Vol. 5 No. 1 Winter 2000

ORACBA News

United States Department of Agriculture Office of Risk Assessment and Cost-Benefit Analysis

How Can We Choose Among Life-Saving Programs? Why Do Economists Keep Pushing Cost-Benefit Analysis?

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Introduction

Many government agencies are charged with protecting some aspect of public health or safety. For example, the Department of Transportation mandates airline safety equipment; the Environmental Protection Agency chooses which toxic waste sites to clean up; and the U.S.
Department of Agriculture and the Food and Drug Administration (FDA) determine the stringency of food safety regulations. For some foodborne hazards, positive levels of contamination have been judged acceptable, while others are not allowed. The choices these agencies make affect risks faced by everyone, and many of the choices are literally life-and-death decisions. How should these risk decisions be made? The following note is intended to articulate the economist's answer. We argue that more lives could be saved and more suffering avoided if policy makers discriminated among programs on the basis of dollar benefits and costs. We argue that ultimately, economic efficiency is the best tool we have to save lives and reduce morbidity.

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Prioritizing Food Safety Funding

To anchor our arguments and highlight the practical problems agencies face in making choices among health and safety programs, we focus on foodborne risks. It is difficult to prioritize funding for foodborne illness reduction programs for at least three reasons: first there is a wide variety of foodborne risks and potential adverse health outcomes; second, there is inadequate information on dose-response functions and the incidence of foodborne illness; and third, there are many agencies responsible for some aspect of food safety. In recognition of both the difficulty and the importance of prioritizing food safety funding, Congress established the Risk Assessment Consortium (RAC). RAC, which is composed of representatives from many

agencies, is charged with recommending a means for setting priorities within and across agencies. It is currently wrestling with the decision of how to rank research and regulatory programs across pathogens, contaminants, and chemical residues, across all foods that carry risks, and across all types of potential adverse health effects (deaths, short-term illnesses, chronic conditions).

Clearly, determining which health and safety problems are the most important, and which programs should be funded is a difficult choice—a choice that many would prefer to avoid. However, resource constraints make these choices unavoidable. Food safety agencies, like all government agencies, need to make choices because they do not have the resources (money, labor, time) to do everything. One of the implications of limited government budgets is that it is impossible to protect everyone from every threat to their health and safety. In fact, the resources to eliminate even a small portion of all hazards do not exist. As noted by Viscusi,

> *The need for economic balancing is inevitable in a world of constrained resources. Suppose that we were to devote the entire U.S. gross domestic product to the prevention of fatal accidents. Even then, we would be only able to spend $55 million per fatality...That expenditure would leave literally nothing for other goods, such as other risks or environmental pollution, let alone basics like food, housing and medical care.* (p. 120)

A number of different approaches to prioritizing choices exist and RAC, and every agency confronting such a choice, must determine which approach to adopt. Should agencies prioritize on the basis of numbers of individuals who become ill or on the severity of illnesses? Should they put more effort into hazards in widely consumed foods? Do children's illnesses deserve more attention than those of the elderly? Many Federal decisions regarding health and safety are made on the basis of risk standards. Risk standards determine the level of risk above which the regulatory agency must take action to reduce risk levels. With risk standards, agencies cannot discriminate among programs on the basis of cost: hazards that are very expensive

90:10 Phenomenon

Viscusi and Hamilton claim that because many government agencies are not allowed to consider costs to prioritize funding allocation, or are unable to do so, much of the resources of government agencies charged with protecting public health is used to reduce small risks at great expense while more substantial and more easily mitigated risks persist. They characterize this outcome as a "90:10 phenomenon." Namely, society spends 90 percent of its resources to achieve the last 10 percent of risk-reduction benefits. When the 90:10 phenomenon characterizes the outcome of risk mitigation choices, more deaths, illnesses, and injuries are likely than when expenditures are targeted first toward large risks that are relatively inexpensive to address.

Cost Per Life Saved

Several studies have demonstrated that Viscusi's and Hamilton's characterization of agency decision making has merit. Morrall showed that the variance of cost per life saved for health and safety regulations is enormous. The National Highway Traffic Safety Administration's 1967 rule on steering column protection was estimated to save 1,300 lives annually at a cost of $100 per life saved (1984$). At the other end of the scale, the Occupational Safety and Health Administration's 1985 formaldehyde regulation was estimated to save 0.010 life annually at a cost of $72 billion per life saved (1984$). A similar tabulation by Tengs et al. showed that in recent years, the cost per life saved varied over 11 orders of magnitude among government interventions, with ever more expensive projects undertaken.

The result of not being able to prioritize according to cost is that fewer lives are saved and more money is spent. Tengs and Graham showed that with some simple rules for allocating costs among life-saving interventions, expanding those that are most cost-effective and contracting others, the number of lives saved could be more than double the current number. Alternatively, the current number of lives

saved could be maintained at a savings of $31 billion per year (1993$).

