Staff Paper

FQPA Implementation to Reduce
Pesticide Residue Risks:
Part II: Implementation Alternatives and Strategies

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Staff Paper 99-46 October 1999

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The authors acknowledge financial support from the Elton R. Smith Endowment at Michigan State University. They are grateful for helpful comments on earlier drafts from Bob Boehm, Dave Ervin, Glenn Fox, Craig Harris, Mark Keating, Madhu Khanna, Sarah Lynch, and Mark Whalon, but the authors alone are responsible for the content and viewpoints expressed in the paper.

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Acronyms and Definitions

ACIC	Agricultural Conservation Innovation Center
BMP	Best management practices
EPA	U.S. Environmental Protection Agency
FFDCA	Federal Food, Drug and Cosmetics Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FQPA	Food Quality Protection Act (1996)
IPM	Integrated pest management
OECD	Organization for Economic Cooperation and Development
RMA	USDA Risk Management Agency
TRAC	Tolerance Reassessment Advisory Committee
USDA	U.S. Department of Agriculture
WTO	World Trade Organization

The Risk Cup:	The total exposure for an individual permitted under the FQPA has been termed "the risk cup." The risk cup is a pesticide-exposure performance standard for chemicals sharing a common toxic mode of action in humans; it is based on an individual's exposure stemming from all food and non-food sources.
Aggregate Exposure:	Exposure to a chemical from all possible sources and routes of exposure for a single chemical.
Cumulative Exposure:	Exposures to two or more chemicals that share a common toxic mode of action.

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Executive Summary

Implementation of the Food Quality Protection Act (FQPA) is fraught with difficulty due to the divergent perspectives and demands of stakeholders in the process. In "Part I: Agricultural Producer Concerns," the authors reviewed the concerns of food producers about potential FQPA threats to farm profitability, international competitiveness, consumer perceptions, and the development of pest resistance to remaining pesticides. Fortunately, lessons from past environmental policy and economic theory offer useful principles for how to implement the FQPA. This paper, "Part II: Implementation Alternatives and Strategies" addresses ways to accommodate producer concerns while meeting the policy mandate of reducing risk from pesticide exposure, especially for infants and children. In so doing, the authors are neither advocating nor criticizing this FQPA policy mandate; rather, they are providing policy analysis of alternative implementation strategies.

Alternative ways to prioritize pesticide uses

A key for the implementation challenge of the FQPA is the prioritization of uses of risky pesticides that are restricted. According to the FQPA mandate, such restrictions must assure,

with "reasonable certainty, that no harm will result from aggregate and cumulative exposure" to pesticides. Producers are concerned that their profitability and competitiveness will be undermined if valuable pesticide uses are excluded. How to allocate the scarce content of the "risk cup" of permissible pesticide uses is a classic economic problem.

The economic analysis of environmental policy over the past 30 years has shown that most successful regulations focus on *environmental performance rather than on production processes* (ends rather than means). An outcomes focus leaves the producer flexibility to achieve the target outcome at lowest cost. Furthermore, if markets can be created to allow the profitable trading of pollution rights, the overall costs of meeting environmental performance standards may fall even farther as those with a competitive advantage in cleaner production processes are allowed to profit from it. Also, providing it can be done without jeopardizing human health, environmental regulations are best imposed firmly but *gradually*, providing producers time to adjust. Gradual implementation without jeopardizing health suggests that regulations should target the "worst first" – those chemicals most likely to harm sub-populations because of their cumulative exposure. Based on these guiding principles, the authors analyze five policy alternatives for prioritizing pesticide uses, including the current practice of pesticide use registration:

(1) Selective registration of pesticide uses. This alternative would extend the pre-FQPA policy of registering individual pesticide uses to apply to entire classes of pesticides sharing the same toxicological mode of action in humans (as specified under the FQPA). Pesticide uses causing high health risks are denied registration (i.e., they are forbidden).

(2) Establishment of markets for pesticide risk. Under this alternative, the EPA would designate risk levels for each pesticide use and make publicly available a quantity of tradable risk

shares corresponding to the safely permissible amount of risk from a specified class of pesticides. Pesticide users would be required to acquire risk shares in order to be allowed to use restricted pesticides. However, no specific pesticide uses would be forbidden.

(3) Hazard-based pesticide taxation. Under this alternative, the EPA would designate sales taxes on selected pesticides, corresponding to the assessed human health risks. Taxes would be set at levels expected to restrict pesticide use to the safely permissible amount of risk from a specified class of pesticides. No specific pesticide uses would be forbidden.

(4) Residue limits by crop product as a performance standard. Under this alternative, the EPA would set pesticide residue limits for each retail crop product, based on likely human exposure levels. No specific pesticide uses would be forbidden.

(5) Prescription-pesticide farming. Under this alternative, pest management professionals would be licensed to prescribe restricted pesticides balancing crop production needs with potential pesticide risks.

These five alternative ways to ration uses of risky pesticides are evaluated according to six criteria: (1) conforms with "no harm" mandate for sensitive individuals; (2) conforms with "no harm" mandate for majority of individuals; (3) promises acceptable costs of administration and enforcement; (4) minimizes the cost of adjustment by producers; (5) does not stifle technological innovation; (6) is politically feasible.

Of the alternatives reviewed, the authors conclude that *pesticide residue standards appear to offer the greatest promise of meeting these criteria while also respecting the guiding principles of a flexible, outcomes orientation and amenability to gradual implementation.*

Strategies for implementation

Assuming the FQPA mandate of reasonable certainty of "no-harm" is the goal, and having chosen a prioritization process, it will be important to assist farmers in making the transition to FQPA compliance as smoothly as possible. The transition may be facilitated by crop insurance against pest damage; such insurance is currently being examined on an experimental basis. Crop pest insurance would compensate producers for yield losses due to their transition to reduced use of targeted pesticides. It should encourage more public and private consultants to assist producers in developing alternative systems.

Crop product labels constitute another implementation strategy. These labels would certify responsible pest management or FQPA compliance. They could attract higher market prices and might thereby induce innovations to find cheaper ways to achieve low-risk pest management. However, they would require third-party verification and a consumer awareness advertising campaign.

New research and outreach will be needed to develop and diffuse alternative ways to manage pests safely. There is an acute need for improved, lower risk products as well as improved understanding of obstacles to their adoption. But the budget-constrained national Extension services and Natural Resource Conservation Service will require fresh resources in order either (1) to deliver to producers the new educational and technical assistance programs needed for successful transition to FQPA-compliant pest management or (2) to certify private consultants to do the same.

In addition to such transition strategies, new trade and market development strategies should accompany implementation of the FQPA. As discussed in Part I, new research is needed

to determine whether differential access to pesticide inputs has a significant effect on the domestic and international competitiveness of U.S. crops. Where there appear to be serious risks to competitiveness, bilateral negotiations may be warranted, as may other measures, such as encouraging international farmer-to-farmer alliances and the eco-labeling of crop products to certify compliance with the FQPA. There also is a need to assure that residue testing of imported foods takes place in a statistically valid manner at the level of detection needed to assure that foreign foods do not exceed any residue norms required of domestically produced foods.

