AGRICULTURAL PRACTICES AND WATER QUALITY IN SASKATCHEWAN:

THE SOCIAL ECOLOGY OF RESOURCE MANAGEMENT

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ABSTRACT

This thesis presents the results of exploratory sociological research designed to better understand how farmers select agricultural practices with the potential to effect water quality. The primary research methodology is a Rapid Rural Appraisal of thirty farms in five rural municipalities in Saskatchewan, Canada during the year 2000 growing season. The data establishes that a variety of economic, institutional, organizational, and social factors interact in dynamic ways to influence farmer resource management decisions and that the resulting agricultural practices have the potential for subtle and dramatic effects on water quality in Saskatchewan. Risk-mitigating farming methods known as "Best Management Practices" (BMPs) are interpreted by farmers in the field research as being both appropriate and problematic. Alternative initiatives and communication strategies are identified in the field data that offer support to production and productivity in the agriculture sector while also promoting water quality. The research suggests that measures such as providing accessible public water quality data, promoting water treatment for individual households, and educating rural women and youth about water quality issues may merit further investigation.

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CHAPTER 1

THE SOCIOLOGY OF AGRICULTURAL PRACTICES AND WATER QUALITY

1.1 Introduction

This thesis presents the results of exploratory sociological research designed to better understand how farmers select agricultural practices with the potential to effect water quality. The primary research methodology is a Rapid Rural Appraisal of thirty farms in five rural municipalities in Saskatchewan, Canada during the year 2000 growing season. The research identifies how farmers rely on varied information and underlying factors when they make resource management decisions.

The term 'agricultural practices' refers here to a range of farming techniques that producers use for production in the agriculture industry. Agricultural practices can be simple or complex, traditional or recently developed. Agricultural practices can include both productive measures and risk-mitigating farming methods designed to protect the environment and human health. Agricultural practices scientifically certified and endorsed to increase production and productivity while limiting environmental risk are known in the agriculture industry as "Best Management Practices" or BMPs (Bailey and Waddell: 1978).

Best Management Practices (BMPs) designed to protect rural water quality are the product of scientific research that purports to be value free. The prevailing hypothesis in BMP literature is that risk-mitigating factors transform

agrochemical farming and intensive livestock operations into environmentally and socially acceptable farming methods. Lockie (1997) suggests that management practices in agriculture are labeled 'best' because each represents the 'best' possible compromise between production of a particular commodity and the health of farmers and the environment. In any case, farmers are not adopting BMPs as widely as anticipated by government and industry. The primary and secondary data indicate that farmers sometimes adopt productive aspects of BMPs without implementing the risk-mitigating measures that make them safe. Degraded water quality is a potential risk in these situations.

The term "social ecology" refers to how a critical examination of social, political and production trends can lead to a reconstructive ecological and ethical approach to society (Institute for Social Ecology: 2002). In this case, local agriculture, or the culture of growing food in Saskatchewan, is deconstructed to examine how current production strategies present risks to water quality in the environment. The research looks for links between the culture of farming and changes in local social and natural environments. The research also examines how the 'agri-cultural' practices of farmers are not only determined by their instrumental interaction with their environments but by market conditions, regulatory frameworks, farm structures and the social characteristics of the farmers themselves.

Pure water is rare in rural landscapes. Water quality is determined by what it contains, it is a transport medium. Agricultural practices may introduce minerals, salts, soils, chemicals, fertilizers, microorganisms, and animal manure

into water (Libby and Boggess: 1990). The essential nature of water—it sustains life, agriculture and industry—suggests the need for more research and implementation of sustainable risk management options to protect water quality (Chociolko and Leiss: 1994).

The research strategy for this thesis uses both quantitative and qualitative sociological data to probe how farmers interpret and understand links between agricultural practices and risks to water quality. The sociological literature on agriculture in Canada suggests that the agri-food industry has undergone dramatic structural changes in recent decades, which, in turn, have contributed to changes in the social and environmental attributes of rural communities (Rosaasen and Lokken: 1994). Farmer notions of risk are examined in the context of changing economic, social, and natural environments. Primary and secondary data used in this thesis suggest that a diversity of resource management strategies exist among farmers. All agricultural practice decisions, however, are interpreted in this text as being inherently social because they are made in a social context (Vanclay: 1992).

To understand agricultural practices and water quality sociologically is to understand how farmers interpret their social and natural environments, how they conceptualize their resource management decisions, and how these decisions, in turn, alter social and natural environments. A sociological analysis offers a deeper understanding of how agriculture affects the environment and rural people and how social and natural environments, in turn, become important factors in the further development of socially and ecologically stable

production strategies. The main benefit of a sociological approach to the study of agricultural practices and water quality is the opportunity to gain insight and feedback into how farmers choose the agricultural practices that can affect water quality. With this social understanding, it becomes more possible to identify teachable moments or situations in which programs to conserve, protect, and enhance water quality can be designed, delivered and more readily accepted by farmers and other agro-industry actors.