The studies by Morrall, Tengs et al., and Tengs and Graham all make the point that substantial public health benefits could be realized if agencies paid more attention to program benefits and costs. However, though their point is well taken, the simple cost-effectiveness comparisons used in all these studies is inadequate for prioritizing funding allocation for most government agencies. These studies focused exclusively on fatal risks, ignoring morbidity and non-fatal accidents. That simplification yielded a common unit of account by which programs could be compared—cost per life saved. Most health and safety decisions cannot be reduced to a simple tally of cost per life saved. Regulatory decisions often require evaluating a wide range of risks involving morbidity and non-fatal accidents. Even the set of foodborne pathogens, a subset of foodborne risks, yields a wide range of adverse health outcomes, including gastrointestinal illness, kidney failure, arthritis, mental retardation, paralysis, septicemia, and death. These risks do not have a common outcome and therefore cannot be ranked through a simple cost-effectiveness analysis. In fact, it is very difficult to reduce them to any common unit for ranking purposes.

Quality Adjusted Life Years

Analysts have tried several ways of modifying cost-effectiveness to account for the variety of health outcomes programs yield. One of the most popular methods is to construct a health index that accounts for changes in both length and quality of life. To calculate Quality Adjusted Life Years (QALY) analysts use individual assessments of health outcomes arrayed on a 0-1 scale, with 0 indicating death and 1 indicating robust good health. With a QALY scale, adverse health outcomes that compromise both lifespan and functional ability are converted to a common unit of account. Because QALY provide a common unit of account, they provide a means for ranking and prioritizing funding allocation across diverse types of programs, such as nutrition and dialysis programs. All things equal, those programs with the highest QALY per dollar calculation should be funded before those with lower QALY per dollar calculations. However, though the QALY approach imposes a certain logic to funding allocation, it is incomplete. With the QALY approach analysts could decide whether a nutrition or dialysis program should be funded first, but they would be unable to determine whether either program was worth the cost. QALY do not provide a measure of net benefits. A QALY-per-dollar calculation does not provide information as to whether program benefits outweigh costs. In addition, because QALY are used only by public health analysts, they do not provide a straightforward means for making comparisons with non-health goods and services. For example, analysts would be unable to say whether the QALY generated by a nutrition program were more valuable than a college education.

Willingness to Pay

The economic approach to comparing programs with divergent health outcomes is to calculate how much each program is worth to the individuals who benefit from government-financed risk reduction. With this approach, analysts estimate consumers' willingness to pay (WTP) for reductions in health risk or improvements in health. They estimate the dollar value of small reductions in health risks. The WTP approach uses dollars to convert health outcomes into a common unit of measurement. Using money as the common unit of measurement, analysts can rank dissimilar programs with different health outcomes: the costs and benefits of

a kidney machine can be compared with those of a nutrition program. Using money to measure both benefits and costs also allows analysts to calculate net benefits, thereby providing an indication of whether a program is worthwhile. Net benefit calculations allow analysts to compare the value of a program with the value of goods and labor services that have to be used to carry out the program. Negative net benefits are an indicator that the program is not worthwhile, regardless of whether it is ranked higher than every other program. Negative net benefits indicate the goods and labor services are more valuable elsewhere. Furthermore, because money is already in common use in ranking choices and in conveying value, analyses based on a money scale allow analysts to compare public health programs with alternative ways individuals might spend their money. The costs and benefits of a nutrition program could be compared with those of a college scholarship program.

Dollar-based calculations of program costs and benefits are clearly very valuable for evaluating programs and prioritizing funding across diverse programs targeting diverse health outcomes. However, the real strength of the WTP approach is that, unlike any other approach, it helps target funding toward those programs providing the type of risk reduction most highly valued by society. There are profound differences in the way that individuals value reductions in different risks. WTP gives us a means of ranking diverse risks, not just by the size of the risk, but by how uncomfortable individuals are about the risk.

Consumer Preferences

Some risks rank quite low when preferences are considered. For example, skiing carries a risk of injury and death, but very few skiers would welcome a government program that banned skiing on the basis of risk. In fact, the risk may be part of the attraction to the sport. Saccharin carries a cancer risk, but consumers' preferences have been revealed, and we know that consumers are willing to accept the risk for the benefit of an artificial sweetener. FDA attempted to ban saccharin on the basis of potential cancer cases, but consideration of consumer preferences led Congress to stop FDA's action (Cummings). Other risks rank quite high when preferences are considered. For example, when exposure to cancer-causing environmental pollutants is possible, individuals may become fearful, even when risks are identical to those of saccharin. Magat, Viscusi, and Huber found that a significant proportion of the population values reductions in cancer risk much more highly than reductions in the risk of automobile fatality. Similarly, preferences provide a clear justification for assigning high priority to programs that reduce children's risks. In investigating risk preferences toward household chemicals, insecticides and cleaning products, Viscusi, Magat, and Huber found a WTP to reduce risks to children 2.3 times higher than for adults.

If funding is prioritized simply on the basis of outcome, without any regard to consumer preferences, then the deaths due to skiing would be ranked equal to the deaths due to childhood leukemia. The dollar values consumers attach to risk reduction help us to discriminate among risks to identify safety programs that are most valuable to consumers and to avoid funding risk reduction that would actually make consumers worse off. Only by recognizing that preferences for risk reduction vary across risks can we make sense of how to efficiently reduce risks.

For a more extensive discussion of this issue, see "Assigning Values to Life: Comparing Methods for Valuing Health Risks," by Fred Kuchler and Elise Golan. Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 784, November 1999. The report is available through the ERS website at www.econ.ag.gov.

