Agricultural Health and Safety: A Research Agenda for Agricultural Economists

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Abstract: Agriculture is a hazardous profession with large rates of work related injury and illness. Although economists have addressed these issues in general, there is need for additional economic analysis. Using prostate cancer as an example, this paper discusses economic research needed to analyze and understand agricultural health and safety issues.

Keyword and JEL Codes: agricultural health and safety, economic research agenda, A11, I10.

Agricultural Health and Safety: A Research Agenda for Agricultural Economists.

Agriculture is one of the most hazardous industries with high rates of accidental death, injury, and occurrences of work related illnesses. For instance, "The fatality rate for agricultural workers is estimated to be six times higher than the average rate for all industries" (NSC). Additionally, there is evidence that farmers experience a higher risk of certain types of cancer (Frey 1991 and 1995). Illness among farmers and their families has been associated with agricultural environmental conditions. "Causative agricultural exposures have not been conclusively identified, but agents of concern include nitrates, pesticides, viruses, antigenic stimulants, and various fuels, oils, and solvents" (NCASH). These types of hazards affect the economic well-being of farm operators, farm workers, farm families, farm operations, farm communities, and agricultural industries.

Although agricultural injuries and safety issues have been addressed by several Extension programs at land-grant universities, medical or public health research has largely ignored agricultural health and safety (Donham and Storm). While mining and agriculture are two of the most deadly industries, in 1985 the amount spent by the federal government on occupational safety for mining was $181.68/worker while the amount spent for agriculture was $0.30/worker (NCASH).

In 2000, the North Central Region Administrators of Agricultural Experiment Stations established the Committee on Agricultural Safety and Health Research and Extension (NCR-197). The purpose was to better use the land grant system to help "reduce work

related injuries, illnesses, death, and property loss." In their 2003 report, NCR-197 listed twelve research and extension priorities for health and safety. Area of expertise suggests that none of the NCR-197 members were economists and economic costs and benefits were not included in the list of criteria used to prioritize the twelve topics. The purpose of this paper is to identify potential economic contributions in understanding, analyzing, and addressing agricultural health and safety issues.

Prostate Cancer

Proportional Mortality Ratio (PMR) is the standardization rate most often used by epidemiologists when studying cancer. PMR is the proportion of deaths in a study group due to a specific cause divided by the proportion of deaths in a reference population due to the same specific cause. Alavanja, et al. (2003) found that for prostate cancer the PMR of Iowa and North Carolina pesticide applicators was 1.14. A mortality study of Kansas farmers showed a PMR of 1.17 for prostate cancer (Frey 1991). A similar, more recent, study focusing on morbidity showed a 1.38 standardization rate among Kansas farmers (Frey 1995). Blair notes that, "The excess among farmers is of special concern because prostate cancer is the most common tumor among men." The evidence provided in these studies make prostate cancer a high priority illness for economic analysis.

Prostate cancer illustrates why the connection between cancer and agriculture is difficult to measure. Of the cases of prostate cancer reported in Alavanja, et al. 2003, 88% occurred in men over the age of 55. In 2002, the average age of farmers (Total farming and other occupations) in the U.S. was 55.3 (NASS). The age at which this disease occurs may suggest that the environmental or chemical factors that cause prostrate cancer

may not have an immediate impact. This delay between cause and effect is characteristic of many illnesses that show an elevated risk among farmers making it very hard to pinpoint what is causing the illness.

In addition to Frey's research, Blair compiled the work of several epidemiologists showing an association between farming and an increase in prostate cancer. A shortcoming of the majority of these studies is that the excess in cancer has not been directly related to a specific cause associated with agriculture production. However, "The occurrence of these excesses in many investigations of different epidemiologic designs from a number of countries indicates that they are unlikely to be spurious findings" (Blair).

