PURDUE PESTICIDE PROGRAMS

Purdue University Cooperative Extension Service

PESTICIDES AND FOOD SAFETY

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PROFILE OF CONCERN

The food distribution network composed of farmers, grain handlers, shippers, food processors, and retailers is providing today's consumers year-round access to an abundant selection of vegetables, fruits, and grains never before available to the public. Encouraged by the medical and health care communities to eat a more wholesome and nutritious diet, the public has demonstrated a willingness to increase the consumption of fruits and vegetables as one method of improving personal health.

The selective use of pesticides to control pests (insects, diseases, weeds) of food crops has played a major role in increasing the availability of produce and grains to the consumer. Pesticides have allowed growers and handlers of food products to expand production into new geographical areas, increase production volume, extend shelf life, and improve the appearance of many of our commonly grown foods. The consequences of using pesticides for food production and the realization that some foods do contain pesticide residues are of paramount importance to today's health conscious consumer. Specifically, the public continues to voice its concerns by ranking pesticide residue as one of the top five food safety issues. For example, public opinion polls indicate that in selecting produce, an important consideration is that foods are certified free of pesticide residues. The public's concern that consuming foods containing pesticide residues may adversely impact their health is critical.

Nearly four out of ten individuals presently believe that the potential risks from pesticide residues outweigh the potential health benefits of eating fresh fruits and vegetables. However, nutritionists and dieticians generally agree that the issue of pesticide residues on food is not a top food issue. Rather, it is stressed that food safety issues should focus around establishing fruits, vegetables, and grains as a larger proportion of our daily diet (see Food Guide Pyramid on back cover for recommendations) and educating the public on the negative consequences (e.g., food poisoning) of improper preparation and/or storage of foods. It is hoped that this publication will educate the consumer to better evaluate the impact of minimal pesticide residues on human health and to weigh the benefits and risks associated with the consumption of foods containing trace pesticide residues.

WHAT CONSUMERS CONSIDER IMPORTANT WHEN SELECTING FRESH PRODUCE

Characteristic	Percent of People
appearance	97
taste/flavor	96
freshness	96
price	70
residue testing	68
nutritional value	66
shelf life	60
convenience	51
size	45
in-season	41
calorie content	26
organically grown	22
brand name	10

SOURCE: The Packer's Fresh Trends Consumer Profile Study.

PESTICIDE USE ON THE FARM

The American public relies on two percent of its citizens to produce its food supply. Many of today's food producers are taking an Integrated Pest Management (IPM) approach to preventing, reducing or eliminating pest problems. Growers and processors must make complicated decisions prior to planting, during the growing season, and during postharvest handling. Scientific IPM strategies give the grower economic incentives for sustaining long-term crop protection with minimal disruption to the environment. The agricultural community typically will use pesticides judiciously as part of the IPM strategy whenever proven alternatives are not available for pest control.

Growers are hiring professional crop consultants with increasing frequency for advice on maintaining or increasing production through the utilization of IPM programs structured toward their specific agronomic situations. Agricultural products leaving the farm are subjected to IPM at the food processing facility. IPM practices such as plant sanitation, monitoring for insect and rodent pests, and controlled temperature strategies in the food plant environment are routinely incorporated into the food processing chain; the result is often a reduced need for pesticide application. Informed decision-making via the IPM approach ultimately effects a profitable agricultural production system and benefits the consumer by providing foods with minimal or no pesticide residue.

EVALUATION AND REGULATION OF PESTICIDES

The Environmental Protection Agency (EPA) is mandated by federal law to evaluate the benefits of using a pesticide versus the risks its use might pose to public health and the environment. To evaluate the risks and benefits of pesticide use, the EPA requires all pesticide manufacturers to conduct extensive scientific

testing prior to product registration for sale and use in the United States. The manufacturers of all pesticides must compile and document information related to chemistry, toxicology, food residues, application rates, environmental impact assessment, and human safety. Normally it takes 5-10 years and upwards of $100 million to bring a new active ingredient (pesticide) to the point of approval for use by the public—a significant investment. But such scientific evaluation and regulatory scrutiny is essential to provide today's consumers with the benefits of high quality food.