1.2 Theoretical Framework

The theoretical foundation of this inquiry is the political economy of agriculture. The analysis pays close attention to how agricultural practice decisions are influenced in a large degree by regulatory frameworks, market forces, farm organization structures and social contingencies. While political and economic developments frame agricultural practice decisions by establishing external constraints on the economic returns of individual farm unit investments, organizational and social contingencies internalized within farm units such as new production strategies, intergenerational transfers of capital, and dynamic labor and gender relationships arise in response to these external influences of economic risk.

The theoretical framework of political economy holds that those in dominant political and financial positions have the ability to establish standards that are sometimes in direct opposition with the interests of the majority of

smaller-scale actors in the same industry. The result is that large actors including large producers and commercial firms in the industry profit at the expense of smaller producers who are squeezed out of the industry by diminishing returns. For example, in the agriculture industry, large food processing companies and large grocery retail outlets typically have more possibilities to manipulate market conditions of primary commodities or influence regulatory frameworks than do individual producers (Goodman and Watts: 1997). A political economy analysis of this trend, concerned with agricultural effects on the environment, would tend to explain environmental degradation caused by small agricultural producers as a consequence of market pressures and the intensifying agricultural production requirements inherent in a competitive market economy (Buttel and Swanson: 1986). In another example, large corporate livestock barns receive a disproportionate amount of fiscal and legislative support from the Saskatchewan government compared to smaller individual producers simply because their size and financial strength enable these entities to more effectively solicit and organize political support (Bowden: 2001).

In the tradition of political economy, this thesis accepts Vanclay's (1992) argument that rural water quality degradation is a social problem, influenced by structural conditions created by the economy and supported by the state. This inquiry takes as its starting point the supposition that agricultural practices are dynamic and socially reproduced. Farmers operating within this framework select agricultural practices in what Parent (1996) describes as 'socially

embedded ways'. This means that agricultural practice options available to farmers are often chosen in response to conditions external and internal to individual farm units and that these conditions do not always support environmentally farming practices.

Foster and Magdoff (1998) observe that agriculture is dependent upon the exploitation of natural resources and human labor because over time in a competitive market, producers are always forced to produce more to earn on volume what they once did on margin. The financial pressure to produce more with fewer resources forces producers to either expand production, to exit the sector, or to search for higher returns in high-risk niche markets. In this analysis, the social effects of market pressures include the alienation of farmers not only from their own production processes and produce but also from each other in their natural and social environments. The results of the industrial agricultural production process, therefore, are constant pressure toward degraded social relations, inequality, and a degraded ecology (Gertler: 1999).

A political economy analysis could interpret the agriculture industry in Saskatchewan as largely extractive in nature with farmers and their agricultural practices presenting real threats to rural water quality because of market pressures and lack of political support. Magdoff et al. (1998) suggest that competitive economic pressures on farmers have always affected the social reproduction of the agriculture industry and of rural communities. They further argue that market competition drives all industrial, social, and environmental

changes in rural areas. This includes the degradation of social and natural environments including the potential for water quality degradation.

Foster and Magdoff (1988) observe that pre-modern forms of agriculture traditionally resisted the pressures of industrial modes of production. Several factors had traditionally limited the ability of agricultural producers to rise far above a subsistence form of self sustaining economic unit. Land tenure arrangements with numerous small farms and the dependence of production on geological conditions and climate made agriculture a risky enterprise, as did the need for seasonal labor. Most pre-modern farms were mixed agricultural holdings.

Farmers began to achieve limited control of the means of production with the expansion of the private ownership of land as some farmers were able to eventually buy out their neighbors. As some farms grew in size and complexity, these farmers realized production for urban markets (Foster and Magdoff, 1998). Large-scale farmers were better able to use efficiencies of scale to take advantage of expanded production requirements. Small-scale farmers who produced less tended to become marginal actors in grain and livestock markets. Many small-scale farmers were forced by economic necessity to sell their small land holdings, move into cities and enter labor markets.

In a political economy analysis, government has a broad responsibility to create or foster conditions to stimulate agricultural development to grow food for increasing urban populations while, at the same time, protecting the legitimacy and fiscal health of the state. Government typically attempts to

achieve both goals by supporting the interests of large farming operations and the merchants who trade their goods. Government programs that favor large industrial actors have a tendency to adversely affect some small and medium sized producers who are not able to equally share in benefits. Sutherland (1987) notes that roads and railways constructed at public expense disproportionately benefit larger farmers. Market competition and government support for large economic players in the agricultural market strongly influence the agricultural practice options available to smaller scale producers in the industry.