The ongoing cohort study by the National Cancer Institute is addressing the links between types of cancer and causes such as use of specific pesticides. The first publication from this study (Alavanja, et al. 2003) concludes that, "Farming has been the most consistent occupational risk factor for prostate cancer." *The Agricultural Health Study*, started in 1994, may make more meaningful economic analysis possible as researchers seek to identify a specific chemical as the cause of the excess of prostate cancer (Alavanja, et al. 1996).

Statement of the Economic Problem

The economic problem with the higher incidence of prostate cancer in agriculture is that having prostate cancer or seeking to avoid it involves costs.

For purposes of addressing the economic problem that having prostate cancer or seeking to avoid it involves costs, the problem can be disaggregated into the following four major sub-problems:

1. Costs of prostate cancer to individual farmers,
2. Economic impacts of prostate cancer on farm operations,
3. Farm level costs and benefits of avoiding prostate cancer, and
4. Industry level economic impacts of avoiding prostate cancer.

The discussion of each sub-problem will include:

1. Statement of the economic problem
2. Existing research
3. Applicable economic theory
4. Appropriate analytical techniques
5. Data to address the problem
6. Potential impact of the economic analysis of the problem

SUBPROBLEM 1. COSTS OF PROSTATE CANCER TO INDIVIDUAL FARMERS

1.1. Costs of prostate cancer to individual farmers: Economic Problem. Issues that affect the costs of prostate cancer to individual farmers include treatments, family history and probability of having prostate cancer, insurance and loss of income.

Treatment. The cost associated with the treatment of prostate cancer will depend on the stage in which the cancer is detected. These costs may include surgery or other medical procedures, radiation and chemotherapy treatments, and rehabilitation. Treatment costs to farmers may be larger than costs of similar services in metropolitan areas because the quality and availability of health care in rural communities may be limited and travel costs for treatment may be large.

Family history and probability. There is evidence that farmers with a family history of prostate cancer are more likely to develop prostate cancer than the rest of the population (Alavanja, et al. 2003). Therefore, in families with a history of prostate cancer, the higher probability of prostate cancer brings a higher cost of unsafe practices.

Insurance. The cost of health, life, disability and long-term care insurance can be a major annual cash outlay that, especially in stressful economic times, may seem excessive for protection from the economic consequences of injuries and illnesses that may not occur. Farmers may choose high deductibles over quality of coverage to minimize premium levels. The high deductible can become a large expenditure when facing a serious injury or prolonged illness. Insurance may be especially costly for older farmers. Moreover, coverage may be limited or put at a higher risk level when applicants are involved in production agriculture. If owner/operators are unable to continue working, they are not eligible for unemployment insurance because they are self-employed. No coverage is a very risky option in an industry as hazardous as agriculture.

All of these insurance coverage problems can bring financial stress to an individual producer and his or her family whether it comes in the form of expensive premiums or high medical costs that their policy did not cover.

Loss of Income. Illness severity will impact the amount of lost income an individual incurs. If a case of prostate cancer affects labor efficiency over a long period of time, then there may be a large amount lost. With early detection and only minor medical procedures, there may be no income lost.

1.2. Costs of prostate cancer to individual farmers: Existing Research. Existing research dealing with prostate cancer is epidemiological (e.g., Frey 1991 and 1995, Blair). The direct links to specific causes are being researched (Alavanja, et al. 2003). Forensic economists routinely measure injuries or illnesses in legal cases involving plaintiffs who have sued defendants for damages. A lot of information about insurance exists (e.g., Walden). Examples of studies focused on agriculture include Schneiders, et al., Von Essen, et al., and Whitaker and Slesinger.

1.3. Costs of prostate cancer to individual farmers: Economic Theory. Costs theory may be applied to the costs mentioned above such as treatment, insurance and loss of income. These costs may be adjusted for probability of getting prostate cancer, which may be affected by family history. Costs will need to be adjusted for the time value of money when costs are incurred over time.