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Director's Corner by Nell Ahl and Clare Narrod

Our official name is the Office of Risk Assessment and Cost-Benefit Analysis, familiarly known as ORACBA. There have been questions from time to time about why ORACBA is not more involved in the review of economic analyses associated with major rule making. This column attempts to explain how things came to be and to suggest ways that risk assessment and cost-benefit analysis can better work together, for they are truly complementary tools.

ORACBA was given its name and charge by Congress as part of P.L. 103-354, the action which initiated a reorganization for U.S. Department of Agriculture (USDA) in 1994. Before this reorganization, the Assistant Secretary for Economics had been in charge of reviewing economic analyses of rules proposed by the Department. In addition, the USDA had, and still has, many economists in the various agencies, including a stellar research staff in the Economic Research Service (ERS). In 1994, there were few agricultural science-based risk assessors in government, academe, or the private sector. The consensus between the Chief Economist, Keith Collins, and the new Director of ORACBA, Nell Ahl, was that ORACBA should concentrate on developing the Department's risk assessment capability while the Immediate Office (IO) of the Office of the Chief Economist would continue to perform economic reviews. Staff of ORACBA and IO have worked together for the past 4 years to ensure that the two analyses presented with a proposed rule are consistent, reasonable, transparent, and defensible.

The experience of IO and ORACBA has led to many questions about the interface of these two fields. What

kinds of things have we learned? How can the process be improved? Since the interface is a little-researched area, how can we encourage dialog and scholarship?

ORACBA sponsored a Symposium on this interface at the Society for Risk Analysis (SRA) meetings in 1998. The topic was also discussed at SRA and the American Association of Agricultural Economists in 1999. There is a growing interest in this interface, not only in several USDA agencies, but also in the Food and Drug Administration, especially in the Center for Food Safety and Applied Nutrition (CFSAN). To encourage dialog, ORACBA devotes this issue of the *ORACBA News* to this interface. Two economists from ERS, Fred Kuchler and Elise Golan, contributed the lead article for this issue. Clare Narrod, an economist and an American Association for the Advancement of Science (AAAS) Risk Policy Fellow placed at ORACBA for fiscal year 2000, has taken the ideas presented in the lead article and expanded them. These ideas are based on her work with Tanya Roberts and Michael Ollinger of the ERS and Scott Malcolm of the University of Delaware, while completing her first year as a AAAS Fellow with the Food Safety and Inspection Service.

ORACBA is committed to developing a working conference for late summer or early fall 2000 in which economists and risk assessors will come together to explore this interface. The outcome of this conference will be made available as "white papers" on the ORACBA website. For more information, contact Clare Narrod at e-mail cnarrod@oce.usda.gov.

With that, I give my pen to Clare.

To expand on what Fred Kuchler and Elise Golan wrote, economists are also interested in questions of technology change and the impact of the choice of technology among different size agricultural producers with regard to pathogen reduction. Economists are now developing methods to compare the use, effectiveness, and the degree to which different control technologies have penetrated the market. Cost-effectiveness analysis is a useful tool that can be used by both the private sector and policy makers in conjunction with risk analysis to gain insight into their need for pathogen-reducing technologies.

An understanding of this is important because not all firms face the same decision criteria when choosing between technologies. Differences between firms are due to a combination of economies of scale associated with varying technologies and effectiveness of combining different pathogen reduction strategies. Allowing firms to choose a strategy that is optimal for them may be preferred from a policy perspective, rather than mandating the use of a certain technology that may result in some firms going out of business.

Jensen *et al*. (1998) were among the first to evaluate improved food safety in the meat industry by comparing the costs and effectiveness of interventions using the mean pathogen reduction of technologies and combinations of technologies. The limits to this are that the outcome does not account for uncertainty and variability associated with the process. Narrod *et al*. (1999) expanded this model to account for this. The advantage of this approach is that it uses a probabilistic risk assessment (PRA) model to evaluate the effectiveness of various technologies, accounting for non-uniformity of their effectiveness, thus enabling development of a preliminary cost effectiveness framework.

A plant's capability to adopt various technologies results in different adoption costs for similar technologies. A plant with a stable workforce may realize greater benefits from worker training because it has a lower likelihood of losing training value due to worker departures than does a plant with high worker turnover. Additionally, plants with higher throughputs have lower pathogen-reducing equipment costs per animal than do plants with lower throughputs. Plants with sufficiently high throughputs may choose to use an

expensive, but highly effective technology while plants with lower volumes may either not use this expensive technology or use a contract provider of the technology.

Another factor affecting technological adoption is economies of scale in the use of the technology. Economies of scale arise because (1) the high initial implementation cost of certain technology systems may be a hurdle for small plants with limited capital, and (2) large plants already are operating under some form of quality management system comparable to that technology while many small plants have to implement that technology from scratch.