As the food system evolves toward supplying consumers the food attributes they desire, there is a need for market development of foods that offer lower pesticide risk. While retailers will continue responding to these market opportunities, they currently lack a trusted system of pesticide risk labeling that can certify risk to consumers. Pesticide residue levels can feasibly become a contractually monitored quality attribute if consumers demand it and if it can be labeled and certified on retail foods. FQPA implementation should proceed in ways that build self-perpetuating incentives for innovation into technologies and marketing approaches that reduce pesticide risks to assure safer foods on the nation's tables and high chairs.

I. FQPA Implementation to Reduce Pesticide Residue Risks: Part II: Implementation Alternatives and Strategies

Implementation of the Food Quality Protection Act (FQPA) is fraught with difficulty due to the divergent perspectives and demands of stakeholders in the process. In "Part I: Agricultural Producer Concerns" (Batie, Swinton and Schulz, 1999), the authors reviewed concerns from food producers about potential FQPA threats to farm profitability, international competitiveness, consumer perceptions, and the development of pest resistance to remaining pesticides[1].

Fortunately, lessons from past environmental policy experience and economic theory offer useful principles for how to implement the FQPA. This paper, "Part II: Implementation Alternatives and Strategies," addresses ways to accommodate producer concerns while meeting the policy mandate of reducing risk from pesticide exposure, especially for infants and children. In focusing on near-term implementation, the authors will not question the provisions of the Act itself, nor will they explore thoroughly the long-term agenda for complementary research.

Part I reviewed the research basis for agricultural producers' concerns regarding the potential impacts of FQPA implementation on farm profitability, international competitiveness, consumer food demand, and the development of pest resistance. The validity of producers' concerns depends in large part on the processes to be developed and implemented by the U.S. Environmental Protection Agency (EPA) in defining "reasonable certainty" of "no harm.." There are numerous elements to such decisions, many of which are controversial – even among

[1]A reader unfamiliar with FQPA is directed to "Part I: Agricultural Producer Concerns" as it identifies the intent and history of the legislation. The introduction to Part I is repeated in Appendix A here in Part II for readers' convenience.

scientists.[2] Considerable EPA effort is currently directed at airing and resolving these controversies and answering the question as to the allowable maximum exposures for chemicals sharing a common mode of toxicity (i.e., the size of the "risk cup") as well as contributions of various chemical uses to "filling the cup." In addition, the determination of which pesticides are associated with the highest-risk in diets has been given considerable attention (Consumers Union, 1998; EPA, 1998b).

As these controversies are resolved, there are almost certain to be more pesticide uses than can be allowed to assure a "reasonable certainty of no harm." Some means of prioritizing uses will have to be developed, and several alternatives are available. These alternatives will be reviewed in the following section. But apart from alternatives for allocating pesticide risks among potential uses, FQPA implementation raises other important issues, including strategies for transition to alternative pest management practices, trade policy in foods with reduced pesticide risks, and market development. All of these alternatives need to be explored for ways in which FQPA implementation can accommodate producer needs and concerns while complying with its legislative mandate to protect U.S. food consumers.

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[2]The EPA has comprehensive staff papers available on the World Wide Web (http://www.epa.gov/pesticides) which discuss how they are resolving those complex and controversial issues. The science issues in implementing the FQPA are extraordinarily complex, evolving, and controversial (Flora, 1990; Wargo, 1996). These issues include, for example, the 10-fold safety factor in determining dietary exposure assessment, interpreting the exposure implications of "no detectable residues," collecting and using information from producers, processors, and registrants, handling missing data, determining drinking water and residential exposures, aggregating exposures from all sources, and developing cumulative risk assessments (EPA, 1998a).

II. Policy Alternatives for Prioritizing Pesticide Uses

The need for a prioritization process arises from the limited amount of pesticide exposure risk permitted under FQPA. The total permissible exposure for an individual under the FQPA has been termed "the risk cup." The "risk cup" is a pesticide-exposure performance standard for chemicals sharing a common toxic mode of action in humans; it is based on an individual's exposure stemming from all food and non-food sources. Most of the scientific debate so far has focused on the measurement of the capacity of the cup for sensitive individuals, contributions made by specific forms of pesticide exposure, and the probability of exposure.

Relatively little attention has been paid to FQPA implementation once the measurement issues are settled. That is, once the EPA has determined the size of the "risk cup" and how much risk is contributed by different uses, how should risk be allocated among those various uses? If golf course turf protection and strawberries require the same, restricted use pesticide, which deserves preference? Making these allocation decisions for hundreds of pesticides in thousands of uses is not easy. The FQPA mandate is to provide "a reasonable certainty that no harm will result from aggregate and cumulative exposure" to pesticides. This stricture must be met by any prioritization process. Ideally, such a process should also offer acceptable costs of administration and enforcement, minimal costs of adjustment by producers, and incentives for future technological innovation.

Limitations of the "No-harm" Mandate

To date, the EPA has interpreted the "no-harm" mandate to mean that the total cumulative exposure to chemicals with a common mode of action (e.g., neurotoxins) for the most sensitive

individuals, when aggregated across all sources (e.g., food, drinking water, and residential exposures), must be significantly below levels that toxicology tests have shown to cause harm. In pursuing this interpretation, EPA has focused on the diets of sensitive sub-populations and related these diets to aggregated exposures of chemicals with a common mode of action.

In focusing on the most sensitive sub-populations, this approach excludes ways of prioritizing pesticide uses that would protect a large majority of people from pesticide risks, but would not protect all consumers. Any such large-majority alternative approach would require special measures to protect sensitive individuals. An example would be an educational campaign to alert sensitive sub-populations (or their guardians) to eat only pesticide-free foods, thus increasing the size of the risk cup and the number of allowable uses for non-sensitive populations.

Another approach precluded by the EPA's interpretation is pesticide residue labeling of foods, with consumers allowed to decide in the marketplace whether they wish to consume them. As will be indicated below, the strict "no harm-to-sensitive individuals" interpretation eliminates consideration of many policy alternatives–including the use of most market incentives.

Who should get priority access to risky pesticides?

Allocating the right to use high-risk chemicals should begin by examining whose interests are at stake as well as what general lessons are offered from past experience. The EPA is charged with protecting the most sensitive individuals from possible health damages due to pesticide exposure. This need suggests particular attention to the diet, drinking water, and residential exposure of these individuals.

Although FQPA focuses on pesticide-sensitive consumers, there are other stakeholders in what might be called the "pesticide value chain." These actors extend from the pesticide manufacturer to the pesticide user to the consumer of pesticide treated products.[3] Pesticide users, including farmers, would benefit if allowable pesticide risks for each "risk cup" were prioritized based on the user-level impact of reduced pesticide availability. This prioritization would dictate retaining those pesticide uses which generate the largest user benefits, presumably those uses whose alternatives are the least available, the least efficacious, most costly, or most likely to engender genetic pest resistance.

Society's larger interests may be best served by giving certain pesticide users preferential treatment. For example, farmers of food crops might be viewed as higher priority users than golf course managers. On the other hand, consumers of pesticide treated products (e.g., food consumers, golfers, gardeners) constitute a stakeholder group interested in protecting pesticide uses whose loss would trigger the greatest harm to consumer welfare (e.g., via product price increases). Even environmentalists might care to protect certain risky pesticide uses if their loss would give rise to alternative practices that caused greater environmental or health damage.