1.4. Costs of prostate cancer to individual farmers: Analytical Techniques. Various methods have been used to measure the value of life (e.g., Kuchler and Golan). Of the methods discussed in Kuchler and Golan we prefer the cost-of-illness (COI) method because "COI approach provides an accounting of the dollars spent on medical expenses and the wage dollars that are forgone as a result of illness, accident, or premature death" (Kuchler and Golan, p. 16).

1.5. Costs of prostate cancer to individual farmers: Data. Epidemiological data show the excess cases of prostate cancer in agriculture. Costs associated with treatment are needed. Lost life and lost work (and less efficiency in work) data are needed to show the effect a battle with or death from this illness has on an individual and his or her family. Direct cost of medicine, hospital stays, doctor visits, operations, and rehabilitation expenses will need to be considered.

1.6. Costs of prostate cancer to individual farmers: Potential Impact. Lack of information about the costs of illnesses such as prostate cancer causes these costs to be ignored. When costs of illnesses (including health insurance) are omitted from farm budgets, or analyses based on those budgets, costs of production are understated and profit is overstated. This lack of information affects decisions of both crop producers and agricultural policy makers. More accurate measurement of the economic costs associated with health and safety is needed so that producers may consider those costs and the impact they will have on profit when they make production decisions. An important outcome is increased awareness of the costs of having prostate cancer.

SUBPROBLEM 2: ECONOMIC IMPACTS OF PROSTATE CANCER ON FARM OPERATIONS

2.1. Economic impacts of prostate cancer on farm operations: Economic Problem.

If a farmer experiences prostate cancer, he or she may need to be replaced by substitute labor which may increase costs and reduce farm profit. These impacts along with the costs of treating the disease may result in loss of assets.

Substitute Labor. Hired labor may be required to replace the lost labor of the affected farmer. Hired labor has cash costs of wages and benefits and may be less productive than owner/operator labor. Consultants by be required to replace the knowledge and expertise of the affected farmer.

Loss of assets. Lost opportunities and effectiveness of the farmer affected by prostrate cancer may cause the operation to become less competitive, resulting in loss of productive resources. Liquidation of farm resources may be required to pay medical bills. The death or disability of an owner/operator and/or large medical costs may lead to the demise of the operation associated with that individual. The demise of an operation may involve displacement of the farm family and hired labor.

2.2. Economic impacts of prostate cancer on farm operations: Existing Research.

Negative impacts of farmer health problems or death are well documented. For example, Kelsey found expected income lost because of people killed in farm accidents is large and

that less than five years after fatal accidents, 67% of the families no longer operate the farms.

2.3. Economic impacts of prostate cancer on farm operations: Economic Theory. There will be a need for an analysis of the probability of a producer being affected by the elevated chance of developing prostate cancer because of the added environmental hazards associated with agricultural practices and how costs to the individual affect the operation. Present value of the indirect cost of lost income will be needed to help evaluate this loss.

2.4. Economic impacts of prostate cancer on farm operations: Analytical Techniques. Budgeting may be used to compare costs and returns associated with alternative production practices. Mathematical programming may be used to evaluate alternatives in the context of whole farm situations.

2.5. Economic impacts of prostate cancer on farm operations: Data. Data will be needed on the costs of having prostate cancer and the costs and efficiency of substitute labor and management compared to the costs and efficiency of the person affected with prostate cancer. These data will need to be considered in the context of the whole-farm and whole-family cash flow and wealth.

2.6. Economic impacts of prostate cancer on farm operations: Potential Impact.

More accurate measurement of the economic costs and benefits associated with health and safety is needed so that producers may consider those costs and the impact they will have on profit when they make production decisions. Changes in the allocation of resources on farms could occur if monetary costs and benefits of health and safety issues were better understood. Such changes could alter how managers evaluate and organize production and, therefore, contribute to safer and healthier production agriculture. A shift in production practices away from biological hazards associated with higher incidence of illness for farmers could perhaps contribute to safer food and a cleaner environment; therefore, benefiting both producers and consumers.