A political economy analysis of potential water quality degradation from agricultural practices could interpret this relationship as a function of short-term planning for profit accumulation without regard for the long-term productive capacity of the land to produce food for future generations. In Capital Volume 3 published in 1894, Karl Marx wrote:

> Even an entire society, a nation, or all simultaneously existing societies taken together, are not owners of the earth, they are simply its possessors, its beneficiaries, and have to bequeath it in an improved state to succeeding generations (From Capital Vol. 3, quoted in Foster and Magdoff, 1998).

A philosophy that land should not be privately owned or spoiled is, of course, similar to First Nations peoples' traditional views of land. In Saskatchewan, European settlers began to alienate the land of the prairies into, first, government-owned and then, later, corporate or private properties for settlers. The history and tradition of mainstream agriculture in Saskatchewan, like in so many other places, has been one of dividing, conquering and spoiling the land

for short-term profits with little regard for immediate environmental impacts and the production requirements of future generations.

Agricultural science has provided the means to continue extracting value from resource-depleted farmland by developing new commercial input technologies (Buttel: 1997). Most farmland in Saskatchewan is rendered economically productive today through methods that include the use of commercial fertilizers and herbicides even though the long-term affects of these agents on the environment are unclear. With more intensive and extensive agrochemical use and the growth of the intensive livestock industry, rural water quality is facing threats that did not exist as recently as forty years ago.

The agriculture industry in Saskatchewan has adapted and improved the efficiency of the production process despite operating in the deteriorated natural environments that the industry has fostered. The depleted natural resource base and the reliance of agriculture on commercial inputs and foreign markets affect the social reproduction of actors in the agriculture industry and that of rural communities. The resulting intensification of agricultural practices increases risks to water quality because there are more possible point and non-point sources of water pollution in rural areas.

The theoretical framework of political economy strives to give a voice to those without power who are usually excluded from the decision making process (Basran and Hay: 1988). The logic behind this form of analysis is that a larger, more complete and accurate interpretation of a situation is possible only by examining the views of those marginalized from mainstream political and

economic decisions. In this case, individual prairie farmers are given a chance to voice their concerns and opinions about the conditions and factors that influence their agricultural practice decisions. The thirty farmers in this study represent a wide range of farming styles and social circumstances. The methodology is designed to create a research atmosphere where each farmer is encouraged to examine his or her own practices objectively. The interviews were designed to help producers to conceptualize and examine their own agricultural practices in the context of larger networks of market forces, regulatory frameworks, familial traditions and expectations, and personal aspirations. Farmers have much to say about the agricultural practices they choose. With a political economy analysis, insight is generated into how and why their choices are influenced by dynamic external and internal factors.

1.3 Research Objectives

The research provides a contextualized sociological analysis of how farmers perceive their choices of agricultural practices and how these choices affect rural water quality. This study recognizes that farmers and indigenous peoples have unique relationships with the natural environment that may be fundamentally different to those envisioned in urban notions of the countryside (Heffernan, 1982b; Hassanein and Kloppenburg, 1995). As a minority group in society, farmers must manage their limited resources within the context of laws and policies designed for and by an increasingly urban population. Although water is a basic requirement of human, livestock, and crop life, farmers often

overlook the quality of rural water until it raises immediate human health concerns.

The primary objective of this research is to develop conceptual tools for understanding how factors including economic, social, organizational, and institutional variables affect farm decision-making with respect to water quality on Saskatchewan farms. The research is designed to reveal how farmers perceive water quality in the context of social, organizational, economic, and regulatory pressures.

The secondary objectives of the research are to (1) uncover land and water stewardship risks associated with economic pressures due to agricultural restructuring and the protracted farm crisis, (2) present social and environmental concerns about water quality in the context of the working landscape and in the words of Saskatchewan farmers, (3) provide insights into why farmers adopt certain farming methods and reject others, and (4) contribute to the development of new approaches and tools for the promotion of agricultural practices that protect water quality.

1.4 Summary

This chapter introduced exploratory sociological research designed to interpret why farmers select agricultural practices with the potential to degrade water quality. The theoretical framework draws principally on a political economy of agriculture that examines structural constraints in the economy and

in regulatory frameworks that limit the choices available to industry participants. The main objective of the study is to understand the context of social, organizational, economic, and regulatory pressures that influence farmers when they make their resource management decisions. The analysis organizes these pressures into groups of economic, institutional (mainly political), organizational, and social factors that are introduced and examined in chapter 2. Secondary objectives of this study are to understand how the resource management choices of farmers affect natural, social, and productive environments and to uncover new opportunities to promote water quality.