PESTICIDES, PESTS, & PEST MANAGEMENT

PESTICIDES are chemicals used for the prevention, elimination, or control of unwanted pests. Pesticides are usually organic chemicals, but some are inorganic compounds. They can be produced in the laboratory, or naturally by the plant.

PESTS include plants and animals that vector disease, interfere with the production of food and fiber crops, or otherwise detract from our quality of life. Weeds, insects, nematodes, fungal and bacterial diseases, and rodents are examples of pests.

INTEGRATED PEST MANAGEMENT is an ecological approach to pest management in which all available control techniques are consolidated into a unified program so that pest populations can be managed in such a manner that economic damage is avoided and adverse side effects are minimized. Practices used as a part of this management philosophy include the following:

- destruction of crop debris
- having pests feed and concentrate on trap crops
- tillage and cultivation
- crop rotation
- selectivity of planting and harvest dates
- soil test analysis for crop nutrient needs
- planting crop species adapted for local conditions
- using genetically improved crop varieties with resistance to specific pests
- using biological control
- predicting pest outbreaks with computers
- pheromones for trapping pests
- scouting and monitoring for pests
- economic thresholds as guides to pest control
- better timing and application of pesticides
- use of biological insecticides
- improved pesticide application efficiency
- adapting promising technology, including the use of infrared scanners, satellite photos, gene-splicing biotechnology, and new pesticide delivery systems that incorporate farm specific information on tractor mounted computers.

PROCESS FOR ALLOWING NON-CANCER-CAUSING PESTICIDE USE ON FOOD

The registration of a pesticide for use in our gardens or a farmer's field requires assessment of the potential negative effects of that pesticide on human health. To anticipate how a pesticide might impact human health, laboratory animals such as mice and rats are exposed to varying dosages in their foods—from very minimal to extremely high levels. Scientists and health experts then evaluate the observable effect(s) of consuming known quantities of that specific pesticide on reproduction, respiration, and the immune system. Information gained from such tests is evaluated by health professionals and medical experts to determine potential human effects.

Evaluation Process

1. Scientists from the Environmental Protection Agency begin the evaluation process by determining the highest pesticide dose that can be fed to laboratory animals to cause adverse health effects but not death. This dose is called the *Maximum Tolerated Dose* (MTD).

2. The second step in the evaluation process is the selection of the highest pesticide dose that does *not* cause observable harm or side effects in experimental animals. This dose level is referred to as the *No-Observable Adverse Effect Level* (NOAEL). The NOAEL value can be developed from acute (single incident) or chronic (multiple exposure) studies. The NOAEL is the first safety level.

3. The NOAEL usually is divided by a safety factor of 100 (safety factors range from 10 to 10,000) to take into account individual differences among people and the extrapolation of human health information from animal data. This second safety level is called the *Reference Dose* (RFD).

4. The RFD generally is expressed in terms of milligrams of a pesticide consumed per kilogram of body weight (mg/kg) per day. It is the amount of a pesticide residue that, *if ingested daily over a 70-year lifetime*, a human could consume without expecting any health-related problems. It is the RFD that is used as the toxicological indicator when pesticide residues are tested on foods designated for human consumption.

WHO REGULATES PESTICIDES?

ENVIRONMENTAL PROTECTION AGENCY
- evaluates pesticide risks and benefits
- is responsibe for registering all pesticides at the federal level
- legally mandates the setting of food tolerances
- holds all authority granted under the *Federal Insecticide, Fungicide, and Rodenticide Act*

FOOD AND DRUG ADMINISTRATION
- monitors domestic and imported foods for levels of pesticide residues
- has legal authority by the *Federal Food, Drug, and Cosmetic Act*

UNITED STATES DEPARTMENT OF AGRICULTURE
- monitors meat, poultry, and egg products for pesticide residues
- has authority under the *Meat Inspection Act,* the *Poultry Products Inspection Act,* and the *Egg Products Inspection Act*

STATE PESTICIDE REGULATORY PROGRAMS
- Most states have the legal authority and statutory responsibility to register pesticides and to regulate pesticide use, storage, disposal, and certification. Programs dealing with pesticide food safety and residue monitoring vary from state to state. Contact your state Department of Agriculture for the programs in your state.