As noted by McDowell *et al.* (1995:120), "Food safety managers are faced with the problem of assembling a "portfolio" of mitigation techniques to obtain some desired level of safety (or maximizing safety for a given cost)." To evaluate the overall effectiveness of reducing pathogens in the output of the plant, probabilistic risk assessment (PRA) models can be used to quantitatively address the uncertainty and variability surrounding risk increasing and decreasing events**.** In such a model, each step in the process can represent either increases or decreases in the pathogen load on a product by an amount drawn from a probability distribution representing the range of contamination, in the case of contamination events, or the range of effectiveness, in the case of decontamination technologies. By cycling the model through a large number of iterations, a probability distribution is obtained for the contamination level of a product. The model is run for the baseline case, (i.e., no improved technologies are present) producing the cumulative distribution function (cdf), F_0. Including one or more pathogen reduction technologies

and running the modified PRA model results in a second cdf, F_1, typically shifted to the left. This shift reflects the degree to which pathogens are reduced in the final product. (See figure 1.)

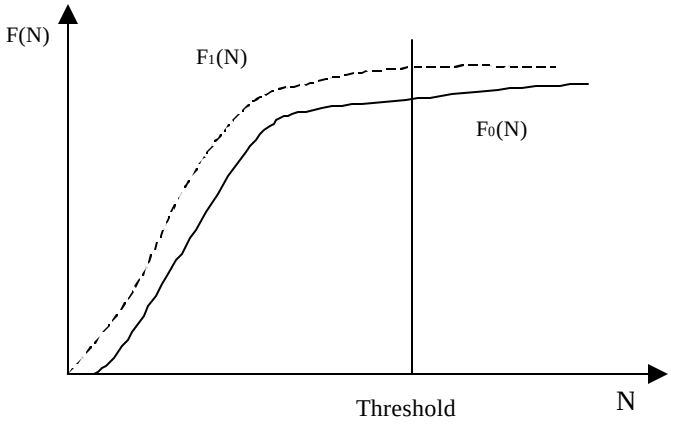

Figure 1. Cumulative distribution of a pathogen in a product.

From a risk assessment standpoint, what is of interest is not the expected value of contamination but rather the frequency with which a product posing some level of risk occurs. Focus is on the right-hand tail of the distribution, rather than the mean value. To evaluate the effectiveness of technology adoption strategies, a risk tolerance threshold is selected. The change of expected pathogen frequency above the threshold compared to the baseline model represents the effectiveness of the adoption strategy. This is expressed as:

$$P(\text{product contamination above threshold}) = (F_1(\text{Threshold}) - F_0(\text{Threshold}))$$

The difference $F_1 - F_0$ represents the change in the probability that the product is above the risk threshold.

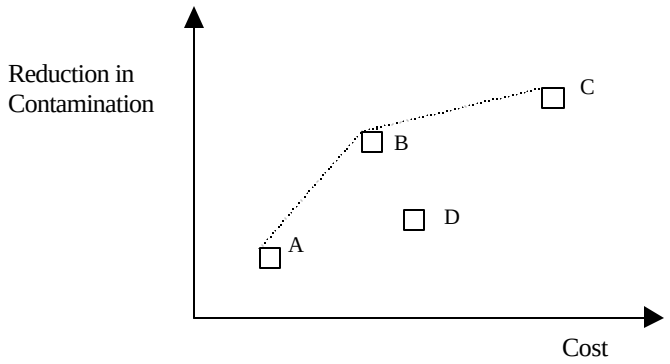

Figure 2: Cost versus pathogen for hypothetical strategies.

Using such an analysis, hypothetical strategies can be compared. Figure 2 illustrates that strategy D can be excluded since strategy B dominates D in the sense that B is both more effective and less costly. Choices of adoption strategies can be limited to non-dominated strategies A, B, and C. This simple method illustrates a way of linking technology evaluation with quantitative risk assessment models. The benefit of doing so is that it enables plants to see more clearly the trade-offs between technologies and pathogen reduction given their costs. Some of these choices may be superior to others in terms of pathogen reduction, but more costly to certain plants based on their size of operations. The outer envelope of strategies marks the feasible and efficient mix of interventions. Some factors may prevent the widespread adoption of these technologies even if they are shown to be effective. Plants may not adopt some technologies, despite their effectiveness in pathogen reduction, because there are not the proper market incentives for adoption or investment in research for development of new technologies. The method discussed above illustrates a general way to link probabilistic risk assessments with technology evaluation. The benefits of using such methods are that they allow both policy makers and private firms to clearly see the tradeoffs between pathogen reduction measures given their costs. For a more extensive discussion of this issue, see "Pathogen Reduction Options In Slaughterhouses And Methods For Evaluating Their Economic Effectiveness" by Clare A. Narrod; Scott A. Malcolm; Michael Ollinger; Tanya Roberts, American Agricultural Economics Association Annual Meeting, August 8-11, 1999, Nashville, Tennessee. The report is available from http://agecon.lib.umn.edu/cgi-bin/ifetch?AGECON+11890471+F.

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Risk Assessor in Profile: Dr. Eric Ebel

Our featured USDA risk assessor in this issue is Dr. Eric Ebel of the Food Safety and Inspection Service (FSIS), Office of Public Health and Science, Epidemiology and Risk Assessment Division. He is stationed in Ft. Collins, Colorado, along with his colleague, Dr. Wayne Schlosser. Wayne was our featured USDA risk assessor in *ORACBA News,* Vol. 2, No. 3, May-June 1997. These two risk assessors work closely together and, to some people, seem to be an inseparable set. Some of their previous project team members jokingly call them "Mutt and Jeff" or "Click and Clack." In truth, their interaction allows a synergy of their skills that accounts for their great work output.