CHAPTER 2

AGRICULTURAL RESOURCES AND THE CONTEXT OF FARMER DECISION MAKING

2.1 Introduction

This chapter begins with an explanation from the literature of how agricultural practices can degrade water quality. This is followed by a review of the multidisciplinary literature in which economic, institutional, organizational, and social factors are identified as significant influences of how farmers' choose their agricultural practices. Changing market conditions, government programs, life cycles of the farm and farmer, and social environments are discussed in the sections that follow.

Farmers choose agricultural practices, including BMPs, for a variety of reasons. The literature describing the factors that affect agricultural practice decisions and describing the consequences of these practices leads to several inescapable conclusions. First, the factors that affect the agricultural practice decisions of Saskatchewan farmers are sometimes as variable as the land and climate conditions that farmers must work with. Second, the factors of influence over the agricultural practice decisions of farmers often overlap and interact making clear and definitive causal statements problematic. Third, that the agricultural practice decisions of farmers do modify natural environments and have the potential to seriously harm water quality in rural areas.

2.2 Agricultural Practices, Water Quality, and Risks to Ecosystem Health

Saskatchewan farmers modify the natural landscapes around them when they grow crops and raise livestock. Braden and Lovejoy (1990) remind us that every production process, including agriculture, generates byproducts with little or no direct or immediate commercial value. According to Libby and Boggess (1990), agricultural production generates byproducts in the forms of manure and unstable fertilizers, pesticides, and mobile soil particles. Each of these groups of byproducts have the potential to seriously degrade both ground and surface water on site and downstream. An intensification of agricultural production generally produces an intensification of externalities and an increased potential for these byproducts to negatively affect water quality.

Uri (1990) suggests that cropping practices, pesticide and fertilizer strategies, and manure management are responsible for significantly degraded surface and ground water supplies in agricultural areas. He identifies the three main types of water quality impairment from agricultural practices as sedimentation, eutrophication, and pesticide contamination. During the Walkerton Ontario 2000 incident, the public became generally aware that pathogens such as the E-coli bacteria were also agriculturally based water contaminants (Mackie: 2000).

Duncan (1996) suggests that water pollution from agriculture has environmental consequences that may affect the long-term productive capacity of agricultural production. Ring (1977), Segerson (1990), and Savoury and

Butterfield (1999) warn that degraded water quality may eventually increase production costs by increasing the need for water treatment and the public costs associated with the enforcement of regulatory measures.

The tragedy of the commons thesis of Hardin (1968) describes how the use of resources by individuals or corporations for profit may degrade natural environments while those doing the damage often avoid bearing the costs. A production process such as agriculture that can degrade a resource base may increase future social and production costs associated with production on a degraded resource base. While those responsible for the pollution are not liable for environmental damage, the collective resources that populations depend upon are degraded. Libby and Boggess (1990) cite Unites States Environmental Protection Agency (EPA) estimates that an average of 1.8 million fish are killed annually in the US from pesticides, excessive nutrients, or livestock effluents from agricultural practices. The fish may or may not have a commercial value but they represent a consequence of degraded water quality. The farmers responsible do not pay for restocking the fish. If restocking occurs at all, government departments do it at public expense.

Batchelor et al. (2000) propose that water quality degraded by agricultural practices increases health risks downstream and increases the need for public investments in water testing and treatment facilities. Mackie (2000) describes the Walkerton, Ontario crisis of May 2000 when E. coli 0157 bacteria from cattle manure that was spread in a field was washed by heavy rains into a municipal well. The contaminated well water was processed in a faulty water

treatment plant and distributed throughout the town. Seven people died and over 2,300 became ill from drinking the water from their household faucets. The official Walkerton report absolves the farmer who spread the manure of responsibility because he followed 'proper practices' (CBC, 2002).

Walkerton 2000 is a near worst-case scenario as described by Buttel and Swanson (1986). They suggest that unchecked private resource management decisions of farmers (combined with lax regulation and oversight of treatment facilities) can potentially create social consequences and costs downstream in other areas. With Walkerton, the social consequences were measured in seven human lives and 2300 people suffering illness or disability.

Since the Walkerton incident, increased municipal water testing across Canada has uncovered high levels of bacteria and inadequate treatment systems and processes in many towns. Rogers (2001), a radio journalist, notes that in the summer of 1999 before Walkerton, there were no boil water notices issued for rural Saskatchewan communities. In the summer of 2000, after the heightened awareness of water quality and increased municipal testing brought on by the Walkerton scare, there were 66 boil water notices in rural Saskatchewan towns and villages.