The competing interests of stakeholder groups are difficult to satisfy. However, some general principles appear to be applicable. First, once a high risk family of chemicals has been targeted and a "risk cup" defined that establishes the aggregate and cumulative exposure level equivalent to a "reasonable certainty of no harm" for sensitive sub-populations, special priority

[3]Under FIFRA (up to 1996), manufacturers' interests were chiefly served, as they got to choose whether to keep a given pesticide use based on their own cost-benefit analysis of re-registration testing costs versus expected future sales revenues. This system created the "minor use" pesticide problem, whereby pesticide uses that accounted for low pesticide sales volumes were sometimes dropped.

might be accorded to those participants in the pesticide value chain who would suffer the greatest harm from specified reduced pesticide uses. Whether manufacturer of pesticides, user of pesticides, or consumer of pesticide-treated products, this principle would call for recognizing the potential costs of losing specified pesticide uses, emphasizing reducing those uses that have the most efficacious, lowest cost alternatives.

Second, the process should allow flexibility in how risk reduction goals are met, mitigating the adjustment costs for producers. Such flexibility would, for example, allow use of an otherwise risky pesticide when the pesticide residue is removed in washing or processing activities (see Textbox 1). Such an approach requires monitoring of final residue exposures in the diet which, in turn, implies the need for a low cost method of revealing residues (e.g., by use of chemical markers) as well as monitoring procedures for grocery products.

Third, the costs of adjustment are likely to be high enough in all cases that efforts should be made to encourage technological innovation that might make future pest control safer or less costly. Fourth, it is desirable that any prioritization scheme should operate at reasonable administrative and enforcement cost. Finally, any process must be politically feasible (Browne, 1999).

Following these principles, some possible alternatives for allocating uses present themselves. These alternatives allow for more user flexibility and more gradual adjustment to reduced pesticide uses. However a major challenge is for these alternatives to assure that they will indeed protect sensitive individuals with reasonable certainty.

Textbox 1. Post-Harvest Processing to Reduce Pesticide Residues

Reducing pesticide use is not the only way to curtail pesticide residue risks. Post-harvest processing can sharply reduce residues reaching the consumer. Apples are a case in point.

Apples are susceptible to a large number of diseases (apple scab, powdery mildew, sooty blotch) and insect pests (codling moth, apple maggot, scales and apple aphids). Significant quantities of pesticides are often necessary to protect them from damage that consumers would find unacceptable. This necessity leads to pesticide residues on (or in) the apple at harvest. The use of postharvest chlorine dips and ozonated wash treatments has shown potential to reduce pesticide residues on apples, particularly the organophosphate insecticide azinphos-methyl, the fungicide captan, and the insecticide formetanate hydrochloride (Hendrix, 1991; Ong, et al, 1995). Similar research needs to be directed at a broader range of agricultural practices, products and inputs.

III. Weighing Policy Alternatives for Prioritizing Pesticide Use

Prior to FQPA, the U.S. policy precedent for managing pesticide risks was to permit only registered pesticide uses (where "uses" means carefully defined crop-pesticide combinations). By permitting only registered pesticide uses, the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) effectively banned selected uses that were deemed unsafe. FIFRA was amended by FQPA in 1996. If the FIFRA approach were extended under FQPA to cover entire groups of pesticides sharing a common toxicological mode of action in humans, the result might be severe profitability impacts (see Part I [Batie, Swinton and Schulz, 1999]). But both environmental policy experience and economic theory suggest that there are policy alternatives to categorical pesticide bans that can achieve the risk reductions mandated by the FQPA.

Proposed alternatives and evaluation criteria

Three decades of environmental policy has taught us is that, in general, compliance costs of environmental policy tend to be lower (1) when there is producer flexibility in pursuit of performance outcomes, (2) when there is a gradual phase-in of requirements to give affected parties time for adjustment, and (3) when there is targeting to the concern with the greatest potential social payoff (Batie and Arcenas, 1998).

The first point on pursuit of performance outcomes means that the most cost-effective environmental policy designs tend to be those that use pollution taxes or performance requirements to focus on pollution outcomes, rather than the processes that create them[4]

[4]This conclusion depends, however, on the magnitude of the costs of obtaining pollution monitoring information, as well as on the costs of administration and enforcement. Economists refer to these costs as transaction costs.

(Cropper and Oates, 1992). In order to be effective, both taxes and performance standards on pollution require that the pollution outcomes be measurable. By focusing on pollution outcomes, producers are left free to choose how to meet the mandated reduction of pollutants. That is, the law tells them what must be accomplished, but not how to do it (Batie and Ervin, 1999).[5] This flexibility can result in important innovations in environmentally efficient technologies (Swinton and Casey, 1999).

Performance requirements can become even more cost-efficient at reducing pollution when markets exist which allow firms to profit if they cut pollution even more than required (Cropper and Oates, 1992). This discovery has given birth to several schemes that allow firms to trade marketable pollution permits, creating a market for pollution reduction where none existed before.[6]

Where marketable pollution permits exist, flexibility can give rise to innovative agreements allowing firms to capitalize on the comparative advantage of each in reducing pollution (while producing marketed products). The flexibility principle is at the heart of the kind of environmental policies that management expert Michael Porter has advocated to make American businesses "green and competitive" (Porter and van der Linde, 1995a). Performance goals and pollution taxes can be phased in over time to allow time for producer adjustments in their farming

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[5]The performance requirement also needs to be coupled with constraints inhibiting the shifting of pollution to other pathways (e.g., water pollution to air pollution).

[6]The practicality of markets for potential pollutants is well established with sulfur dioxide permit trading, as authorized in the Clean Air Act. Sulfur dioxide trading has resulted in substantial cost savings for a required sulfur emission reduction, estimated at over $2 billion a year over a "command and control" regulatory approach (Hanley, Shogen and White, 1997). This savings occurred, in part, because of incentives which caused utility companies to substitute lover polluting technologies and fuels for higher polluting one.

systems and to enable flexible responses. For mitigating dietary risks under the FQPA, the lessons of performance goals targeted to areas of greatest social concern, flexibility, and time to adjust translate into several policy alternatives. Each has different strengths and weaknesses and all deserve review.

The desired outcome targeted under the FQPA is the reduction of health risks associated with specific pesticide uses. So one policy alternative would be for EPA to divide up the "risk cup" into quantified pesticide risk shares, to distribute those shares, and to design a market that allowed the risk shares to be traded. Such a market would allow those growers who can most efficiently reduce pesticide risk do so, while other growers who badly need restricted pesticides could buy the right to generate more pesticide risk than they would otherwise be allowed.

Hazard-based sales taxes on pesticide purchases constitute a second alternative. These taxes would have to be set at levels expected to restrict aggregate and cumulative risks from related pesticides to acceptable levels. Like marketable pesticide risk shares, pesticide taxes would also permit markets to allocate a permissible amount of risk among pesticide uses.

A third alternative would let EPA set pesticide residue standards by crop, seeking to maintain the aggregate exposure level within the no-harm mandate. Although this approach would not allow flexibility in allocating residue risks across crops, it would still permit flexibility in how to remain within that limit in each crop.

A fourth alternative would be to remove pesticide risk allocation from the hands of farmers, placing it instead in the hands of licensed professionals. This "prescription pesticide" approach (Coble et al., 1998) would let trained professional crop consultants play a role analogous to medical doctors who can prescribe dangerous drugs if they believe that the health

risks posed by failing to use the drug are significantly greater than those of using it. Again, EPA would have to develop a way to ensure that pesticide risks did not exceed levels that would violate the "no harm" mandate.