5. Next, EPA scientists determine how much of a particular pesticide residue the average consumer might ingest over a life expectancy of 70 years. One measure used to calculate lifetime exposures is the *Theoretical Maximum Residue Contribution* (TMRC). The TMRC assumes that the foods we consume will contain maximum amounts of pesticide residues. These theoretical residue calculations assume that the maximum allowable amount of a pesticide will be applied to 100 percent of the labeled crops, that the number of pesticide applications will be in accordance with the maximum allowed by the product label, and that the food commodities will be consumed daily for a lifetime. The TMRC is calculated by multiplying the tolerance on each crop by the average daily consumption of that crop. The individual TMRCs are then added to derive a single, *Theoretical Maximum Residue Contribution* which serves as one of the indicators for theoretical exposure.

6. The ultimate objective is the comparison between the total theoretical amount of that specific pesticide residue which we consume daily over a lifetime (TMRC value) and the highest safety level (RFD value). The pesticide is believed harmless to public health when the TMRC value is below the RFD safety value. If the TMRC is above the RFD, the Environmental Protection Agency reviews actual residue data or requires the development of such data to ascertain more realistic exposure estimates. This second exposure estimate incorporates "real world" residues into the calculations and is termed the *Anticipated Residue Contribution* (ARC). The ARC allows for a realistic refinement of the TMRC. Actual pesticide use, anticipated residues as determined in controlled field studies, the effects of processing, peeling, washing, and cooking on residues, and regulatory monitoring data represent the kinds of information used to evaluate the ARC alongside the RFD (see Average Residue Reductions During Marketing and Processing, page 6).

7. Finally, EPA examines each new request for the use of the pesticide on a food crop. The residue contribution from that use is added to the TMRC or ARC; and as long as it is below the RFD, a tolerance will be assigned for that use on that specific crop. Tolerances generally will not be approved when the ARC is above the health based RFD criteria.