In "Best Management Practices for Agriculture and Silviculture", Bailey and Waddell (1978) proposed risk-mitigating farming methods designed to balance agricultural production goals with environmental risk-mitigating measures. In the 1980's, government agencies, including the Ontario Department of Agriculture, and Agriculture Canada's Prairie Farm

Rehabilitation Agency (PFRA), began promoting best management practices (BMPs) designed to help farmers protect water quality. Despite their efforts, Lafond (1994) found that many Best Management Practices are not popular with prairie farmers.

A Saskatchewan study by Ross (1999) found that of the farmers she surveyed, 43 percent declared that wetlands are a nuisance, 71 percent drained them to increase cultivated acres, and 70 percent cultivated to the pond's edge. Only 14 percent of farmers surveyed said they would conserve wetlands if the government recommended this. The study found that farmers who organize their farms to maximize productive capacity at the expense of water quality and the health of the local ecosystem do not value natural resources such as wetlands and the organisms that live in them in economic terms. Ross recommends government financial incentives to farmers to convince them to manage their farms differently. She recommends promoting conservation-based farming practices such as maintaining wetlands and adopting buffer zones around them to minimize the damage to water quality from intensive cropping practices.

Buttel and Swanson (1986) suggest that farmers have few real incentives to implement BMPs. Falkenmark et al. (2000) suggest that structural conditions influence farmers to choose agricultural practices that are potentially dangerous to water quality. Farmers, in their opinion, implement resource management decisions that are potentially dangerous to water quality in response to competitive industrial pressure in an unregulated environment.

They argue that this trend toward water quality degradation is likely to continue unless structural changes are made in industry or to regulatory frameworks. Hence, unless conditions change, farmers in the future will likely do less to preserve water quality.

2.3 Economic Factors

Whatmore (1993) describes agriculture as part of the agri-food industry in which capital accumulates and farmers are marginalized. She asserts that resource management decisions taken at the farm level are primarily in response to decisions of corporate agribusiness leaders and that farmers have very little choice in their agricultural practices if they wish to remain competitive. Miranowski (1986) found that the macroeconomic forces of export demand, real interest/exchange rates, and commodity prices are beyond the control of farmers but significantly affect farm decision-making.

Basran and Hay (1988) assert that the availability of agricultural land, which is relatively fixed in supply, is an important consideration for farmers making resource management decisions. As both family and corporate farmers experience higher input costs and lower prices for their commodities, farmers strive to increase acreage under cultivation as the primary means of increasing production levels. The demand for arable land, therefore, increases, as does the cost for agricultural land even though farm commodity prices may decline or remain stagnant. The high demand and price of land contributes to the

economic risk of farm operations, which in turn, influences resource management decisions of farmers.

Stirling (1998) found that in temperate agriculture regions such as Saskatchewan, farmers make large capital investments in machinery that sits idle for most of the year. Large capital expenditures add economic risk for farmers who often have to adopt a short-term, risk-averse, and profit oriented management style. This strategy typically imposes environmental risks on the landscape and on its inhabitants.

Vail (1982) demonstrated that farmers make resource management decisions that are partially determined by the technology they can afford, their debt load, and the price and contract conditions of selling their products. Batie (1996) suggests that the high risk involved in farming may lead some farmers to discount the long-term benefits of soil and water conservation. Savory and Butterfield (1999) suggest that family farmers who work and live on the land are forced by market conditions into high commercial input regimes that are high risk in nature and that this risk contributes to the economic instability of farm families.

Buttel and Swanson (1986) observe that farmers use fertilizers and pesticides to reduce risks to their income but in doing so, may slowly degrade soil and water quality. Van Kooten et al. (1989) suggest that farmers are unlikely to change farming practices for long-term conservation reasons unless given immediate and direct financial incentives to do so. A study of Saskatchewan farmers by Forsberg (1991) found that farmers would adopt

conservation measures only when these actions offer immediate economic benefits. Bultena and Hoiberg (1986) found that BMPs would be adopted when farmers perceive the primary benefit to be economic. A good example is zero-till, also known as no-till farming. No-till is short for 'no tillage', a cropping method designed to reduce soil erosion by reducing soil disturbances from cultivation. In Saskatchewan, it is associated with continuous cropping rather than summer fallow, and with increased use of commercial inputs, especially herbicides to control weeds and fertilizers that maintain yield. Gray et al. (1996) found that the emphasis on no-till as a more economically efficient production strategy was the primary reason farmers adopted the practice.

Friesen (1999) found that farmers in Manitoba are removing tree shelterbelts to increase their acreage and grow more crops. This is an example of how a short-term economic decision can override a standard and well-established conservation policy. Although tree shelterbelts are known to combat or prevent wind erosion, the immediate gain caused by having slightly more arable land is affecting farmers' practices.

Taxes on farmland represent indirect costs of production to farmers. Friesen (1999) notes that farmland taxes prompt some farmers to destroy natural habitats to make the most of their tax expenditures. This action destroys wetlands that act as natural water filtration systems and woodlots that act as buffer zones for surface runoff.