We propose six criteria for evaluating these policy alternatives:

(1) conforms with "no harm" mandate for sensitive individuals;

(2) conforms with "no harm" mandate for majority of individuals;

(3) promises acceptable costs of administration and enforcement;

(4) minimizes the cost of adjustment by producers;

(5) does not stifle technological innovation;

(6) is politically feasible.

Criteria (1) and (2) verify that the alternatives meet the intent of the FQPA law, as interpreted strictly (1) or more loosely (2). Criterion (3) evaluates the transaction cost of enforcing the policy. Criterion (4) evaluates the compliance and adjustment burden on producers. Criterion (5) evaluates the effect on future innovation (which could reduce future compliance costs). Criterion (6) applies a political acid test to the prior health and economic criteria. The following section employs these evaluation criteria to assess four alternative approaches to prioritizing pesticide uses:

(a) selective registration of pesticide uses (a variant the *status quo* based on FIFRA),

(b) establishment of markets for pesticide risk,

(c) hazard-based pesticide taxation,

(d) residue standards by crop as a performance standard,

(e) prescription-pesticide farming.

1. Selective Registration

The selective pesticide registration process established under FIFRA scores highly on the criterion of protecting the most sensitive individuals in the population. Banning risky pesticide uses by denying registration for those uses clearly provides "reasonable certainty" of protecting sensitive members of the population. This approach is essentially the one that EPA was following as of August, 1999[7]. While there is still a possibility that a sensitive toddler might become exposed to a risky dose of pesticide by playing in a freshly sprayed backyard ant hill, rather than by drinking fruit juice, the registration tool should provide protection to the great majority of sensitive individuals.

Administrative and enforcement costs of selective registration can be rated relatively low. Although the EPA must devote extensive time and effort to making the pesticide registration decisions, monitoring compliance with registrations is relatively low-cost. By contrast, selective registration scores poorly on producer adjustment costs, as producers are obliged to abandon entirely a compound that is not reregistered. For growers of "minor use" fruit and vegetable crops, there may remain few viable alternatives, and pest resistance development may be a serious problem. Selective registration scores moderately on encouragement of technological innovation. By forbidding a given crop-pesticide combination, it discourages near-term research into lower-risk variants of existing pesticide uses. However, over the long term, pesticide bans affecting major crops create powerful incentives for development of alternatives.

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[7]In August, 1999, EPA announce plans to eliminate specific uses of methyl parathion as well as azinphos methyl, two organophosphate pesticides. It also announced an 18 month schedule for completing its review of all 39 organophosphates.

Selective registration is, of course, politically feasible, as manifested by its current use. However, the intense lobbying by American Farm Bureau Federation and other agricultural interest groups suggests that selective registration may not remain politically viable if applied to entire categories of pesticides sharing a common mode of action.

2. Creating a market for pesticide risk shares

A different alternative to selective registration of pesticide uses is to let all uses remain in the "risk cup," with users themselves choosing whether to by the right to shares of that maximum allowable risk. Beginning with a "risk cup" that observes the cumulative, aggregate "reasonable certainty of no harm" criterion, this solution would let users allocate the contents of the risk cup by means of a carefully designed market rather than having government allocate pesticide uses by fiat.

This alternative is not the same as leaving pesticide uses to the free market, because there currently exists no market for pesticide risk. Such a market would have to be designed. The market could not simply be in pesticide use rights, because the target of public concern is not pesticide use, but rather the exposure risks that vary by pesticide use. A market for pesticide use risk could be designed in various ways. Just how to implement a market solution would take careful study and debate as there are many variants on how to create a market for pesticide risk. (Textbox 2 discusses one possible approach to setting up such a market.) The central idea is to

let pesticide users allocate risk through selling and buying pesticide risk shares in a market setting[8].

Marketable pesticide risk shares would minimize producer adjustment costs and encourage innovation in risk-reducing pesticide use, scoring highly by both of these criteria. For producers, a market leaves open the door to use a risky pesticide if the expected benefits are worth the cost of the pesticide plus the cost of the risk shares required to use it. Although pesticide users would incur unfamiliar costs in buying risk shares, they would only elect to pay those costs if they believed they would be better off. Moreover, such a market minimizes total compliance cost of achieving a target level of risk reduction (Baumol and Oates, 1988).

What tradable pesticide risk shares would not do is to protect all individuals from high risk. Although proper specification of the "risk cup" would protect the majority, the freedom of the market could not reliably protect sensitive individuals. In other words, tradable risk shares offer no guarantee that a sensitive individual would not eat a diet that contained enough pesticide residues to be considered high risk. An example might be a toddler who favors a diet heavy in peaches and apples. The child could be exposed to high risk even though the fruit growers had purchased pesticide risk shares adequate for the mean population-level risk posed by pesticide residues on those fruits.

[8]In order for a market for pesticide risk to operate effectively -- all users of pesticides -- including suppliers of U.S. food imports -- would be required to purchase marketable pesticide risk shares.

Textbox 2. Establishing a Market for Pesticide Risk.

Establishing a market for pesticide risk might follow these four steps:

(1) Define the maximum allowable risk per year (the capacity of the "risk cup"), measured in a standard risk unit. This maximum might be measured in abstract medical terms like the total amount that could cause no more than a given rate of cancer risk or endocrine risk per year. More tractably, it might be denominated in some form of standard pesticide-equivalent units. Such units might be established for pesticides with a common mode of action. For example, risk levels for organophosphate insecticides could be measured in, say, "malathion-equivalent" units.

(2) Associate a level of risk with each pesticide use (e.g., "malathion-equivalent" risk units per unit of pesticide X in use Y).

(3) Let the federal government sell or grant property rights to dated shares of the maximum allowable annual risk.

(4) Require that pesticide users acquire the necessary risk shares and "pay" a government agency (or other holder of such property rights) the risk share sum corresponding to the pesticide use they need. (Ensuring compliance with stated pesticide uses may require pesticide uses to be implemented by licensed and bonded pesticide applicators.)

In principle, sensitive individuals could be warned of risks by pesticide residue labeling. The literature on risk perceptions highlights the discomfort of individuals with involuntary risks. Such "ecolabeling" might even sharply reduce public fear of pesticides by allowing those who worry most to avoid them. In fact, ecolabeling is attracting increasing attention as a means to exploit the latent willingness-to-pay of "green" consumers (van Ravenswaay and Blend, 1999).

However, the historic precedent in the United States has been for government programs to assure the public safety, be it in the food supply or air travel. A labeling approach that relied on consumer awareness to protect health and safety would defy this precedent and likely would be

politically unacceptable. An added drawback is that the political wrangling and administrative costs of creating a new market in pesticide risk might be overwhelming.

3. Hazard-based pesticide taxes

Levying sales taxes on pesticides according to the health risks posed offers another way to assure acceptable risk while leaving flexibility to producers. The justification for pesticide taxes is that they communicate riskiness to pesticide users via prices (Wargo, 1996). Hazard-based taxes compensate the public for health risks beyond the farm household while also discouraging the use of risky pesticides (Zilberman and Millock, 1997). The size of the tax would need to vary with the riskiness of the pesticide in the diet; ideally it would be set on pesticide residues that could be monitored (Hanley, Shogren and White, 1997).[9] An appropriately set tax should encourage the use of available lower cost, lower-risk substitutes (chemicals and/or practices), while retaining the option to use higher-risk pesticides if suitable alternatives do not exist--albeit at a higher cost per use. There is sound economic rationale for making riskier uses more expensive (Bromley, 1994; Ervin and Schmitz, 1996).