PESTICIDES SHOWN TO CAUSE CANCER IN LABORATORY ANIMALS

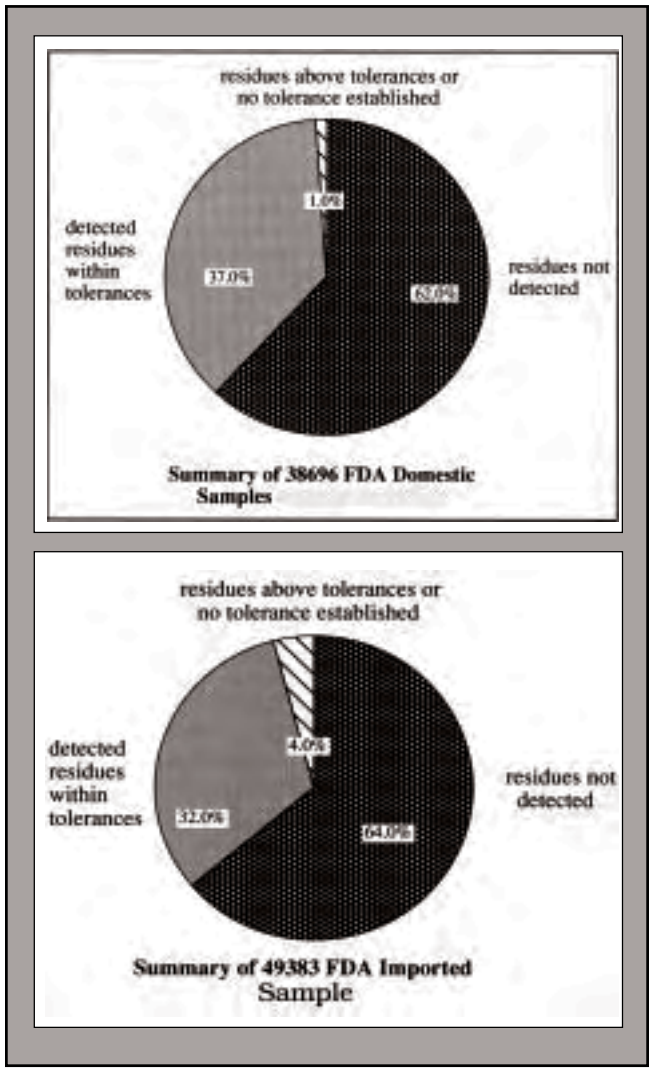
Scientific and medical evaluations continue for pesticides shown to cause cancer in laboratory animals. The evaluation process is extremely complex, uses highly sophisticated mathematical models, and assumes a daily exposure over a 70-year period. The ultimate outcome is to predict the potential increase in cancer cases, from laboratory animals exposed to high concentrations to humans exposed to low level residues in their diets. EPA will allow the use of a pesticide on a food crop if the estimated risk of its causing cancer is one in a million or less. The likelihood of any person developing cancer from a lifetime exposure range of zero to one in a million has been coined the negligible risk standard, or the de minimis interpretation. The general rule of thumb is that EPA will not grant a food tolerance for pesticides that are estimated to increase cancer rates in excess of the current one in a-million guideline.

HOW MUCH PESTICIDE RESIDUE IS ACTUALLY IN OUR FOOD?

Pesticide Residue Monitoring. The Food and Drug Administration (FDA), United States Department of

Agriculture (USDA), and many states have in place a pesticide residue monitoring program aimed at detecting residues which exceed legal tolerances or for which there are no tolerances established; in either case, food products containing illegal residues are subject to seizure and destruction. Each year, FDA samples approximately one percent of the food supply, or about 20,000 fresh food specimens grown domestically or imported. The majority of samples are derived from produce grown in other countries. These fresh vegetables and fruits are subjected to chemical analyses that can detect upwards of 268 pesticides or their metabolites.

The adjacent graphs summarize results from pesticide residue studies of imported and domestic crops grown between 1987 and 1991. These FDA results are very comparable to the results obtained from USDA and state pesticide residue monitoring programs. Such residue monitoring programs provide only an overview of potential exposures to pesticide residues. They do not take into account information on the effects of washing, peeling, and processing on pesticide residues, but provide only crude estimates relative to the dietary intake of pesticide residues in food. However, the monitoring programs do deliver a very important message to consumers: that pesticide label use directions are being followed strictly by the agricultural community. Pesticide residues on the majority of foods tested were within legal tolerances; and some foods were found to contain *no* detectable residue. This important point clearly supports the public's view that our farmers do have the prerequisite knowledge to properly and correctly manage pesticides. This single fact gives credence to federal and state regulatory decision makers who rely on the agricultural community to follow label directions and precautions to minimize potential adverse impact on human health.



Total Diet Study. FDA does conduct a Total Diet Study which is a market basket approach that analyzes pesticide residues after food has been prepared for eating. Foods are collected four times a year from four geographical areas. A total of 267 food items are selected and prepared in institutional kitchens. All of the foods are analyzed for pesticide residues after they are in table-ready or final food form. The Total Diet Study yields the best insights into actual pesticide residue exposures and takes into account the reduction of pesticide residues which occurs in the course of growing, handling, shipping, processing, washing, peeling, and cooking. Over the last four years, approximately 55 out of more than 200 pesticides have been detected in the Total Diet Study. The nine residues found frequently in the 1989,1990, and 1991 total diet studies are presented in Table 1. The total consumption of foods containing these residues can then be used to estimate daily intake over a lifetime. For example, malathion was detected in approximately twenty percent of the table-ready foods sampled. The residues found on specific food items were multiplied by the amount of the food consumed. In the malathion example, children between 6 and 11 months, young adults between 14 and 16 years, and older adults between the ages of 60 and 65 consumed an average of 0.1, 0.08, and 0.04 micrograms per kilogram of body weight per day, respectively, of this pesticide. Those exposure values were then compared to the RFD criteria established by EPA and the World Health Organization. The conclusion drawn from the total diet studies is that pesticide residues being detected represent only one percent of the RFD and generally are about 10,000 times lower than the NOAEL. FDA's monitoring reveals that the "...levels of pesticide residue found in the U.S. food supply are generally below

