Environmental Risks Facing Farmers

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Farming is a risky business. Farmers always have had to cope with a wide variety of risks. But, environmental risk – at least the awareness of environmental risk -- is relatively new to most farmers. In fact, few people had even heard the word "environment" before Rachel Carson's book, "Silent Spring," hit the best seller lists in the early 1960s. Farming -- specifically, use of agricultural pesticides -- was the primary focus of Carson's warning of a coming spring when no birds would sing.

The first national Earth Day was celebrated in 1970, marking the formal beginning of the environmental movement in the United States. The Environmental Protection Agency (EPA) was formed in the early 1970s, at the insistence of a growing coalition of environmental activist organizations. National environmental policy was sidetracked in the 1980s, during the Reagan era, when almost anything that interfered with industry profits and growth was deemed unnecessary and inappropriate. However, the environment was not something newly created by activists. The environment has always been there, and it will never go away. The environment returned to the political agenda during the 1990s. Environmental issues – soil conservation and water quality – became important dimensions of agricultural policy beginning with the 1990 farm bill. The environmental impacts of confinement animal feeding operations remain a volatile political issue in many parts of the country. The tide of environmental concerns may continue to ebb and flow, but environmentalism is here to stay.

Prior to the mid-20^{th} century, we weren't concerned about the environment because we were incapable of doing it any real harm. We were sufficiently few in numbers and our technologies were sufficiently benign that the environment could withstand or absorb just about anything we could do to it. We could destroy the productivity of natural resources, such as farmland and forests, and we could pollute the streams with minerals and chemicals, but then, we could always move on to some new environment and start over again. We didn't have to stay and live in our "fouled nests". Left alone, the environment eventually would heal and restore itself.

But our numbers have grown and so have our appetites for things that are either pulled from or are dumped into the natural environment. Our extractive technologies have become more effective, and thus more destructive, and we have seemingly lost any will to refrain from doing whatever we are capable of doing to satisfy our greed. Yet, common sense tells us that we are degrading and destroying our natural environment – the ecosystem of which we ourselves are a part. Environmental risks are real – both to individuals, farmers and others, and to the whole of human society. Our collective awareness of environmental risks, like the environment itself, is not going to go away.

Farmers interact more closely with their natural environment than almost any occupational group. They are among the primary reapers of the ecological bounty of the land – of nature's yielding human needs and wants. But, they are also among the first to feel the impacts of their environmental mistakes – of nature's fighting back to protect itself from harm. With every attempt to coax more from nature, there is an environmental risk to the one doing the coaxing – to the farmer.

Today, health risks -- from applying pesticides to crops or livestock, from drinking contaminated water, from breathing polluted air, and from association with animal hormones and genetically manipulated organisms – are ever-present factors in the day-to-day life of farm families and farm workers. Risks resulting from damage done first to the ecosystem – such as pollution of water and air with chemicals, sediment, and noxious odors – also affect farmers, but mostly affect those living downstream or downwind from the farm. They represent risks, none-the-less, to the farmer's ability to farm – at least to farm using methods of their choosing. Environmental risks affecting the productivity of the land are more long-term and less direct – but are none the less real risks to the survival of farms and of farming.

Risk versus Uncertainty

Most environmental "risks" actually should be called "uncertainties" rather than risks. The word "risk" generally is reserved – at least in professional circles – for those things that have a quantifiable chance or probability of happening. The term risk also refers to something bad or unfavorable. For example, there is a definite risk of losing at the game of poker while holding a specific "hand" of cards -- losing is a bad outcome that has a specific probability or chance of happening. First, we know how many cards of what kind are in a deck, so we can determine the numbers of different "poker hands" – straits, flushes, full-houses, pairs, etc. – possible when a deck is dealt. With that information, we can determine the probability or odds of us getting the particular hand of cards we are now holding. And if we were smart enough, we could calculate the chance that anyone else at the table had been dealt a hand that would beat ours. The risk of our losing with a particular poker hand may not be easy to calculate but it has a definite probability of happening.

We often estimate risks for situations where the range of possibilities is not actually known, but where we believe we have reasonable estimates of what the probabilities may be. The risk of rain is one such estimate. The weatherman doesn't actually know the probability of rain for any given day in the future, because a day in the future is not dealt from some known deck of all possible days. Each day is brand new. But, forecasters may have observed a sufficient number of similar patterns in the past, and be sufficiently confident in the repeatability of those patterns, that they feel they can make quantitative predictions about weather in the future. The forecast of a sixty-percent chance of rain is such a prediction. Under similar conditions in the past, they estimate that in sixty-percent of those cases, it has rained the following day. So they say the chance, or risk, of rain is sixty percent.