An enormous literature addresses the complexities of setting appropriate "emission" or "ambient" taxes (e.g., Baumol and Oates, 1988; Hanley, Shogren and White, 1997; Zilberman and Millock, 1997). One frequent impediment to taxes is their political unpalatability. As a result, "emission" and "ambient" taxes, where they exist, are usually set too low to produce the desired

[9]The taxation approach is consistent with the Organization for Economic Cooperation and Development (OECD) principle of "polluter pays"-- that is, the users of the pesticide should bear both pollution control and pollution damage costs (Bromley, 1994; Hanley, Shogren and White, 1997).

outcomes of reduction of use and induced innovation. Taxes may have to be set quite high to influence use. For example, Deepak, Spreen and Van Sickle (1999) found that it would take a 186 percent pesticide input tax to reduce the use of methyl bromide by 50 percent.[10]

A related problem with political acceptability is the worry that taxation could render U.S. agricultural products uncompetitive with foreign produced products. Clearly the validity of this concern depends on whether the taxes are applied to imported foods. Nonetheless, this concern magnifies the political feasibility problem inherent in any tax alternative.

Were it not for high administrative costs, the theoretically ideal tax would target pesticide residues in food and drinking water. The less costly alternative of taxing pesticide production inputs can only protect consumers if 1) the taxes are based on likely risks and 2) pesticide uses are monitored. As in the case of tradable risk shares, this requirement imposes significant enforcement costs.

Furthermore, taxes themselves offer no guarantee that sensitive individuals will be protected against high risks. While the concept is that the higher prices communicate risk information to consumers, the linkage is suspect. Given that production costs are such a small portion of many retail food costs, even a large tax may not translate into higher food prices. Even if higher prices do result, as they might for some fresh fruits and vegetables, some consumers might equate higher prices with higher quality. As with the tradable risk share alternative, this

[10]If taxation is viewed as politically unacceptable, subsidies could also provide incentives to select lower-risk alternatives in order to avoid targeted pesticide uses. Such an approach requires governmental funding, however, and would violate the"polluter pays" principle that has become established in much of U.S. environmental policy. Subsidies can also result in a "moral hazard" if they provide perverse incentives for farmers to use more of the targeted pesticides in order to receive large subsidies to voluntarily abandon their use.

problem could be reduced by pesticide residue labeling. But as noted above, there is little precedent for consumers taking responsibility for assuring there own safety in this regard.

Overall, hazard-based pesticide taxes would appear to score highly on producer adjustment costs and encouragement of innovation. Whether residue-based or use-based, taxes would be costly to monitor, and so score poorly on administrative costs. Pesticide input taxes would be cheap to administer, but would do a poor job at protecting consumers from residue risks. Pesticide taxes in any form would have to be so high that they would likely be politically infeasible. (This is true despite the fact that taxes offer producers flexibility that might be worth more to them than an apparently cost-free ban on selected pesticide uses.)

4. Pesticide residue limits as performance standards

Pesticide residue limits on retail food products constitute a different way to reduce dietary pesticide risk. Like the previous two options, this approach to prioritizing pesticide uses need not totally exclude any uses from the "risk cup" in order to reduce aggregate uses to the desired "performance" level. As such, they score highly on the criteria of reducing producer adjustment costs and encouraging technological innovation. By focusing directly on residues as the source of risk, they also score highly on meeting the no-harm mandate, though not as well as the selective registration approach. Specifically, residues on a crop such as apples can be based on the probable consumption of a highly sensitive individual, taking into account cumulative and aggregate exposure, so the no harm mandate can be met, although it will require significant investment in research to determined the appropriate residue levels.

Pesticide residue limits on foods will require low-cost methods of residue detection if they are to score well on administrative and enforcement costs. Indeed, residue limits can only succeed if it is possible to assign liability to some segment of the food chain for failure to achieve required residue limits[11]. The establishment of effective monitoring and enforcement procedures is a challenging task, given that so little residue testing is currently being undertaken. So administrative and enforcement costs are moderate to high for this option. As for political feasibility, performance standards have appeal in that they focus on the public concern – pesticide residues – and they do not present an obvious up-front cost in the way the hazard-based taxes do. Hence, they may be rated politically feasible.

5. Prescription pesticide use

Another way to maintain valuable, but high risk pesticides, while meeting the public requirement for reduced exposure, is to permit use of risky pesticides by prescription only (Coble, et al., 1998). A prescription-pesticide use approach would be analogous to the medical practice of prescribing medicine for a diagnosed illness; a chemical would be made available only after a trained and licenced professional had diagnosed the situation as requiring a particular use. The Gerber Products Company is already using a prescription approach with its growers (University of Maine, 1998).

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[11]The assignment of liability for any product historically tends toward the least powerful agent in the supply chain -- in this case, most likely producers. However, it may be the case that residue limits can be better met by another agent in the supply chain. For example, processors may meet standards through processing activities such as washing and peeling fruits and vegetables. Presumably liability for meeting residue limits might then reside with the processor.

As Coble et al. (1998) note, implementation of prescription-only pesticide use on a broad scale would require a "cooperative and parallel development of efforts within the regulated (users and suppliers) and regulatory (federal and state) communities" (p.4). These efforts would need to be directed toward appropriate classification of pesticides for prescription use so as to assure appropriate reductions in dietary risks, as well as to assure the qualifications of prescribers and the quality of their services. All these tasks are quite challenging. There is also a considerable public education and outreach agenda that would need to accompany the implementation of such a program.

While there are many practical problems that would need to be solved for pesticide-prescription farming (Coble et al., 1998), such an approach would allow limited use of high-risk pesticides. In effect, the prescription-pesticide approach follows a professionally supervised and monitored input standard in lieu of a performance standard while still providing some flexibility in choice of pesticides. As such, it scores well on the criterion of holding down producers' adjustment costs.

However, unless there is an aggregate (domestic and imported) constraint on pesticide use by crop-pesticide combination, it is difficult to assure that the most sensitive individuals are protected. That is, if all the allowable prescription-use went to one crop, say apples, which are found in large volumes in children's diets, then prescription pesticide farming will not assure the protection of children as mandated by the EPA. Hence, prescription pesticide use does not necessarily meet the "no harm" mandate for sensitive populations. As noted above, this problem could be solved by pesticide residue labeling, allowing consumers to choose the risk level they find acceptable. Still, there is scant evidence that such an approach would be politically viable.

The administrative and enforcement costs of prescription pesticide use would likely be moderate, once a system had been developed for the licensing of professional prescription providers (presumably pest management consultants)[12]. Some administrative costs could be picked up by growers paying consulting fees. The comforting analogy between medical doctors and pest management consultants would likely favor the political acceptability of this option.

Reviewing alternatives for pesticide use prioritization

A comparative evaluation of the five alternatives is summarized in Table 1. Only two of the options appear to meet the "no harm" mandate for susceptible populations: selective registration and residue standards. All five, however, could meet the "no harm" mandate for the majority of consumers. Looking at the remaining evaluation criteria, options (2) and (3) can be dropped from consideration in spite of their theoretical economic efficiency. For both tradable pesticide risk shares and hazard-based taxes, low political feasibility combined with high costs for either producer adjustment or administration/enforcement would make them unacceptable. Likewise, the *status quo* of selective pesticide registration, when applied as a ban to entire pesticide classes, scores unacceptably on producer adjustment costs and discouraging near-term technological innovation.