safety limits set by the Environmental Protection Agency."

Circle of Poison. Foods imported from foreign countries into the United States are the subject of a great amount of public debate and scrutiny from policymakers in Congress. The discussion involves what has become known as the "Circle of Poison." There are approximately 25 pesticides manufactured in the United States that are neither registered for domestic use nor have food tolerances established by EPA. These pesticides are sold for use in foreign agricultural production.

The vast majority of Circle of Poison candidate pesticides is comprised of pesticides that have not been registered in this country since profits from their sale here could not justify the expense of securing registration. As an example, U.S. manufacturers produce pesticides for export that may be used on coffee or other tropical crops not grown in this country; and since they will not be used here, U.S. registration is not required. These "unregistered" pesticides are very different from "banned" chemicals that had a history of use in this country. It is also important to realize that many pesticide bans were the result of other types of adverse effects (i. e., environmental, ecological, worker safety) rather than food safety concern.

The debate centers on allowing foreign commodities from crops treated with these pesticides to enter the United States on an import basis. Hence, the term "Circle of Poison." FDA's monitoring efforts, although limited, indicate that only a small number of imported

AVERAGE RESIDUE REDUCTIONS DURING MARKETING AND PROCESSING

The following examples are approximate reductions. The actual values may vary dramtically, depending on the crop and also on the amount of residue.

	Percent Reduction
Shipping to Supermarket	
Peppers	14
Celery	86
Cabbage	86
Lettuce	87
Cucumbers	100
Tomatoes	100
Washing	
Apples	14
Grapes	36
Peaches	73
Tomatoes	83
Trimming	
Lettuce	89
Cabbage	93
Heating	
Potatoes	
Baked	61
Boiled	68
Chipped	86
Beans	
Canned	72
Frozen	92

SOURCES: Food Safety, 1992. J.M. Jones; Pesticide Residues and Food Safety. 1991. B. G. Tweedy, ed.

TABLE 1. RESULTS FROM THE 1997 & 1999 FOOD AND DRUG ADMINISTRATION TOTAL DIET STUDIES.

DETECTABLE PESTICIDE RESIDUES				WHAT WE CONSUME			SAFETY STANDARDS	
	FREQUENCY OF OCCURRENCE IN THE TOTAL DIET STUDY			µG/KG BODY WT/DAY*			REFERENCE DOSE µG/KG BODY WT/DAY*	
Active Ingredient	1997 (%)	1998 (%)	1997 (%)	6-11 months	14-16 (male) years	60-65 (female) years	World Health Organization	Environmental Protection Agency
malathion	16	15	17	0.100	0.080	0.040	20	20
DDT	24	21	22	0.080	0.030	0.010	20	0.5
chlorpyrifos (M)	16	18	18	0.020	0.020	0.010	10	3
endosulfan	14	12	15	0.030	0.010	0.020	6	0.05
chlorpyrifos	8	9	9	0.020	0.004	0.003	10	3
dieldrin	12	10	14	0.001	0.002	0.002	0.1	0.05
chlorpropham	8	5	7	0.230	0.390	0.180	-	200

* Food and Drug Administration: Residues in Foods. 1990. Journal of the Association of Official Analytical Chemists. Volume 74.

