communication, George Farnsworth, October 10, 2003). Table A-1 shows the average wholesale prices we estimated from this data. If a similar table were created for all active ingredients, the comparison described above could be completed. The limiting resource is DPR staff time to print the raw revenue information and tally it for each of the 900-plus active ingredients. Based on our experience, about two months of one person's time would be more than sufficient for this task. That is a small investment for the important economic information that would be obtained, but in a time of budget cuts, DPR senior staff have understandably not been willing to make that investment.

Table A-1: Estimated Wholesale Price of Selected Pesticides in California, 2002

Active Ingredient	Average Dollars Per Pound
2,4 D, all	$9.48
bacillus thuringiensis	$17.12
carbaryl	$12.39
chlorine dioxide	$54.04
chlorine gas	$0.14
chlorpyrifos	$10.21
copper hydroxide, all	$2.48
copper sulfate, all	$0.69
cottonseed oil	$1.73
diazinon	$7.72
diuron	$8.72
glyphosate, all	$10.08
malathion	$4.16
metam sodium	$0.67
methyl bromide	$4.00
petroleum hydrocarbons	$98.00
simazine	$3.63
sodium carbonate	$0.52
sodium hypochlorite	$1.23
sulfur	$0.20
Trifluralin	$2.21
Ziram	$2.34

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654 13th Street, Preservation Park, Oakland, California 94612
telephone 510-251-1600 • telefax 510-251-2203
www.pacinst.org