SUBPROBLEM 3: FARM LEVEL COSTS AND BENEFITS OF AVOIDING PROSTATE CANCER.

3.1. Farm level costs and benefits of avoiding prostate cancer: Economic Problem.

Economic impacts on farm operations may involve higher input costs, lower production levels, and changes in crops produced.

Higher input cost. Avoidance of inputs that may be associated with prostate cancer may involve substitution of more expensive inputs. Substitution of more expensive inputs will increase production cost.

Lower production levels. If the efficiency of inputs substituted is lower than efficiency of inputs associated with prostate cancer, then the substitutions will reduce yields. If the reduction in yields is too small to shift the market supply curve (so that output price does not change) then revenue to the individual producer will be reduced.

Change in crops produced. Another possible strategy for avoiding inputs that may be associated with prostate cancer is to shift to production of crops that do not require the use of those inputs. The impact on net income will be determined by the relative profitability of alternative crops. If crop substitutions involve production of crops that are new to the producer, then the producer may face a learning curve and lower income during early years of the new crops.

3.2. Farm level costs and benefits of avoiding prostate cancer: Existing Research.

Economic analysis of alternative production practices and technologies has been (e.g., Casey, et al.) and continues to be (e.g., Carey and Zilberman) a significant area of research for agricultural economists.

3.3. Farm level costs and benefits of avoiding prostate cancer: Economic Theory.

Economic theory used on the problem of prostate cancer will focus on the relationship between risk aversion and growth/profit. Production economics may be used to analyze possible changes in production practices in an effort to reduce or eliminate the increased likelihood of prostate cancer. There will be need to evaluate the effect changes in production practices could have on individual operations.

Opportunity cost of adopting safer production activities is an important issue. Will money be allocated to develop a safer working environment or will the money be put towards capital investments and growth? If a farmer invests in a safer work environment instead of investing in growing his or her operation, how will output and revenue be affected? Risk will need to be measured by recognizing that wealth likely has diminishing marginal utility. This suggests that wealthier farmers are more likely to spend money to avoid health and safety risk. Which has more utility, less profit but safer or more profit and less safe? Multi-attribute utility may need to be considered. The degree to which greater potential profit or safer production practices are chosen will affect the marginal revenue and the marginal cost. The added cost associated with adopting safer production practices may increase the marginal cost of production and reduce profit. The added cost associated with a capital expenditure may also increase the marginal revenue therefore reducing profit levels less than spending money on a risk mitigation technique that has no increased income associated with it. Long-term analyses may show that the possible cost associated with an illness is more than the increase in revenue resulting from an output enhancing capital expenditure. Individual producers may see the reduction of risk of illness by changing production practices as a favorable compensation for the reduction in production and profit levels.

3.4. Farm level costs and benefits of avoiding prostate cancer: Analytical Techniques. Budgeting may be used to compare safer alternative production practices with those practices currently in use. Mathematical programming could be used to explore possibilities and to analyze impacts in the context of whole-farm situations.

3.5. Farm level costs and benefits of avoiding prostate cancer: Data. Current inputs, costs, and output levels will need to be specified and compared to those of safer production practices. Average resources available on representative farms or resources available on actual farms used as case studies will be needed to construct farm models for measuring whole-farm impacts.

3.6. Farm level costs and benefits of avoiding prostate cancer: Potential impact. The reduction or elimination of the additional health risk associated with the excess occurrence of prostate cancer is the desired benefit. The value of this benefit is the costs of adverse economic consequences that are avoided. The costs are the economic costs associated with a risk reduction strategy. If the excess occurrence of prostate cancer is reduced, producers may have a longer and healthier life.

The observance of the costs associated with prostate cancer may lead to a change in production practices. If the ultimate decision means the elimination of certain production tools, the industry could anticipate the impact and prepare accordingly. Economist could analyze costs of effective new tools to replace old production tools without an interruption in production. Economic incentives for farmers to develop safer production practices may be developed. Von Essen, Thu, and Donham provide an example of this.