Many risks in farming are of the same nature as the risk of rain. A farmer remembers, or collects information concerning, conditions under which bad things – crop failures, animal health problems, low prices, inability to get credit, accidents, etc. – have happened in the past. The future is never like the past, but past patterns may have an observable tendency to be repeated in the future. So farmers can calculate risk of a crop failure, for example, at the beginning of the season, based on past history of yields with similar soil moisture, weather patterns, etc. Risk estimates may change during the season as more information about this particular crop, such as planting date, germination, early weed pressures, etc., become known. The actual yield is never known with certainty until the crop is in the bin, but the risk or chance of a poor yield can be calculated at any point along the way.

Professional economic forecasters, market analysts, use this same basic approach. They use whatever information is currently available to identify past trends and current conditions that may affect production and prices in the future. They then estimate what they think is the most likely or most probable future price or production level – or range of prices and production levels. Some even estimate the chances that prices or production will fall below some specific levels, and thus, provide estimates of price or production risks. But, their estimates of risks are based on estimates of possibilities – they have no means of knowing what is actually "possible," let alone what is actually going to happen.

The premiums or costs for all types of insurance – including health insurance, crop-insurance, hedging and options – are based on similar calculations of risks. Whether the specific hazard covered by insurance will or will not happen is not known with certainty, otherwise there would be either no need or no ability to insure against it. In addition, the actual range or distribution of future possibilities cannot be known with certainty, because the future has never happened before. But, there is sufficient history of what has happened under similar conditions in the past – ill health, crop failure, and low prices – to allow the insurer to estimate the probability or chances of being required to pay claims of varying amounts. The insurance company's risks of having to pay claims are actually risks that policyholders have shifted to the insurance company in return for the payment of premiums. Of course, insurance premiums include costs of operation and profits for the insurance company in addition to their expected claim payments.

Uncertainty is fundamentally different from risk. Uncertainty means that not only are future outcomes unknown, but even the distributions of possible future outcomes are unknown. Not only do we not know for sure whether our poker hand is good enough to win, we can't even calculate the odds or chances of losing. Not only do we not know whether we are going to have a crop failure, we can't even calculate the probability of having a crop failure. We simply cannot forecast an uncertain future outcome with "any" degree of confidence. We cannot calculate a logical insurance premium, because we can't calculate the probability or size of possible claims.

When an outcome is uncertain, the risks are unknown. We may have to make decisions under conditions of uncertainty, but we cannot logically calculate the risks of a wrong decision. Such decisions may be based on past experiences in similar situations, or on hunches or intuition, but they cannot be based on either known distributions of possibilities or empirical estimates of risks. Most decisions concerning the environment are of this basic nature.

Environmental Health Uncertainties

So called *environmental risks* are almost always *environmental uncertainties*. We simply do not know, nor can we know, the risks of future adverse consequences of our current encounters with nature. Not only do we not know the specific outcomes; we don't even know the distribution or range of possibilities. There is no way that we can accurately assess the risk that something we do to the environment today will create, or not create, future harm. Thus, there is no way that we can obtain objective, unbiased estimates of whether current benefits obtained from our tinkering with the environment outweigh the risks of future negative consequences. Supposed objective cost/benefit estimates are mostly just guesses disguised by complex models and methodologies. Demands that we make decisions based only on such estimates – decisions based on "good science" – are demands that we accept the biased guesses of one particular group of scientists and not those of others.

Environmental uncertainties in farming include exposure of farmers and farm workers to commercial chemicals during application and exposure of others to air and water polluted by agricultural chemicals. Each of these cases embody significant possibilities that the actions of farmers today may do significant future harm to themselves, their families, their neighbors, society in general -- even to the future of humanity. Thus, decisions affecting the natural environment are critically important, in spite of the fact that neither farmers nor policymakers have unbiased, objective information upon which to base their decisions. There simply is no "good science" to guide them.

Pesticides are poisons designed to kill living things – bacteria, weeds, insects and fungus. Humans share a great deal of genetic material in common with other living things – including plants and insects as well as animals. So it should be no surprise that pesticides can have adverse impacts on human health, including death. Potential adverse health effects on farmers, farm workers and others living close to farms include cancer, respiratory disease, birth defects, and damage to the immune and endocrine systems of the body.