[12]The use of the Internet as a means of individuals "skirting" enforcement of required prescriptions of human drugs, however, suggests additional challenges and enforcement costs for the licensing of professional prescription providers and the oversight of pesticide prescriptions.

Table 1: Evaluation of alternative means to prioritize uses of risky pesticides.

Prioritization alternative	**Evaluation Criteria**					
	"No harm" to sensitive individuals	**"No harm" to majority of consumers**	**Administrative & enforcement costs**	**Producer adjustment costs**	**Incentives for innovation**	**Political feasibility**
Selective registration	✔	✔	Medium	High	✔	High
Tradable pesticide risk shares		✔	High	Medium	✔	Low
Hazard-based taxes		✔	Low	High	✔	Low
Residue standards	✔-	✔	Medium-high	Medium	✔	Medium-high
Prescription pesticide use		✔	Medium	Low		Medium

The remaining alternatives are residue standards and prescription pesticide use. Both are moderately costly for regulatory enforcement and producer adjustment, and both appear to be moderately politically feasible. The residue standards alternative appears more promising in that it has greater potential to encourage technological innovation (by publicly establishing residue standards that innovators can respond to). Moreover, by focusing directly on the source of risk to consumers, it has greater possibility of protecting the most sensitive individuals. Of the alternatives reviewed, pesticide residue standards appear to offer the most promising mix of achieving protection from pesticide risks, economic efficiency and political feasibility.

That selective pesticide registration currently prevails is an artifact of precedent. During the first three decades after the original FIFRA was passed in 1947, chemical assay methods were more costly and not always capable of detecting residues of some risky pesticides. It made sense to protect consumers via input standards in via bans (non-registration) on selective crop-pesticide combinations. Moreover, the environmental economic theory and empirical evidence had not yet been developed to show the cost savings results from outcome-oriented policies. In light of the evolution of both toxicological chemistry and such evidence, pesticide residue standards now appear to be a better policy implementation choice than selective registration. Compared with selective registration of pesticides, residue standards appear to offer lower producer adjustment costs and greater potential to encourage technological innovation and are therefore worthy of more policy attention.

IV. Transition Strategies

Determining how to prioritize competing uses of risky pesticides within the "risk cup" is only the next step among many in the process of transition to farming with reduced pesticide risks. Assuming the FQPA mandate of "no harm" is the goal, and having chosen a prioritization process, it will be important to make the transition to FQPA-compliant agriculture in the least disruptive way. FQPA compliance will require other adjustments as well. New research and outreach will be needed to develop and diffuse alternative ways to manage pests safely. Profitably marketing crops that offer greater safety from pesticide residues but may cost more to grow will pose new challenges as well – in markets both at home and abroad. The following section suggests policies and research activities to smooth the transition to safer foods with agricultural prosperity.

Phased implementation, putting the "worst first"

Adequate time to adjust will be necessary for any pesticide prioritization process. Residue performance standards offer the appeal that they can be phased in over time to give producers and agribusinesses time to adjust and to search for the least cost methods of achieving the residue performance requirements. The U.S. agricultural sector deserves time to adjust to major changes, due to the large, fixed investment in existing crop and production systems. Changing systems and/or practices is likely to require different knowledge, production and marketing management, and financial investment.

Phasing in regulations does not imply that every reduction of pesticide must be phased in over a long period. Rather, it implies the need for policy attention targeted to the most risky

chemical uses first, with longer transition periods for less risky chemical uses. For example, one analysis estimates that most of the dietary risk from organophosphate and carbamate insecticides comes from only 40 insecticide-crop combinations out of the 300 in use (Consumers Union, 1998). If this analysis is supported by EPA risk assessments, then these 40 insecticide crop combinations should be targeted by policy for residue performance standards before the other 260. Also, if fewer, more risky uses are targeted, scarce public and private funds can then be better focused on transition assistance and related pest management research and development (Porter and van der Linde, 1995a and 1995b). Furthermore, other "less risky" chemicals can then be guaranteed space in the risk cup, assuring farmers of their continued availability.[13]

Transition crop-pest insurance

One possible transition strategy is to insure those farmers who are experimenting with lower-pesticide-risk production systems against serious yield losses. A transitional pesticide-deficit, yield-insurance policy could pay on yield losses due to reduction in certain pesticide uses over, say, a five year period. Such a policy would compensate producers for any yield losses during a transitional period and thus may reduce political opposition to FQPA while allowing time for new substitute technologies to emerge and be refined. Insured producers seeking assistance in

[13]The EPA is already considering ways that various "less-risky" organophospate (OPs) could be "guaranteed" space in a "risk cup." Potential criteria are that the OPs in question have:

"Non-detectable residues at harvest and/or consumption"
or (1) "Low consumption in food items," especially by children,
or (2) "Opportunities for risk mitigation" (e.g., removal of residues in processing).
(See EPA, 1998b)

transition strategies should create a market for more consultants, assistance, and educational programming, as well.

While there are many difficulties in designing yield insurance strategies, there are some experiments under way that may prove helpful. Currently, the U.S. Department of Agriculture's Risk Management Agency (RMA) and the nonprofit Agricultural Conservation Innovation Center (ACIC) of Charleston, South Carolina[14] are both experimenting with innovation insurance policies with which they hope to "reduce risks and speed farmer adoption of both new and time-tested IPM and BMP techniques." The lessons learned from these yield insurance pilot programs could be applied to help facilitate implementing the FQPA.

Revitalized research and outreach to mitigate transition costs

After nearly half a century of reliance on organophosphate and carbamate chemistries for insect control, not to mention B-2 carcinogens for controlling plant diseases, the nation's entire research and outreach infrastructure for pest management will require overhaul to meet the challenges of finding and diffusing new ways to manage pests that threaten food production (Cox, 1999). The potential pest management research agenda in response to FQPA is massive. Systems for prioritizing research needs will vary by whose needs are being served. State agricultural experiment stations may elect to mitigate farmer-level impacts, while chemical and life sciences companies may focus on potential earnings from sales of pesticides or bioengineered pest

[14]For more information, see the web sites of USDA/RMA's pilot research on crop insurance to promote integrated pest management of corn rootworm in the Midwest (http://www.act.fcic.gov/research/pilots/crw-ipm.html) and ACIC's activities on "Promoting Conservation Innovation in Agriculture through Crop Insurance"(http://www.agconserv.com).

management products. The specific research priorities are beyond the purview of this paper. However, in a country where more than 70 percent of agricultural research expenditures occur outside the public sector, it is highly desirable that FQPA implementation create incentives for private sector actors to innovate in ways that will reduce dietary risks in general and pesticide risks in particular (Swinton and Casey, 1999). Risk reduction should be a guiding principle. Besides the acute need for improved, lower risk products and production methods, there is also a need to understand better how to accelerate producer adoption of pest management practices that require less chemical use (Batie and Ervin, 1998).

Implementing flexible requirements that reduce on-farm pesticide reliance requires not only that producers understand the requirement, but also that they possess the knowledge and skills to make a transition from existing practices to practices that reduce the use of risky pesticides. Well targeted programs of assistance tailored to producer needs should be undergirded with both financing and knowledge of the producers' constraints, including financial and knowledge constraints.