SUBPROBLEM 4: INDUSTRY LEVEL ECONOMIC IMPACTS OF AVOIDING PROSTATE CANCER.

4.1. Industry level economic impacts of avoiding prostate cancer: Economic Problem. If a large number of producers change their production practices or if government policy restricts the use of inputs that may be associated with prostate cancer, there may be shifts in supply and price levels. An upward and to the left shift in supply could occur if marginal costs of production increase, because of a government or industry decision to eliminate a productive input. Supply of a crop will also shift if a significant number of producers switch to production of alternative crops. A shift of the supply curve upward and to the left would result in a higher price for those still producing the crop and smaller aggregate production. If demand is inelastic, a price increase will increase total revenue for the industry.

4.2. Industry level economic impacts of avoiding prostate cancer: Existing Research. Industry level economic analyses of restrictions on the use of inputs have been (e.g., Burton and Martin) and continue to be a significant area of research for agricultural economists. Such analyses provide guidelines for evaluating restrictions of the use of inputs that may contribute to farmers' above average incidence of prostate cancer.

4.3. Industry level economic impacts of avoiding prostate cancer: Economic Theory. Supply and demand models provide a framework for analyzing industry level

impacts of restrictions on the use of inputs that may contribute to farmers' above average incidence of prostate cancer. Changes in marginal costs of production will shift supply curves when use of an input is restricted. Interaction between supply and demand will determine a new equilibrium price and quantity. Elasticity of demand will determine the impact of these restrictions on industry revenue.

4.4. Industry level economic impacts of avoiding prostate cancer: Analytical Techniques. Average impacts on individual farm operations will help in the cost calculation of a general agriculture population. The value placed on the work an individual would have done had he or she been there along with any extra expense that was incurred because of this loss needs to be estimated. Present value of the indirect cost of lost income will be needed to help evaluate this loss over time. The figures established by these calculations will help in showing the cost the industry can observe as a cost for not adopting healthier production practices.

The amount of lost production associated with a shift in production practices will need to be estimated. It will show how much the supply curve will shift and the price that would be established if a shift occurs. The difference in the cost of possible substitutes and the cost of the production practice that is eliminated will provide information about the amount that marginal cost will change. It will also aid in estimating the total cost the industry could incur if there is a government intervention to change production practices. These analyses will illustrate the total effect on the industry if there is a change from or

elimination of a typically used production practice because of its connection to farmers' higher than average incidence of prostate cancer.

4.5 Industry level economic impacts of avoiding prostate cancer: Data. Industry level mathematical modeling requires agricultural production for regions that have similar production activities. If equilibrium price and quantity will be determined in these models the demand will need to be specified and if a model for the U. S. (not the world) is used the model will need trade activities that represent a reasonable trade environment.

4.6. Industry level economic impacts of avoiding prostate cancer: Potential Impact. Industry level impacts of alternative policies designed to reduce the incidence of prostate cancer in U.S. agriculture would guide policy makers by measuring the economic impacts of alternative policies. They would also provide input into agricultural producer decisions as decision makers explore possible responses to policies.

Other economic issues

Costs to the community could come in the form of lost sales because an individual is under economic stress or possibly the loss of a community leader. Services in the community will not be affected by only a few losses, however the long-term affect brought about by prostate cancer could contribute to reduction in population in small communities which might cause these communities to loose some of their services

because the population is too small to support them. Quality and availability of rural health care is an important issue that may be affected if rural populations decline.

Summary and Conclusion

This paper discussed literature and economic research needed to address agricultural health and safety. Prostate cancer was used as an example health issue because there is evidence that farmers experience higher incidence of prostate cancer than the general population. Much of the agricultural economics research needed to address prostate cancer requires more conclusive information about the agricultural practice that contribute to prostate cancer.

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