"...in the case of pesticides, it is our belief, as well as that of the larger medical and scientific community, that the benefits of eating fruits and vegetables far outweigh any potential risks that may be involved in digesting foods correctly treated with pesticides..."

-- Dr. Vernon N. Houk, United States Centers for Disease Control

commodities contained pesticide residues which exceeded established tolerances; likewise, only a small number of foods were found to contain pesticide residues for which there were *no* established tolerances.

Exposures to most illegal or violative residues are of no apparent toxicological significance. The logical and widely held perceptions of legal residues as safe residues and illegal residues as unsafe residues are not supported by scientific evidence. The purpose of tolerances is to function as economic disincentives to pesticide misuse, regulate international trade, and emphasize compliance with regulations. Therefore, in exploring the "Circle of Poison" issue it is important not to focus on the *presence* of illegal residues but, instead, to identify specific pesticide residues, examine toxicological information, and determine the quantity of residue actually consumed in the human diet. Such information is essential to the logical assessment of potential risk associated with consumption of foods containing trace residues.

SUMMARY

The key points made in *Pesticides and Food Safety* are that pesticides may improve variety, availability, and quality of foods. IPM programs are decreasing actual pesticide use, regulatory and monitoring programs are in place, and the human health risks from consuming pesticide residues on our foods appear low.

This issue is very complicated and subject to different interpretations due to trust, credibility, values, and familiarity with the scientific process. Thus, we will read and hear various accounts of the supposed contamination of our food supply by pesticide residues. It is important to realize that we must be informed consumers, basing related decisions on information from several sources such as universities, industry, the media, and public and private organizations. Reviewing information from a wide array of origins will allow better understanding of how each group interprets, presents, and answers important questions relative to pesticide residues and food safety.

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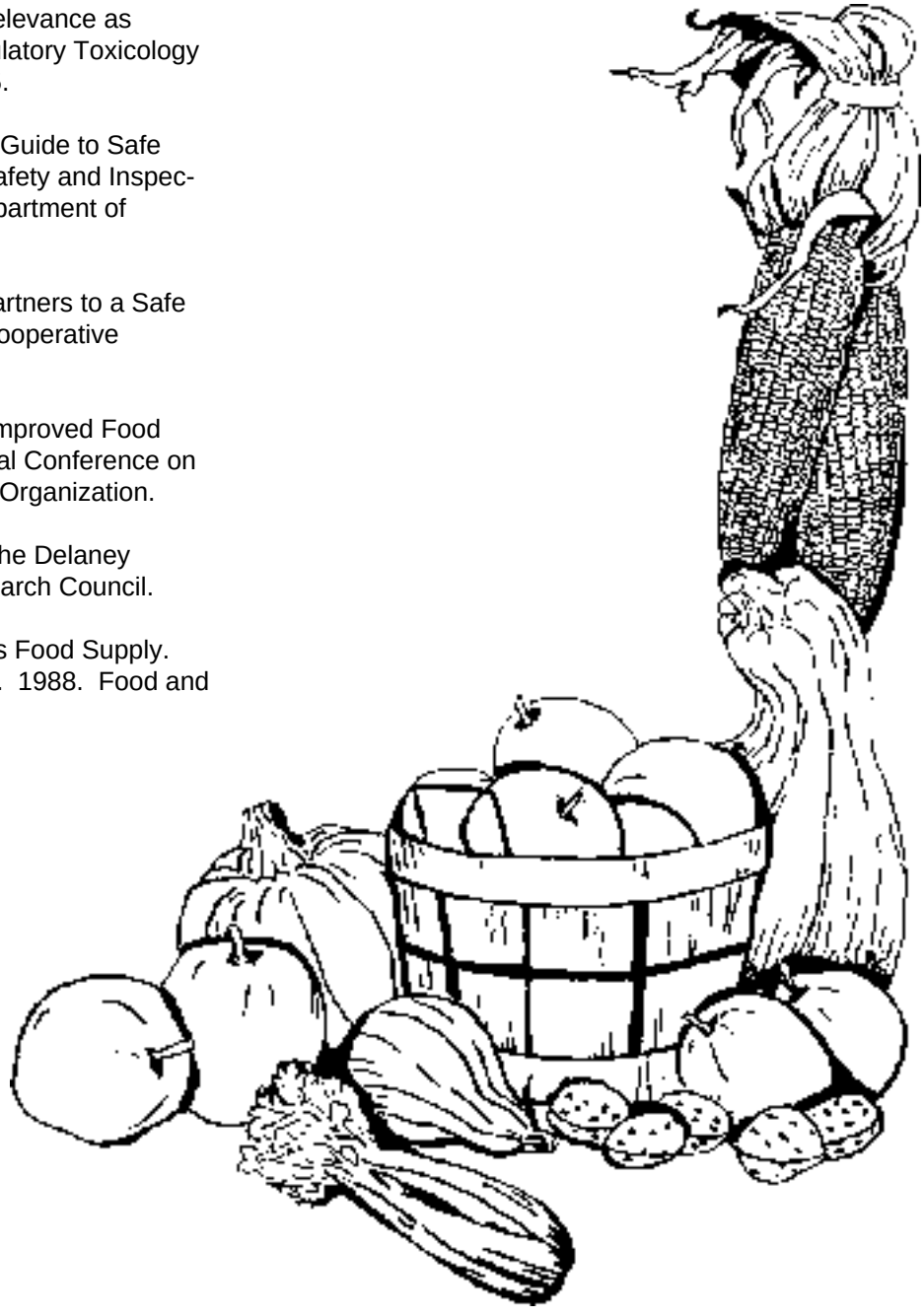