Eric is currently working on the *E. coli* O157:H7 risk assessment on ground beef for FSIS. This draft risk assessment was presented at several venues in December 1999 for review of methods, assumptions, and outputs. The final risk assessment will be published in early 2000. While Eric participated in work on each of the modules of this risk assessment, he was the lead for the production module. His primary responsibility was development of the model and inputs and performing the data analysis. The basic design of the *E. coli* risk assessment is similar to the *Salmonella enteritidis* (SE) risk assessment completed in 1998. (See *ORACBA News*, Vol. 3, No. 3, Summer 1998 for a discussion of the SE risk assessment.) Both Eric and Wayne also worked on that project.

Eric received his Doctor of Veterinary Medicine degree from the University of Illinois (UI) in 1985. After a couple of years of private practice, he took a position with Animal and Plant Health Inspection Service (APHIS), Veterinary Services as a field Veterinary Medical Officer. He was then given the opportunity to return to UI to get a Masters' Degree in Agricultural Economics. After this he worked with the SE Task Force at APHIS and later as the Area Epidemiologist in Idaho. In 1997, he was hired by FSIS as part of its core team of risk assessors.

When asked about his philosophy of risk assessment, he supplied the following quote from a paper he presented last year: "No other technique is quite as rigorous in pulling together disparate evidence and putting it all in one place for interpretation." The co-location of Eric and Wayne by FSIS has proven very successful. They have played a critical part in the success of FSIS risk assessment projects.

News of ORACBA

2000 Risk Forums Changing Format

In the year 2000 the Risk Forum will continue to be held on the second Wednesday of each month in Room 107A, Jamie L. Whitten Federal Building, 12th & Jefferson Drive, SW, Washington, DC. Beginning with February, in addition to the morning presentation and discussion from 10:00 a.m.- 11:30 a.m., there will be an afternoon workshop from 1:00 p.m. - 4:00 p.m. in Room 0768, South Building, 1400 Independence Avenue, SW, Washington, DC. This expanded format will provide a broad overview of the topic in the morning session and a more personal, in-depth information exchange and discussion with the speaker in the afternoon workshop. Don't miss this opportunity to exchange ideas with leaders in the field of risk analysis–with no cost to you. Mark your calendars now and plan to attend both sessions. The following is a list of the speakers and topics for February through July 2000. Remember, in August there will be no Risk Forum. For further information, contact Jennifer Callahan at: (202) 720-8024 or e-mail jcallahan@oce.usda.gov.

2000 Risk Forum Calendar

February 9	Dr. Stan Kaplan/An Introduction to TRIZ: The Russian Theory of Inventive Thinking–Applications to Risk Assessment, Decision Theory, Failure Analysis, and Process Improvement
March 8	Dr. Lawrence Madden/Assessing the Plant Disease Outcome of an Introduced Plant Pathogen: Disease Invasion and Persistence
April 12	Dr. Mark Tumeo/Risk Assessment Center of Excellence at Cleveland State University

May 10	Dr. Richard Lowrance/Evaluation of Riparian Buffers in the USDA Conservation Buffer Initiative	July 11	Dr. Christopher Frey/Quantitative Analysis of Variability and Uncertainty
June 14	Dr. Tsegaye Habtemariam/Modeling and Risk Assessment		

October Risk Forum: Mr. Jim Grueff

Jim Grueff, Assistant Deputy Administrator for International Trade Policy with the U.S. Department of Agriculture's Foreign Agricultural Service, gave a presentation on "International Variations in Approach to Risk and the Importance to Trade" at the October 13th ORACBA Risk Forum. Mr. Grueff was the lead negotiator in the Uruguay Round of the Gatt discussions concerning Sanitary and Phytosanitary (SPS) agreements. His seminar provided a thorough discussion of the current SPS agreement. He emphasized the importance of the Uruguay Round agreement by briefly describing the history of trade agreements preceding the Uruguay Round.

Mr. Grueff discussed the highlights of the Uruguay Round SPS agreement by explaining the key provisions. He pointed out areas within the agreement that were particularly contentious for the negotiators. His involvement with the negotiations not only allowed him to discuss the current meaning of various sections of the agreement, but also

enabled him to describe what the negotiators had in mind when they crafted the agreement.

The forum explained critical concepts in the SPS agreement, providing illustrations of equivalence, appropriate level of protection, and consistency. The SPS agreement required negotiators to acknowledge that some countries had different ways of approaching risk. The appropriate level of protection is a key standard. No one can dictate what the appropriate level of protection is for a particular country. However, there should be consistency in the appropriate level of protection used in the animal and plant health decisions made by each country. The role of economic information in the SPS agreement was discussed.

The seminar concluded with an example of the differing international interpretations of the precautionary approach paragraph in Section 5.7 of the SPS agreement. The European Union's application of the precautionary principle to the importation of beef treated with beef hormones was used as a case study. The evidence for risk to EU consumers from imported beef treated with beef hormones was discussed, as well as the status of the European Union case before the World Trade Organization.