The active ingredients in many agricultural pesticides have been linked with cancer in humans and other animals. However proof of direct causality needed to accurately quantify human health risk simply does not exist. It took more than thirty years to link tobacco smoking to lung cancer – one use of one product linked to one type of cancer. Environmental risks were hardly on the human health "radar screen" thirty years ago. Decades more of scientific inquiry may be required to disentangle linkages of the thousands of different combinations of agricultural pesticides to their consequences. Each chemical combination may be, or may not be, linked to one or more of a whole host of different types of cancer and other diseases. The whole linking process for agricultural chemicals is complicated even further by chemicals in the environment from a host of non-agricultural sources.

Disruption of immunity and endocrine systems can take so many forms and be characterized by so many different symptoms that it is mind-boggling to even to think about how linkages of disruptions with multiple possible causes might be disentangled. Potential problems with human reproduction may take several generations to even become apparent. Health problems linked to odors may be linked to any combination of dozens of different chemical elements in a single "smell." The problem of analysis seems so complex as to have no solution in the foreseeable future. However, there is a growing body of empirical evidence suggesting that farmers are less healthy than are otherwise similar members of the general population, regardless of the source of their maladies.

Health threats to the non-farm population are similar to threats to farmers and farm workers – the linkages are just less direct. When agricultural chemicals get into the ground water or streams they may well show up in drinking water for someone at some point in time. But, it is difficult to predict precisely where and when. The chemical concentration may be less in a city's water supply than in a farmer's own well, or on a farmer's hands, but the health of far more people may be affected. And, it may be far more difficult to link cause and effect.

The EPA has established health advisory levels for concentration of chemicals in drinking water supplies. The goal is to err on the side of human health and safety in establishing these levels. But the fact of the matter is that advisory levels are little more than educated guesses. No one can say with any degree of certainty what levels of risks are associated with various levels of concentration of chemicals in drinking water – i.e. what probability of illness is associated with ingesting various amounts of water containing various concentrations of chemicals. They just "think," and hope, that the advisory levels are low enough to keep anyone from getting sick from drinking the water – or at least low enough so that drinking the water cannot be "linked to" any resulting illness.

Agricultural chemicals that escape into streams and rivers may travel for hundreds of miles before they enter the drinking water supply of some town or city. Long stretches of the Missouri River in the Midwest, for example, carry high concentrations of agricultural chemicals for several weeks following each spring planting season. Nearly every city along the Missouri either draws drinking water from the river or from relatively shallow aquifers in the river bottoms. No farmer individually may apply sufficient chemicals to cause harm. However, Midwest farms collectively use enough chemicals to wreak illness on a whole city of people -- if they were to drink improperly treated water taken from the river at the wrong time of year. But if such a catastrophe happened, no one would be able to say for sure just who was to blame.

It is even more difficult to link specific illnesses to groundwater pollution and air pollution. Chemicals may migrate for miles through underground streams before they even surface in a stream or drinking water well. This process can take months if not years or decades. Particles of pesticides and other chemicals that dissipate into the air during application may attach to dust particles and be carried for miles before settling to the ground or falling as contaminated rain. In the process of migration, agricultural chemicals may become mixed with pollution from a host of other potential sources. It is virtually impossible to link any resulting human illness with a specific cause and its source.

Other Environmental Uncertainties

Agriculture presents additional risks, or rather uncertainties, to the environment beyond those reflected in health risks. The natural environment is a productive system. Agriculture utilizes natural systems to convert solar energy to human useful forms -- the fundamental purpose of agriculture. A healthy, functioning agroecosystem is an efficient, productive ecosystem. If the ecosystem is damaged – its mineral resources degraded or depleted, it biological systems impaired – the efficiency of the system is diminished and its productivity declines.

Agroecosystems rely on interactions among soil, water, and biological organisms -- including plants and animals -- to convert solar energy into food and fiber. Anything that threatens the integrity of this agroecosystem threatens the productivity of the farm. Examples of such threats include soil erosion, loss of soil fertility, and loss of biological diversity – loss of diversity among organisms in soils, in the surface environment, or among plants and animals on the farm. The natural productivity of soils can be degraded through inappropriate use of agricultural chemicals as well as through use of inappropriate tillage and cropping practices. Either of these activities can cause loss of biological diversity of microorganisms in the soils, may change soil structure, reduce its inherent fertility, and impair its overall ability to function as a growing medium for plants.