Farming is a high-risk business and farmers with high debt may be so risk averse that they may not be willing to change farming practices to protect

rural water quality. Boehm (1995) suggests that the need to service debt on family farms shortens the planning horizon of farmers and makes short- term economic imperatives more important to many farmers than long-term soil and water conservation measures. Heffernan and Heffernan (1980) suggest that farms with an operations budget with more than 30% debts to asset base face serious financial difficulties. They argue that these difficulties will adversely affect the ability of farmers to make investments or assume additional risk associated with changing proven practices or adopting new techniques such as BMPs. The implication is that voluntary BMPS to protect water quality may be perceived by farmers as taking on additional risk, possibly at the expense of immediate financial gain or economic survival.

Due to the long-term nature of soil and water conservation and the dynamic range of possible economic, technological, social and environmental variables, Van Kooten et al. (1989) suggest that it is impossible to accurately project the opportunity cost of adopting or rejecting farming practices designed to protect the environment. The speculative nature of long-term opportunity costing of water quality degradation tends to give farmers a low priority threshold for conservation measures and gives government little political support for regulatory measures to manage agricultural practices. The inherent danger of this scenario is that nothing is done until serious water quality problems emerge. This has been the case in many European countries in which the strict regulation of agricultural practices began only after the water quality of urban populations was all too obviously degraded (Libby and Boggess: 1990).

The World Water Council (2000) warns that future costs of treating rural water for consumption in urban areas may prove to be increasingly expensive as agricultural point and non-point pollution increases and accumulates over the long term.

2.4 Institutional, Organizational, and Social Factors

Institutional factors in this text refer to instruments of the state including laws, policies, and programs that various levels of government design and implement for the agriculture industry and for rural populations. The significance of institutional factors in influencing the resource management decisions of farmers is that laws, policies and programs contribute to regulatory frameworks in which farmers make their decisions.

The establishment of agriculture on the prairies, as part of a federal government national plan to develop the west, meant that regional economic development focused on the export of farm commodities to distant markets rather than on a strategy of regional self-sufficiency. Basran and Hay (1988) note that the export oriented economy of Saskatchewan historically sent most grain produced on the prairies, and the surplus value of this commodity, to large population centers in Eastern Canada and to foreign markets.

Boehm (1995) suggests that the political power of prairie communities declined throughout the twentieth century as more people moved from rural areas to urban centers. As a result, local and regional political participation of

farmers have had negligible effects on the provincial and national political process. Wilson (1993) finds that political isolation and alienation of farmers make many government agricultural programs seem irrelevant and "out of touch" to many farmers. He argues that voluntary BMPs promoted by government are unlikely to be warmly received by farmers.

Sutherland (1987) suggests that an export economy is not conducive to environmentally friendly farming practices because the people driving national political and economic developments do not live with degraded rural ecosystems and water resources. They are unaware of, or not inclined to introduce measures to limit damage to water quality as by-products of agricultural production.

The fiscal policies of the state significantly affect the economic and environmental decisions of farmers. Tax policies affect farmers' resource management decisions. Interest and exchange rates indirectly affect costs of production on farms, the cost of long-term investments, and the discounted value of returns coming from such investments. Miranowski (1986) finds that these macroeconomic forces have real bottom-line impacts on economic and environmental sustainability of individual farms. These factors force all farmers to put a high priority on economic thresholds and rates of return on investment.

Heffernan (1982) argues that institutional factors that influence agricultural practices and water quality are policy instruments that may not have been designed for that purpose. State policies designed to stimulate other sectors of the economy can have large impacts on agriculture. Environmental

regulations or the lack thereof, have the potential to influence how agricultural practices affect water quality. Budget cuts to public water quality testing may indirectly determine levels of public awareness of agricultural practices and water quality. Income support programs for farmers based upon previous production may limit incentives for farmers to adopt measures that protect water quality.

Unger (1977) reports that, according to a former Assistant Secretary of Agriculture in the US, rural water quality management rests upon four principles which are (1) a voluntary approach in which farmers are given (2) financial incentives within (3) an integrated local and national government policy framework that recognizes (4) that other agricultural programs affect water quality. Unger suggests that more research and monitoring of water quality are essential for water quality policy.

Van Es (1982) argues that, in the US, it is the role of national and state governments to provide the framework to empower local organizations to promote BMPs and this should include providing public water quality data. Farmers are practical people who understand the importance of science. Without solid data on the affects of their present agricultural practices, farmers will continue to farm as they always have. Baker (1994) found that in many US jurisdictions, there is an unsatisfied need for regular water quality testing. Policy designed to convince farmers that they should change their agricultural practices to protect water quality needs data to be effective.