November Risk Forum: Dr. Greg Johnson

Dr. Greg Johnson of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) presented a seminar on "Weather and Climate Tools for Risk Assessment" at the November 10th Risk Forum. Dr. Johnson is an Applied Climatologist at the NRCS National Water and Climate Center in Portland, Oregon. In an expanded Risk Forum format, Dr. Johnson led an afternoon discussion and demonstration of software, as well as the regular morning seminar. He emphasized that weather is a major source of

uncertainty in many agricultural issues. Both spatial and temporal variability have significant impacts on our ability to predict crop establishment and yields, pest activity, forest health, and other concerns. Different tools address variability categorized as "geographic," point vs. spatial data or "temporal," time series vs. summarized data. Point-summarized data are often easiest to obtain and can be adequate for many risk assessment applications, but their application to regions where data are lacking introduces uncertainties in temperature, precipitation, humidity, etc., that arise from complications arising from topography, seasonality, and averaging period. For risk assessments based on watersheds, long-term data summaries for large geographic areas may be required to get an acceptable depiction of climate; similarly, point-in-time averages of weather parameters are inadequate to estimate the probability of phenomena such as disease outbreak or crop development. Spatial maps produced by Parameter-elevation Regressions on Independent Slopes Model (PRISM) were shown. "Weather generators," or stochastic simulations for producing synthesized time series of weather conditions, also were discussed for their utility in hydrological models, climate change assessments, and possible applications for pest risk assessments. One such simulator, Generation of Weather Elements for Multiple Applications (GEM), developed by USDA, was demonstrated. GEM is being modified to allow researchers and risk assessors to investigate the impact of storm scenarios, to link GEM to large-scale forcings such as El Nino, and to link GEM to PRISM and allow generation of time series for large regions.

Risk Resources
Harvesting Agricultural /Research To Increase Yields

Kate Hayes, National Agricultural Library

All knowledge we've ever created in time will double in ten years. After that it will be every five years. After that it will be every 18 months.[1]

The free flow of information, advanced telecommunications systems, and high-speed travel have all helped fuel this creation of knowledge. Knowledge leads to change, and some suggest that the change society is undergoing during this Electronic Information Age is comparable to the Industrial Revolution.

Through the Internet, researchers exist as members of an extended research community, or a virtual community. So much so that in 1989, William Wulf, then employed by the National Science Foundation, coined the term "collaboratory" for the concept of conducting research and development on the Internet. Wulf describes a *collaboratory* as a "...center without walls, in which the nation's researchers can perform their research without regard to geographic location–interacting with colleagues, accessing instrumentation, sharing data and computational resources, and accessing information in digital libraries."

There is no doubt that global networks are producing global intelligence. In fact, some suggest that by 2020, available knowledge in certain technologies will double every 11 hours.

For those individuals and organizations in the business of managing information, the exponential increase presents both opportunities and challenges. The U.S. Department of Agriculture's National Agricultural Library (NAL) embraces these. The process of managing information means that NAL acquires information; organizes it by cataloging books and indexing journal articles; and provides access to the

information through the AGRICOLA database, document delivery services to users, and the World Wide Web. And lastly, NAL archives and preserves the information. The use of advanced technology to manage and distribute this information means that researchers can find it from their desks at their convenience–and can use it to build upon past discoveries.

To enhance customer access to research information, NAL produces the AGRICOLA database. AGRICOLA–AGRICultural ONLine Access–spans 1970 to present-day food and agricultural sciences literature and contains more than 3.5 million bibliographic records. The database is available through vendors such as DIALOG and SilverPlatter. The Web version of the database, at http://www.nal.usda.gov/ag98/ag98.html, went online in 1998.

In the Web version, customers can search the Books section which includes books, serials, audiovisuals,

and other resources held by NAL and its cooperators, or they can search the article citation index, including journal articles, book chapters, and short reports. As an example, in the Books section, an advanced keyword search on "risk assessment and food safety" revealed *Salmonella enteritidis risk assessment: shell eggs and egg products: final report* prepared for the Food Safety and Inspection Service (FSIS) by the Salmonella enteritidis Risk Assessment Team. This bibliographic citation is linked to the actual document on the FSIS home page so that users can gain immediate access to the full text–thus adding value to the database and for the customer.

In the articles section of www.AGRICOLA, an advanced search identified "Quantitative risk assessment for *Escherichia coli* 0157:H7 in ground beef hamburgers" from the *International Journal of Food Microbiology*, 1998. The NAL indexing of this article shows terms such as "Monte Carlo method," "probabilistic models," "mathematical models," "food microbiology," "foodborne diseases," "food hygiene," and "process risk model"–terms that are important when other researchers want to replicate a study or find out what methodology was used.

It is important to conduct a thorough literature review before starting a research program. AGRICOLA is a good place to start–it reveals the published literature. The Current Research Information System (CRIS), is another database to search. CRIS, on the World Wide Web at http://cristel.nal.usda.gov:8080, identifies USDA-sponsored research and articles stemming from the research. TEKTRAN is a third database to investigate. TEKTRAN, on the web at http://www.nal.usda.gov/ttic/tektran/tektran.html, contains pre-publication notices of articles stemming from research conducted by Agricultural Research Service scientists. Combined, these three databases document research in the food and agricultural sciences–the accomplishments as well as the ongoing research, and the researchers' names and their locations. Both CRIS and TEKTRAN contain current research–they indicate the knowledge base in the food and agricultural sciences and promote the concepts of scientific networks, technical assistance, and cooperative research.