National Telephone Contacts

- Alliance for Food and Fiber, (800) 266-0200. This is a coalition of organizations active in California's food production and distribution industry. The purpose is to serve as an information clearing house for the media and consumers on issues relating to food.

- Consumer Nutrition Hotline, (800) 366-1655. National Center for Nutrition and Dietetics. Registered dietitians answer food and nutrition-related questions.

- Cooperative Extension System, United States Department of Agriculture. Consult county government listing in telephone directory for your local Cooperative Extension office. Cooperative Extension provides research-based information and education programs on all aspects of food and agriculture -- from production through consumption.

- Food Safety and Inspection Service, (800) 535-4555. United States Department of Agriculture. Meat and Poultry Hotline. Home economists answer questions on the safe handling and storage of meat and poultry. They can also assist you with basic nutrition questions on meat and poultry products and the nutrition labeling on these items.

- FoodWatch, (800) 676-3608. A nationwide public education and referral program for agricultural, environmental, and food safety issues.

- National Cancer Institute, (800) 4-CANCER. Information on diet, nutrition, and cancer.

- National Coalition Against the Misuse of Pesticides, (202) 543-5450. The purpose of this organization is to act as a clearinghouse for information on pesticides and the available alternatives.

- National Pesticide Telecommunications Network. (800) 858-PEST. Provides impartial information about pesticides, including product information, recognition and management of pesticide poisonings, safety information, clean-up and disposal procedures, and lab analysis referrals. Operates 24 hours a day, 365 days a year.

- Public Voice for Food and Health Policy, (202) 659-5930. National research, education, and advocacy organization that promotes a safer, healthier, and more affordable food supply.

- U. S. Food & Drug Administration, U. S. Dept. of Health and Human Services, Consumer Affairs & Information Staff. (301) 443-4166. Inspects food other than meat and poultry and enforces EPA regulations for pesticide residues.