Conservation measures require time to be effective. Without immediate visible results, conservation measures may become unpopular due to political and policy changes that may change how farmers value environmentally friendly programs. Reichelderfer (1990) finds that if the benefits of adopting BMPs are variable over time, then the long-term success of the policy promoting BMPs will also vary. He suggests that the three main reasons that agricultural conservation policies in the U.S. fail are 1) that fixed incentive programs are undervalued by farmers in response to changes to macro-economic conditions, 2) programs have not been targeted to areas requiring the most attention, and 3) commodity production incentive policies often override conservation policy by providing more attractive government benefits.

In Saskatchewan, BMPS designed to protect soil and rural water quality are voluntary. Allen and Bernhardt (1995) assert that resource management decisions at the farm level may be the most powerful determining factor of the long-term sustainability of the family farm and rural environments. However, Lafond et al. (1994) found that many prairie farmers ignore BMPs. Buttel and Swanson (1986) argue that the structural conditions created by local and national governments can overwhelm local efforts to protect water quality by removing incentives or by adding bureaucratic obstacles. In their work, they find that voluntary conservation policies, without any fiscal incentives for farmers, are conducive to low adoption rates.

Bowden (2001) observed that the Saskatchewan Agriculture Operations Act protects all farm units, including intensive livestock operations (ILOs), from

prosecution for environmental degradation, provided the farms follow generally accepted farming practices. In contrast to Saskatchewan's nearly non-existent regulation of agricultural practices, ILO farming operations in Quebec are highly regulated due to larger population pressures. All ILO manure lagoons in Quebec are required to have concrete liners and must be covered to protect local water quality Rogers (2001). These kinds of measures are not common in Saskatchewan. The Saskatchewan Agriculture Operations Act ensures virtual 'right to farm' protection to farmers which, when combined with a lack of strong environmental legislation, indicates institutional support for agricultural practices that may be detrimental to water quality. This is an example of how a regulatory framework that supports the agricultural industry may present potential risks to water quality.

How farms are organized is an important factor affecting farmer choices of agricultural practices. Farm organization is an important variable in terms of ability to effectively implement such choices. Farms can be organized as family owned and operated production units, as corporate entities, or as collectively owned and operated enterprises. Land and equipment can be leased or owned. Heffernan (1982a) notes that farm land in the United States that is owned is subject to more conservation-oriented farming practices than rented land. VanVuuren and Ysselstein (1984) and Ervin (1986) find that owners tend to be more conscious of the long-term effects of their farming practices and are more likely to utilize conservation farming methods than renters. Farmers who own the land are more likely to test the soil and are therefore more aware of nitrogen

levels and the dangers of leaching of nutrients into water sources. According to MacArther (1992), farmers who own their land are more likely to use safe farming practices and for this reason, have safer drinking water.

The technical organization of production on farms in terms of farming systems that are diversified or specialized influences farmer decisions that affect water quality. Gertler (1992) reminds us that farms organized for single commodity production usually present more risks to the environment than mixed grain and livestock farms. The organization of labor on farms is determined by the level of technology used in agricultural production. Technological advances in farming equipment and agrochemical usage often allow farm operations to intensify production with minimal increases in labor costs, but with increasing risks to water quality. Dumanski and Smyth (1994) contend that farming marginal land using intensive farming practices is more likely to result in water degradation. Wolf and Wood (1997) find that while use of technology such as precision farming may enhance production, local knowledge of ecosystems is often eroded and natural water purifiers such as wetlands may be destroyed. They warn that farms managed without regard for potential damage to water quality will likely be detrimental to water quality.

Organization of farms in some First Nations communities are unique due to collective ownership of land. For some Aboriginal peoples, land can be an all-encompassing term that includes water, snow, ice, and air (Wolfe: 1989). The term 'land' has immediate, intimate, and spiritual connotations that link Aboriginal peoples to their environment. However, many bands in

Saskatchewan rent reservation farmlands to Non-Aboriginal farmers on a crop share or cash rent basis. The reserves may not have the capital or organizational resources to farm the land in a cost effective manner. Therefore, agricultural practices, with their affects to water quality on Aboriginal lands, are largely determined by Non-Aboriginal people who rent the land (Whetter: 1998).

Benson (2000) indicates that size and scale of prairie farming operations may not be a good predictor of farmer attitudes and agricultural practices. He states that although there is a public perception that intensive livestock operations and large grain farms are responsible for rural water contamination because they operate on a large scale, many threats to water quality can occur due to poor resource management on smaller scale operations where farmers choose economic survival over care of the resource base.