The wealth of knowledge produced daily, and the amount of information available on databases and the Internet, can lead to confusion. Where to start, what to search, and how to search are just a few of the dilemmas! Fortunately, help is still available through NAL's Information Research Services staff in Beltsville at (301) 504-5479 or agref@nal.usda.gov or in Washington, DC, at

(202) 720-3434.

References

1. Deborah Trail. "Principle Centered Leadership for the 21st Century" (Presentation delivered at the Federal Laboratory Consortium, Salt Lake City, UT. 20 April 1999.)

Risk Calendar

January 2000

January 10-12 – Second International Conference on Geospatial Information in Agriculture and Forestry, Disney's Coronado Springs Resort, Lake Buena Vista, FL. For more information, contact ERIM International, Agriculture/Forestry Conference, P.O. Box 134008, Ann Arbor, MI 48813-4008, fax (734) 994-5123 or Internet: http://www.erim-int.com/CONF/ag.html.

January 12 – ORACBA Risk Forum, Ecological Risk Characterization of Low Dose, High Toxicity Herbicides, Dr. George E. Taylor, Jr., Professor of Biology, George Mason University. The Forum will be held from 10:00 a.m. to 11:30 a.m. in Room 107A, Whitten Building, 12th & Jefferson Drive, SW, Washington, DC. For more information, call (202) 720-8022.

January 12-13 – Environmental and Occupational Health Sciences Institute (EOHSI), Environmental Health in the 21st Century: Opportunities and Challenges. Risk Assessment, mechanisms of action, stakeholder involvement, children's risk. EOHSI, Piscataway, NJ. Contact Candice Botnick at:(732) 445-0206, e-mail botnick@eohsi.rutgers.edu, Internet: http://eohsi.rutgers.edu/conferences/millenium.html.

January 13-14 – Introduction to Probabilistic Risk Analysis, Washington, DC. For more information, contact The George Washington University Medical Center, Office of Continuing Education in the Health Professions, 2300 K Street, NW, Washington DC 20037 or call (202) 994-4285.

January 18 – Methods in Quantitative Risk Assessment, Johns Hopkins University, School of Hygiene and Public Health, East Baltimore Campus. Course meets Mondays and Wednesdays through March 15, 2000. For more information, call Johns Hopkins University, School of Hygiene and Public Health at (410) 614-6200.

February 2000

February 8-10 – International Conference on Risk Analysis in Aquatic Animal Health, Paris, France. For more information, contact Dr. K. Sugiura, Office International des Epizooties (OIE) Secretariat, 12 Rue de Prony, 75017, Paris, Francis, phone +33-1-44-151888, fax +33-1-42-670987, e-mail k.sugiura-40.int.

February 9 – ORACBA Risk Forum, "Theory of Inventive Problem Solving *(TRIZ),*" Dr. Stan Kaplan, Bayesian Systems, Inc. The Forum will be held from 10:00 a.m. to 11:30 a.m. in Room 107A, Whitten Building, 12th & Jefferson Drive, SW, Washington, DC, followed by a workshop from 1:00 p.m. - 4:00 p.m. in Room 0768, South Building, 1400 Independence Avenue, SW, Washington, DC. For more information, please call (202) 720-8022.

February 14-15 – 2000 FDA Science Forum, FDA and the Science of Safety: New Perspectives, Washington Convention Center, Washington, DC. For more information, call (703) 548-3000 or Internet: http://www.aaps.org/edumeet/fdasf.

February 22-25 – USDA and FDA are sponsoring *Introduction to Risk Analysis* through the Graduate School, USDA. For more information or to register, contact Ann-Lloyd Hufstader at (202) 314-3411.

March 2000

March TBA – 10th Annual West Coast Conference on Contaminated Soils and Water, Southern California. Contact Heather McCreary, AEHS, 150 Fearing Street, Suite 20, Amherst, MA 01002-1944, phone (413) 549-5561, fax (413) 549-0579, e-mail heather@aehs.com. See also http://www.aehs.com.

March 8 – ORACBA Risk Forum, "Assessing the Plant Disease Outcome of an Introduced Plant Pathogen: Disease Invasion and Persistence," Dr. Lawrence Madden, Department of Plant Pathology, The Ohio State University. The Forum will be held

from 10:00 a.m. to 11:30 a.m. in Room 107A, Whitten Building, 12th & Jefferson Drive, SW, Washington, DC, followed by a workshop from 1:00 p.m. to 4:00 p.m. in Room 0768, South Building, 1400 Independence Avenue, SW, Washington, DC. For more information, call (202) 720-8022.

March 13-14 – National Research Council, Committee on Data for Science and Technology, Data for Science and Society: The Second National Conference on Scientific and Technical Data. Managing and using scientific and technical data, data access and policy issues, database management, National Academy of Sciences, Washington, DC. For information, call (202) 334-2688, e-mail CODATACO@NAS.