A phased implementation that is focused on particular pesticide residue risks works best when coupled with educational and financial assistance programs to aid farmers in making the necessary changes in their farming systems. Such programs will require coordination between federal agencies, state agencies, universities, private industry, and non-governmental organizations.

Unfortunately, there has been a serious degradation in the capacity of the agricultural system to deliver education and technical assistance to producers and processors to reduce or eliminate pesticide use in their production systems. Compared with twenty years ago, there are

now significantly fewer specialists in Extension Service or the Natural Resource Conservation Service who can work directly with producers and processors to reduce pesticide risk. There are not yet adequate private consultants to fill this gap. There is also a serious erosion of investments in training and continuing education for specialists and those involved in production (Cox, 1999; Whalon et al., 1999). This lack of capacity to assist in transition is a serious constraint to implementing FQPA for those pesticide uses where reduction in use is a serious challenge.

Trade strategies

The issue of how to respond to trade concerns deserves careful thought and policy attention (see Part I [Batie, Swinton and Schulz 1999]). Some may argue that, to ensure "a level playing field," there needs to be a process standard guaranteeing that U.S. competitors cannot use pesticides in ways that are not legal in the United States. Given that pesticide restrictions in the United States represent a constraint on the permitted production process, such a process standard may at first blush seem the logical response. However, for a variety of reasons, including easy enforceability, the World Trade Organization (WTO) rules rely on product standards rather than process standards[15] (Marchant and Ballenger, 1994). This short paper cannot address the arguments at length. In any case, process standards will not necessarily enhance the competitiveness of U.S. products; indeed, there is reason to suspect the opposite: If trading partner countries imposed countervailing, unrestricted process standards for traded products, U.S. export products might lose market share in these countries.

[15]Process standards are those that refer to the process by which the food or fiber products are produced. Product standards refer to the characteristics of the final product.

One partial response to this competitiveness concern is strict residue standards enforced at the border. Scientifically sound, statistically valid residue testing of imported foods could take place at a level of detection to assure foreign foods are not exceeding residue standards-by-crop that are allowable in domestically produced foods. Such an approach requires sensitive monitoring devices as well as more enforcement efforts.

If residue standards at the retail level became the norm, retailers might well take the lead in assuring that all products–domestic and imported–meet these standards. Even so, there would still be a role for governmental agencies to assure retailers are doing a careful and adequate monitoring of product residues. Depending on the cost of monitoring, centralized laboratory testing of samples might be a lower cost method of achieving statistically valid measures of residues than many independent monitoring efforts.

However harmonizing U.S. residue tolerances with those of other countries is a complicated, ongoing process (Marchant and Ballenger, 1994). The United States participates in the Codex Alimentarius, a United Nations organization which negotiates international criteria on food importation standards, testing, and certification. The FQPA currently resolves this issue by amending the Federal Food, Drug and Cosmetics Act(FFDCA) Section 408 to encourage the EPA to set tolerances on the maximum residue levels established in the Codex, if such standards exist (Schierow, 1998).

Another way of addressing concerns about competitiveness is to use labeling on the final products coupled with a campaign to encourage consumers to purchase domestic products. A label such as “Produced in Accordance with U.S. FQPA Requirements” might provide enough

market differentiation for customers to select the domestic product. However, market research is needed to establish to viability of this approach.

In addition, where competitive issues appear to be serious, various trading tools can be used, including bilateral agreements with trading partners to achieve desired outcomes. Farmer-to farmer alliances of U.S. and non-U.S. farmers could also be created to gain access to lower production cost products or improved seasonal supplies.

Market development strategies

The keys to inducing innovation of risk reducing pest management practices are 1) to leave maximum flexibility to the innovators, and 2) to create a setting where there will be rewards to innovation that can be garnered by risk-reducing innovators. Achieving these outcomes amounts to allowing innovative pesticide users to either increase revenues or to reduce costs. Both are possible, particularly as the food system evolves toward supplying consumers food attributes they desire. Food safety is just such an attribute.

There is evidence from organic food marketing and studies of consumer willingness to pay for some products with reduced pesticide residues (Roosen et al., 1998; van Ravenswaay and Hoehn, 1991). Thus, farm revenues can be increased in those cases where consumers are convinced of the presence of those invisible attributes that they equate with food safety (see Part I [Batie, Swinton and Schulz, 1999]). What appears to be lacking is a trusted system of pesticide risk labeling (standards) that can certify risk to consumers (van Ravenswaay and Blend, 1998). Institutional design of such a trusted system would hold out the potential of rewarding innovative pest managers who can reduce pesticide risk. More closely vertically integrated food supply

chains are already leading to agricultural production contracts that specify product quality. Pesticide residue levels can feasibly become a contractually monitored quality attribute if consumers demand it and if it can be labeled and certified.

V. Conclusion: Food Safety with Agricultural Prosperity

Meeting the dietary safety needs of U.S. children under the FQPA can be consistent with keeping U.S. farmers and agribusinesses prosperous. But to accomplish these twin goals will require innovative regulatory design. Historical lessons suggest that the allocation of acceptable risk in the FQPA pesticide "risk cup" might best be accomplished by designing performance standards that guard producer flexibility. This strategy means departing from the *status quo* of banning specified pesticide uses through the mechanism of EPA pesticide registration.

While many performance-oriented approaches are possible, the one that appears to meet the FQPA mandate is residue limits by retail crop product on a targeted high-risk pesticides. This approach would constitute a major departure from traditional regulation of pesticides for agriculture. Other approaches such as pesticide risk taxes and marketable pesticide risk shares, are conceivable but do not appear politically feasible at this time. Furthermore these latter approaches will not protect the highly sensitive individual from pesticide risks, so they require that special attention be given to these individuals within the context of alternative policies.

Prescription pesticide use constitutes a fourth alternative that substitutes monitored input standards for a performance standard. Theoretically speaking, prescription pesticide use cannot more efficiently allocate risk than the performance-oriented approaches, but if properly administered it might come close. All of these alternatives, except residue standards, would require labeling of products as to residues and allowing consumers to assume the risk of selecting the amount of residues they ingest. Otherwise, there would be the possibility that sub-populations might exceed the safe "reference dose." Such an approach of making consumers responsible for

their own food-based risk choices has no major precedents in American public policy, and would likely be politically unacceptable.

Given the vast deficit in research addressing reduced pesticide agriculture in the United States, implementation of FQPA should be accompanied by a fresh and patient investment in publicly funded research into methods of pest management, processing, and marketing that reduce pesticide residue risks. But public innovation alone will be inadequate to meet the challenge. FQPA implementation should proceed in ways that build self-perpetuating incentives for private innovation into technologies and marketing that will reduce food-borne pesticide risks in a virtuous cycle. Only by inducing a successful public and private agenda for complementary research can FQPA assure a profitable and plentiful supply of safe foods to the tables and high-chairs of U.S. consumers.

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VII. Appendix A: The Food Quality Protection Act[16]

The Food Quality Protection Act (FQPA) is comprehensive legislation intended to protect human health from the hazards of pesticides in our food supply. Because the FQPA represents a major break from the established methods of managing pesticide risk, farmers, agribusinesses, environmentalists, policymakers, and consumers all have concerns about the implementation of the FQPA.

What Is FQPA?