Loss of biological diversity in insect and weed populations, brought about through continual reliance on commercial pesticides, may lead to continual increases in quantities and variety of pesticides needed to keep pest populations under control. Beneficial insects, insects that feed on pest insects, may be destroyed along with pest insects leaving commercial pesticides as the only defense against crop loss. Weeds that compete effectively with other weeds, but not with the crop, may be destroyed, leaving weeds that compete very effectively with the crop, but not with other weeds, to be controlled by commercial herbicides. If pests then become resistant to commercial pesticides, the natural controls of a biologically diverse ecosystem will no longer be in place to keep pests in check. The natural productivity of the system will have been degraded through its loss of diversity.

Crop rotations utilizing fundamentally different types of crops – grasses, legumes, cool season, warm season, etc. – help maintain soil quality and biological diversity both within and above the soil. Effective integration of crop and livestock systems may also enhance the natural productivity of farming systems. For example, most of the plant nutrients removed from the soil may be returned to the soil, in the form of animal manure, when animals, feed grains, and forage crops are all grown on the same farms. Planned rotation grazing of grasses may be used to manage pests and maintain biological diversity among plant species in pastures. In short, diversified farms are more "naturally" productive systems – requiring fewer commercial, off-farm inputs to maintain production levels.

Anything that diminishes the productivity of soils or reduces biological diversity represents a threat to the long run productivity of the farming operation. The actual consequences of such threats may take years, decades, or centuries to become readily apparent. Resistance to pesticides, particular insecticides, may take only a few growing seasons to develop. Loss of soil health and fertility may take longer, but is none the less a readily apparent consequence of past farming practices in all agricultural regions of the world. The negative impacts of specialized crop and livestock systems are even more indirect or subtle and more long term in nature. However, there is little doubt that specialized systems degrade the agricultural natural resource base – only the nature and magnitude of the degradation remains to be documented.

Modern industrial farming systems, characterized by specialization, standardization, and mechanization, are inherently reliant upon commercial inputs – pesticides and fertilizers – and upon cultural practices that threaten the natural environment. However, the multitude of complex linkages between industrial farming methods and environmental degradation make them very difficult to identify and quantify. In addition, those with strong vested interests in maintaining the industrial approach to farming discourage efforts to document and validate negative linkages between industrial agriculture and the natural environment. Thus, for the foreseeable future, the ecological threats to agricultural productivity will remain largely undocumented, unmeasured, unverified and thus uncertain.

Perhaps the most uncertain of all farm related environmental risks today are the risks associated with biotechnology. Quoting from an address by Peter R. Wills, Professor of Physics, University of Auckland in New Zealand, "Everything that happens in biology is based on endless orderly change, especially the flow of matter. The natural patterns and regularities of what we observe in biology depend on the maintenance or processes of change. This applies from the microscopic level of the cell… all the way to the biosphere."

"How this works cannot be understood solely in terms of material structure, whether we are talking about the proteins and DNA molecules in a cell, or the individual organisms existing in an ecosystem. The effects of a gene cannot be assessed by looking at the static relationship between its sequences, the letters of the DNA message it represents, and, the characteristics of the organism to which it is related. The meaning of a gene is determined by the context in which it is expressed. It also contributes to that context. So, when we swap a gene from one organism to another, we cannot know in advance what all the effects will be. We cannot know even in principle."

"The type, speed and scale of genetic change now being undertaken will affect the dynamics of biological systems, ecology and evolution, at their very basis. Changes that cannot be assessed in advance will progressively propagate through the biosphere. The pattern of those changes cannot be expected to fit in with what we already know. The only thing we can know with certainty is that we do not know, and cannot in principle know, what the character of the ultimate outcome will be, except that it will be different from anything that we are familiar with." In biological engineering, we don't know, and can't know, not even in principle, what we are doing to the natural environment and what the environment will do in response – yet we seem committed to doing it. What better example of environmental uncertainty could one possibly devise?

A while back, the head of Monsanto's biotech division gave a seminar on the University of Missouri campus. Their biotech division recently had been split off from their old chemical division -- which was a major player in creating our current chemically dependent agriculture. According to the speaker, the "new" Monsanto is developing new biotech systems of production that will allow agriculture to quit using the chemicals that are currently threatening the natural environment. The new Monsanto is trying to develop a "sustainable" food system, because the old chemically based agriculture isn't environmentally sustainable. In other words, the new Monsanto expects to make billions of dollars in profit solving the problems that the old Monsanto made billions of dollars in profits helping to create.