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NOTES

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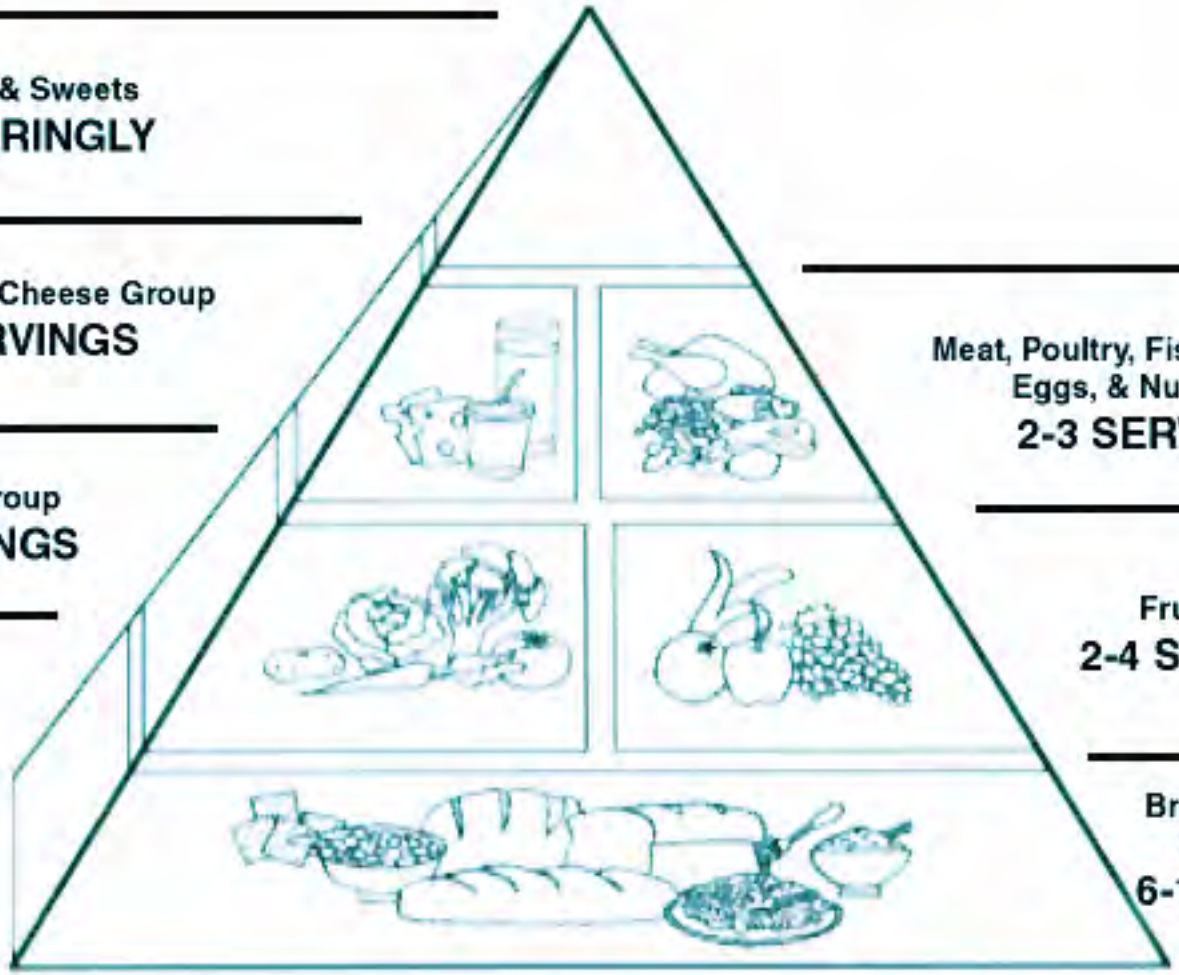
Food Guide Pyramid
A Guide to Daily Food Choices



Fats, Oils, & Sweets
USE SPARINGLY

Milk, Yogurt, & Cheese Group
2-3 SERVINGS

Vegetable Group
3-5 SERVINGS

Meat, Poultry, Fish, Dry Beans, Eggs, & Nuts Group
2-3 SERVINGS

Fruit Group
2-4 SERVINGS

Bread, Cereal, Rice, & Pasta Group
6-11 SERVINGS