The FQPA changed the manner in which pesticide risks are to be managed in the United States. In particular, the FQPA replaces the "zero cancer-risk" standard for pesticide residues in processed food contained in the Delaney Clause with a single health based standard for both raw and processed foods. The new standard requires that pesticide tolerances are set to assure with "a reasonable certainty, that no harm will result from aggregate exposure" to the pesticide. If there is insufficient data to establish the levels at which there is "reasonable certainty that no harm" will occur to infants, children, and other sensitive individuals, an additional tenfold safety margin is to be added. One reason for the addition of this safety factor is that pesticides may be harmful to the nervous system and reproductive organs–particularly of infants, toddlers and small children. Besides being smaller than adults, children's bodies are still developing, and they tend to

[16]For readers' convenience, this appendix reproduces the introduction of FQPA Implementation to Reduce Pesticide Residue Risks: Part I: Agricultural Producer Concerns.

consume–proportionally–many more fruits and vegetables than the average adult (Kuchler, Ralston, Unnevehr, and Chandran, 1996).

Because of these concerns, the FQPA requires that the U.S. Environmental Protection Agency (EPA) treat those pesticides which have a common toxic mechanism as a single hazard, and obligates EPA to consider dietary and non-dietary exposures in an aggregated manner. Thus, attention is focused on exposures stemming from food consumption, drinking water, and residential uses.[17] The Act requires that EPA review all existing tolerances to ensure that they meet the new safety standard by the year 2006. The Act directs EPA to focus first on pesticide uses posing greatest health risks, bringing those tolerances into compliance with the new safety standard of the Act. This last requirement is sometimes referred to as the "worst first" criterion.

FQPA represents a major break with previous pesticide policy–as found in the Federal Insecticide, Fungicide, and Rodenticide Act of 1947 (FIFRA)--which gave considerable weight to the benefits of pesticide use (Cropper and Oates, 1992). The FQPA applies a "precautionary principle" to pesticide risks. The "precautionary principle" is firmly embedded in European environmental policy and requires that regulatory action be taken before uncertainty about possible environmental or health damages is resolved (Hanley, Shogren, and White, 1997). For food safety, this principle rejects the assertion that absence of evidence of harm necessarily equates with safe food (Wargo, 1996). Thus, the FQPA strictly limits the nature and influence of benefits considered in establishing pesticide tolerances. Regulators are to consider only health

[17]While occupational exposure to farm workers is not included in the FQPA, there is currently a petition to the EPA administrator to include farm children as a major subgroup to be included within the FQPA (Natural Resources Defense Council, United Farm Workers of America, Farm Workers Justice Fund, American Public Health Association Petition, 1999; http://www.ecologic-ipm.com/farmkids.PDF).

risks and benefits that accrue to consumers (Schierow, 1998). That is, a policy of the minimization of risk to human health replaces the previous test of balancing costs and benefits (including producer benefits) of chemical uses.[18]

The rationale for this "precautionary principle" approach is that researchers cannot accurately predict the social costs of new pesticides; that is, they cannot predict whether new pesticide will ultimately cause health problems. Advocates of the precautionary principle point to a history of chemical uses that, while initially thought safe, ultimately proved to have negative health impacts (Wargo, 1996).[19]

Legislative History

The FQPA was passed with the support of many farm organizations, consumer groups and environmentalists, in part because it eliminated the distinction between raw and processed food tolerances. When passed in 1958, the Federal Food, Drug, and Cosmetics Act (FFDCA) prohibited the establishment of any processed-food tolerances for food additives classified as

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[18]The EPA, under FQPA can consider pesticide benefits only if either (a) "the pesticide protects consumers against adverse health impacts that are greater than the health risks posed by the pesticide itself" or (b) "the pesticide is needed to prevent a 'significant disruption in [the] domestic production of an adequate, wholesome, and economical food supply.'"

[19]The proverbial version of the "precautionary principle" is "better to be safe than sorry." Accompanying food safety risks, however, is the possibility of taking costly preventive actions that ultimately are found to be unwarranted. Both types of risks impose potential social costs–albeit on different stakeholders. Economic theory provides a less demanding principle–that of the "safe minimum standard." The safe minimum standard also demands protection of human health and environmental quality before uncertainty about impacts are resolved. However, it includes a caveat–action should be taken unless the societal costs (e.g., the lost benefits from withdrawn pesticide uses) of so doing are deemed unacceptably high. What is unacceptably high is a social decision, not a scientific one.

oncogenic (capable of inducing tumors) in animals or humans regardless of whether the additive was deemed to be a health hazard (National Research Council, 1987). This provision of FFDCA, called the Delaney Clause, meant that no residue was allowed in any processed product if the responsible chemical had ever produced tumors in test animals. With advances in chemical toxicology over the succeeding decades, it became possible to detect infinitesimal levels of oncogenic compounds that would have passed undetected during the 1950's. As a result, the Delaney Clause "zero-risk" standard came to be viewed as extreme by many.

To further complicated the issue, pesticide residues found on fresh or raw foods (but not processed foods) were regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Under FIFRA Section 408, pesticide registrations were established by balancing the benefits and costs from using the chemicals. The inherent contradiction between the pesticide usage provisions of FFDCA and FIFRA was a source of frustration to many in the agricultural industry and led, in part, to their support of FQPA.

In discussions leading to passage of FQPA, environmentalists and consumer advocacy groups were willing to eliminate the Delaney "zero-risk" provision in processed foods [20] in exchange for (1) an elimination of criteria which called for the balancing of benefits and costs of pesticide use on fresh foods, (2) shifting from a focus on individual pesticide uses to a focus on aggregate exposure from all pesticides sharing a common biochemical mode of action in humans, (3) introduction of more conservative thresholds to reflect risks based on children's diets, and (4) broadening the health risk criteria beyond cancer to include the possible risk of endocrine-related

[20]The FQPA did not repeal FFDCA Section 409, which contains the Delaney Clause. Section 409 remains in effect for food additives in processed foods that are not pesticide residues. (Schierow, 1998).

reproduction damage and neurological damages. These last two concerns gained visibility following the release of a 1993 National Academy of Science study on pesticides in children's diets (National Research Council, 1993) and a book entitled *Our Stolen Future* which promoted the hypothesis that chemicals, including pesticides, could cause birth defects and fertility problems in humans and other animals (Colborn et al., 1996).

The implementation of FQPA has focused initially on those families of pesticides deemed to pose the greatest threats to human health. The first groups of chemicals being examined are the organophosphate and carbamate insecticides, which are nerve poisons, plus those fungicides classified by EPA as B2 carcinogens.[21] These groups of chemicals are currently used on many crops.

The diverse nature of the many stakeholders and their interests complicate the implementation of FQPA. Relations among many of the stakeholders are marked by distrust and suspicion about underlying motivations and values. Moreover, most agricultural stakeholders tend to originate from a history and culture that emphasizes protection of agricultural profitability, voluntary and community-based programs, and public subsidies to obtain public goals. By contrast, many other stakeholders come from a culture that emphasizes public safety and the pursuit of public goals through more regulatory, top-down programs accompanied by fines and penalties as incentives to obtain public goals (Batie, 1987). Given the many and differing perspectives on these fundamental issues, it is of little surprise that the implementation of the FQPA is exceptionally controversial.

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[21]The U.S. Environmental Protection Agency classifies carcinogens into five groups, A - E. A substance in group B1 or B2 is a Probable Human Carcinogen.