March 19-23 – Society of Toxicology, 39th Annual Meeting, Biomarkers: Harmonization of cancer and non-cancer risk assessment, particulate matter, arsenic, immunotoxicity. Pennsylvania Convention Center, Philadelphia, PA. For more information, call (703) 438-3115, fax (703) 438-3113, e-mail sothq@toxicology.org, Internet: www.toxicology.org.

March 27 – Topics in Risk Assessment Course, Johns Hopkins University, School of Hygiene and Public Health, East Baltimore Campus. Course meets Wednesdays through May 19, 2000. For more information, call Johns Hopkins University, School of Hygiene and Public Health at (410) 614-6200.

March 27 – Introduction to Risk Sciences and Public Policy, Johns Hopkins University, School of Hygiene and Public Health, Greater Washington Campus (DuPont Circle). Course meets Thursdays through May 19, 2000. For more information, call Johns Hopkins University, School of Hygiene and Public Health at (410) 614-6200.

April 2000

April 10-12, ASTM 10th Symposium on Environmental Toxicology and Risk Assessment, Science, Policy and Standardization — Implications for Environmental Decisions. For more information, contact Bruce Geenberg at (519) 888-4567 x3209, fax (519) 746-0614, e-mail greenber@sciborg.uwaterloo.ca.

April 12 – ORACBA Risk Forum, "Risk Assessment Center of Excellence at Cleveland State University," Dr. Mark Tumeo, Center for Environmental Science, Technology and Policy, Cleveland State University. The Forum will be held from 10:00 a.m. to 11:30 a.m. in Room 107A, Whitten Building, 12th & Jefferson Drive, SW, Washington, DC, followed by a workshop from 1:00 p.m. - 4:00 p.m. in Room 0769, South Building, 1400 Independence Avenue, SW, Washington, DC. For more information, call (202) 720-8022.

April 18-19 – Waste Management Conference: Management of Swine and Poultry Waste, Jackson, MS. For more information, see http://www.msstate.ars.usda.gov/1stcall.htm.

May 2000

May 10 – ORACBA Risk Forum, "Evaluation of Riparian Buffers in the USDA - Conservation Buffer Initiative," Dr. Richard Lowrance, Ecologist, Agricultural Research Service, Southeast Watershed Research Lab, U.S. Department of Agriculture. The Forum will be held from 10:00 a.m. to 11:30 a.m. in Room 107A, Whitten Building, 12th & Jefferson Drive, SW, Washington, DC, followed by a workshop from 1:00 p.m. - 4:00 p.m. in Room 0768, South Building, 1400 Independence Avenue, SW, Washington, DC. For more information, call (202) 720-8022.

May 21-25 – SETAC Third World Congress and SETAC Europe 10th Annual Meeting, Global Environmental Issues in the 21st Century: Problems, Causes and Solutions, Brighton, United Kingdom. Topics will include Science and Policies Needed To Achieve Sustainable Ecosystems Regionally and Globally, Extrapolation of Environmental Processes Across Temporal, Spatial and Biological Scales, and Linkages Between Ecosystem Condition and Human Health. For a copy of the First Announcement and First Call for Papers, contact SETAC Europe, Av. E. Mounier 83, Box 3, 1200 Brussels, Belgium, phone +32-2-772-72-81, fax +32-2-770-53-86, or e-mail setac@ping.be.

May 22-25 — Second International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterey Conference Center, Monterey, CA. For more information, contact The Conference Group at (800) 783-6338 or (614) 424-5461, fax (614) 488-5747, e-mail conferencegroup@compuserve.com.

June 2000

June 14 – ORACBA Risk Forum, "Modeling and Risk Assessment," Dr. Tsegaye Habtemariam, Biological Information Management Service, School of Veterinary Medicine, Tuskegee University. The Forum will be held from 10:00 a.m. to 11:30 a.m. in Room 107A, Whitten Building, 12th & Jefferson Drive, SW, Washington, DC, followed by a workshop from 1:00 p.m. - 4:00 p.m. in Room 0768, South Building, 1400 Independence Avenue, SW, Washington, DC. For more information, call (202) 720-8022.

June 26 - 30 – Introduction to Risk Sciences and Public Policy, Johns Hopkins University, School of Hygiene and Public Health, East Baltimore Campus. Summer intensive course. For more information, call Johns Hopkins University, School of Hygiene and Public Health at (410) 614-6200.

July 2000

July 11 – ORACBA Risk Forum, "Quantitative Analysis of Variability and Uncertainty," Dr. Christopher Frey, Department of Engineering, North Carolina State University. The Forum will be held from 10:00 a.m. to 11:30 a.m. in Room 107A, Whitten Building, 12th & Jefferson Drive, SW, Washington, DC, followed by a workshop from 1:00 p.m. - 4:00 p.m. in Room 0768, South Building, 1400 Independence Avenue, SW, Washington, DC. For more information, call (202) 720-8022.

The ***ORACBA*** *Newsletter* reports risk analysis activities in the U.S. Department of Agriculture, upcoming meetings and events, and other activities supporting the development and use of risk assessment in USDA. This quarterly newsletter is available at no charge to risk assessment professionals in USDA. Send comments or address changes to: USDA, **ORACBA**, Room 5248-S, Mail Stop 3811, 1400 Independence Avenue, SW, Washington, D.C. 20250-3811. Call (202) 720-8022, or fax (202) 720-1815.