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A Healthy Ecosystem

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Understanding Pesticide Risk

In 1993 enrollment began for the largest health study of the US farming community, the Agricultural Health Study (AHS). Twelve years later, data from the 89,658 enrollees in Iowa and North Carolina are beginning to generate the most comprehensive assessments of the link between individual pesticides and cancer risk ever published. The risk of various cancers is just one set of health endpoints monitored in this ground-breaking study; other health problems addressed include diseases of the nervous system, as well as respiratory and reproductive health.

There have been various epidemiological attempts to better understand the relationship between pesticide exposure and cancer risk. These, together with laboratory work, have presented a patchwork of data linking some pesticides with increased risk of some cancers. The large scale and comprehensive design of the AHS are meant to specifically address the weaknesses and gaps in prior research.

Enlisting the long-term support of a large portion of the farming communities of two states, Iowa and North Carolina—both with strong agricultural sectors with diverse agricultural methods and products—enables researchers to employ the strengths of prospective cohort studies. The chemical exposure and lifestyle information that is collected from these participants is the most detailed ever: participants responded to about 250 questions in the initial survey.

Fifty pesticides were selected based on their widespread use or if previous studies indicated their potential association with health risks, and 30 more were added based on participant "write-ins." Follow-up surveys every five years provide scientists with updated information. Including spouses in the research is an important aspect that is providing data on women and pesticide use and exposure never before collected. There is also a small percentage of female certified (North Carolina) and licensed (Iowa) pesticide applicators included in the study. Overall, two-thirds of participants are applicators and one-third are spouses. With children also registered, the understanding of the health of farm families is being greatly enhanced by the AHS.

Cancer Findings

Previous research indicates that farmers experience some cancers to a lesser extent than the general population and some cancers to a greater extent. Fewer farmers die from lung, esophagus, bladder, and colon cancers, possibly the result of smoking less, eating a healthier diet and getting more physical exercise than the average American. But studies also suggest that farmers as a group experience higher rates of Hodgkin's disease, leukemia, multiple myeloma, non-Hodgkin's lymphoma, and cancers of the lip, stomach, prostate, skin, brain, and connective tissue.

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The AHS is now at the stage at which disease rates can be assessed, and the study is producing some important cancer findings. These findings reflect about five years of follow-up, following several years of enrollment and data collection. The two ways in which cancer rates are analyzed in the AHS are: 1) the comparison of cancer rates amongst enrollees with those of the general population, and 2) the comparison of cancer rates of those using specific pesticides with those who do not.

A major finding—one that correlates with previously existing data—is that this population of farmers experiences lower overall cancer rates than the general population. The rates found thus far of all cancers except prostate cancer were lower. However, early findings do suggest an association between the use of specific pesticides and an increased risk of specific cancers. It is important to note that discovering these associations does not mean a causal relationship has been found. The AHS employs a rigorous strategy of criteria for causal inference.

Chlorpyrifos and Lung Cancer

In an AHS analysis of exposure to chlorpyrifos, one of the most widely used insecticides in the US, researchers found an association between the use of this pesticide and the incidence of lung cancer, but not with any other cancer. In the highest exposure group, there was a 2.18 relative risk of lung cancer. This finding is of particular interest because farmers in general, and also those within the AHS cohort, have lower rates of lung cancer than the general population, probably because of lower smoking rates. (The chlorpyrifos-lung cancer association in this analysis was determined controlling for all other known cancer risk factors, including smoking.) In addition to its agricultural uses, chlorpyrifos was widely used in US households until 2000, and exposure to chlorpyrifos is the focus of an intensive exposure study within the AHS.

New Insights Regarding Pesticide Exposure

One of the major challenges in studying the effects of pesticide exposure on human health is the difficulty in precisely assessing real-life

exposures. Pesticides are widely used without a detailed understanding of all the various ways they might enter the body and in what quantities they do so. As part of its study of the Iowa and North Carolina farming populations, the AHS has prioritized the improvement of scientific methods to better understand pesticide exposure. This work has revealed much information that enables scientists to more accurately determine potential health effects of pesticide exposure, and also assists in the development of better controls and practices to decrease exposure.

For example, early on in the study members of the research team looked closely at the characteristics of people who self-reported a “high pesticide exposure event.” Closely examining this 14% of the study population enabled the epidemiologists to determine what home and farm features or practices are associated with incidents or experiences leading to unusually high personal exposures. These characteristics ranged from how, where and when work clothing was laundered and the types of pesticides being used, to whether the family was experiencing financial stress. After taking into account education and the total number of lifetime applications made, researchers saw that women had significantly fewer events than men who applied pesticides.

Job characteristics more common among those who reported a high pesticide exposure event included repairing pesticide application equipment oneself and having first used pesticides more than 10 years ago. While the demographic, work practice and job characteristics identified in this investigation were not necessarily the cause of the high pesticide exposure, identifying these factors is a first step in the eventual prevention of these potentially hazardous events. Computer modeling—used as a tool in the AHS for exposure estimates and analyses, in addition to biological measurements—showed that following all pesticide label requirements could prevent many of these high exposure events.

Other analyses looked at exposure hazards of families of pesticide applicators. The design of the AHS takes into account that farmers “living where they work” presents potential exposures for spouses and children. Researchers found that 21% of homes are within 50 yards of the pesticide mixing area, that 27% of appli-

cators store pesticides in their homes (including attached garage or basements), and that most pesticide-contaminated clothing is washed in the same machine as other laundry. At least half of the wives reported working the fields, 40% reported mixing or applying pesticides, and more than half of the children over age 11 did farm chores, some of which may have put them into contact with pesticides.

Researchers are taking this farm, home and work practice information and developing ways to determine the health implications of the resulting exposures. For example, scientists at the EPA conducted a five-day continuous sampling of a group of volunteers in the AHS population in order to gain a detailed understanding of exposure to two pesticides, 2,4-D and chlorpyrifos. Biological samples from volunteering spouses and children were also collected. Exposure to these two pesticides is also being analyzed in a project that compares average exposures between different subpopulations in the AHS, for example between the two states, between male and female, and between farmers and commercial applicators. All of these data will enable a more complete analysis of exposures to these two widely used pesticides and any subsequent health outcomes.

Studies like these both refine exposure information for the AHS specifically, and develop methodologies for future pesticide exposure research. AHS computer models predicting pesticide exposure have already been found to be an effective predictor of exposure in a non-AHS population. AHS efforts also include comparisons between African-American farmers' and white farmers' pesticide use practices in North



Carolina, and analyses of the use of protective equipment and application method. Comparisons of work practices and attitudes toward risk between the two states are proving to be instructive. All of this research also clearly contributes to improved health and safety educa-

tion and communication tailored to the farming community.

Information on the Web

The AHS Web site, www.aghealth.org, contains information for enrollees and others in the format of frequently asked questions as well as agricultural health resources for both states and national links. Much of the web site, while geared toward a scientific readership, is accessible to lay persons wanting to read AHS related journal articles, which are all available in abstract or full text format. Watch the web site for the wealth of information expected to be published in the coming years, during AHS's intensive five-year period (2004-2008) of assessing disease rates and risk factors.

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