The old Monsanto didn't know, and couldn't have known, what problems it would create through its development and promotion of agricultural chemicals. The ecological system is simply too complex to have allowed them to anticipate, with any degree of accuracy, the environmental impacts of using agricultural chemicals over a 50-year span of time. Monsanto and the biotech enterprises know far less today about the future impacts of biotechnology than they knew about agricultural chemicals fifty years ago. The only thing we can know for certain is that we don't know, and can't know, the nature or magnitude of environmental risks associated with biotechnology. Common sense tells us that these threats are potentially monumental, but are uncertain.

The bottom line is that most, if not all, environmental "risks" are actually not risks, but uncertainties. They cannot be quantified with any degree of accuracy, cannot be ensured against with any degree of confidence, and cannot be programmed into any risk-based process of decision making. Environmental uncertainties require a fundamentally different approach to decision-making.

The Precautionary Principle

So how should farmers, and others, make decisions in the face of growing ecological uncertainties? They should make decisions using the "Precautionary Principle" for guidance. "When an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically (ToxicAlert)." In common sense terms, "it's better to be safe than to be sorry."

The Precautionary Principle, as stated by a group of scientists and scholars, is as follows:

"The release and use of toxic substances, the exploitation of resources, and physical alterations of the environment have had substantial unintended consequences affecting human health and the environment. Some of these concerns are high rates of learning deficiency, asthma, cancer, birth defects, and species extinction; along with global climate change, stratospheric ozone depletion and worldwide contamination with toxic substances and nuclear materials.

We believe existing environmental regulations and other decisions, particularly those based on risk assessment, have failed to protect adequately human health and the environment – the larger system of which humans are but a part.

We believe there is compelling evidence that damage to humans and the worldwide environment is of such magnitude and seriousness that new principles for conducting human activities are necessary.

We realize that human activities may involve hazards, but people must proceed more carefully than has been the case in recent history. Corporations, government entities, organizations, communities, scientists, and other individuals must adopt a precautionary approach to all human endeavors.

Therefore, it is necessary to implement the Precautionary Principle: When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.

In this contest the proponent of an activity, rather than the public, should bear the burden of proof.

The process of applying the Precautionary Principle must be open, informed, and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action."

Farmers using the Precautionary Principle would select livestock and cropping systems giving as much or more consideration to their potential impacts on the environment as their impacts on production and profits. Certainly a farming operation must be profitable or the farmer will lose the ability to continue farming, and thus, lose the authority to make resource management decisions. But, for the farm to remain profitable in the long run it must also be ecologically sound and socially responsible. A farm that degrades or destroys the productivity of its resource base or pollutes its natural environment is not sustainable. Since threats to the environment are uncertain, the farmer should take great precautions to protect the environment and natural resources, as long as there is a reasonable chance to do so while maintaining profitability.

In cases where farmers feel compelled to put the environment at risk to maintain economic competitiveness, they should resort to the public policy process – at the local, state, or federal levels. The environment has public as well as private value dimensions. Thus, public policies should be devised to make it economically feasible for farmers to be precautionary in protecting the environment. Such policies may take the form of incentives for farmers to follow production practices that minimize environmental threats and uncertainties. In many cases, however, the environment will have to be protected by out right prohibitions on practices that threaten the natural environment. If all farmers face the same environmental regulations, no one is necessarily put at a competitive disadvantage to the others, and prospects for profits are not necessarily diminished. In these cases, society pays for environmental protection through higher market prices.

Voluntary restraints are the product of cultural or community norms and values. Decent people just don't do some things, and decent farmers don't willfully and deliberately destroy the natural environment. In most cases, however, there is no clear consensus concerning whether particular farming practices do or do not threaten the environment – their impact on the environment is uncertain. In these cases, farmers and policy makers alike should purposely err in favor of protecting the environment. Neither farmers nor policy makers can rely on risk/benefit assessments to make such decisions. Risks cannot be accurately assesses because the outcomes are uncertain. The potential threats to human health and the natural environment are potentially large, often irreversible, and inherently uncertain. Under conditions of environmental uncertainty, it makes common sense to proceed only after taking appropriate precautions.

References

Wells, Peter R., Wellington Forum on Genetically Modified Food, University of Auckland, Auckland, New Zealand, March 25, 1999.

Wingspread Participants (listed by name in reference), "New Principles to Protect Human Health and the Environment," ToxicAlert, www.cqs.com/wing.htm, CQS, Acton, MA, April 8, 1999.