Batie (1986) asserts that farmers, like other people, have multiple roles and goals in their lives that propel them into social interactions with others in society. Farmers are children, parents and neighbors working to maintain or increase the quality of their lives. Many farmers, according to Batie, pride themselves on living close to nature and conduct their farming activities in accordance with what they perceive to be sound environmental management techniques. Nassauer (1997) found that the farming practices a farmer employs are often an indication of the farmer's sense of identity. He suggests that efforts to change the behavior of farmers should focus on changing how farmers define themselves in their own social groups.

Anosike and Coughenour (1990) contend that although resources available to the farmer influence many farm decisions, the age of the farmer is important, as farmers of different ages tend to perceive and manage risk differently. Older farmers tend to be more risk averse than younger farmers. Saskatchewan's farmer population is aging. Many farmers may therefore perceive changing traditional practices as highly risky even if the long-term benefits would be desirable for the environment.

Padgitt and Petrzelka (1994) found that farmers in the US who are approaching retirement tend to be risk-averse and do not usually want to change their methods and equipment for their remaining few years of production. The exceptions are family farms with an heir apparent. These farms almost always intensify operations near the transfer of ownership period. It is during these times that agricultural practices are most likely to change. Farms without an heir apparent more often slow down and approach a maintenance-mode, low input-farming model reflecting the reduced needs and energies of older farmers. Land is sold and the farm is scaled down in size and intensity thereby reducing risks to water quality.

The 'successor effect' is a label that describes how farming becomes more intensive near the elder farmer's retirement as more than one family now must make a living from the same farm operation. In the UK, Potter and Lobley (1992) found significant differences in land use between successor and non-successor farms. Farmers with successors tended to base their agricultural

practices on principles of long-term resource management rather than on short-term profits.

Identification with particular social groups is a social factor that appears to influence farmer choices of agricultural practices. Salamon (1985) found that different values associated with differences in ethnic background dramatically influenced farming practices. Allen and Bernhardt (1995) found that farmers who have similar worldviews are more likely to organize voluntarily with others who share the same beliefs. Bultena (1986) argues that availability of information on farming methods and membership in social groups strongly influences how farmers choose their farming methods.

In a study of 60 Illinois farm families by Salamon et al. (1997), low adoption rates of sustainable farm practices by those she labeled conventional farmers were compared with adoption rates of environmentally conscious farmers. Of the families surveyed, one half practiced state-recommended sustainable agriculture practices and the other half did not. The two groups had distinctly different social characteristics. The environmentally conscious family farms tended to include all members of the family in resource management decisions. Environmentally conscious family farmers regarded their farms primarily as a way of life, while conventional family farmers were more economically focused and usually had a designated head of the family making most of the important decisions. The families using environmentally friendly farming practices had a history of environmentalism and frequently practiced experimentation on their farms while most conventional farmers did not. The

study found that farmers create and reinforce their own sense of identity by socialization with others who share similar views. This sense of identity shapes their own farming philosophy and is expressed in the agricultural practices that they utilize.

Falkenmark et al. (2000) found that agricultural practices and farming habits are hard to change. Their study found that many farmers are caught on a virtual treadmill where they cannot afford to change their farming practices or look at new ways of farming that are less harmful to water quality because these changes represent what they perceive as additional costs or unnecessary operational risks.

Gertler (1999) reminds us that sustainable agriculture includes cultural as well as ecological diversity. Cultural diversity supports diversity in farming methods. Heffernan (1982b) warns that the social diversity of rural communities has diminished with the result that agricultural practices are becoming similar in different regions. He emphasizes that as agricultural practices are being homogenized, the water quality of rural residents is increasingly in danger of contamination due to standardized, industrial farming methods being applied to different conditions and terrain.

2.5 Summary

This chapter identified four groups of factors that influence the agricultural practice decisions of farmers. The factors are categorized here as economic, institutional, organizational, and social. The most influential economic factor identified is economic risk associated with agricultural production and price conditions for farm commodities. Lack of government policies granting incentives to farmers to adopt BMPs is the most influential institutional factor. The most important organizational factor affecting agricultural practices is land tenure with rented land at greater risk than land that is owned. Identity of the farmer is the most influential social factor that affects farmer choices of agricultural practices. Farmers belonging to or identifying with social groups that share particular notions of acceptable farming methods, (e.g. organic farming associations, soil conservation associations), tend to follow the same practices as other group members.

Farmers juggle many priorities and water quality considerations may not be what they perceive to be the most important or urgent. The challenge for those promoting agricultural practices designed to protect water quality is to integrate water quality protection into the decision making process of farmers. The literature suggests that this requires linking the protection of water quality with the reduction of economic risk of farm operations, giving farmers an obvious and active political voice in environmental stewardship initiatives, targeting programs to a diverse range of farming systems, and reaching farmers with new information through their organized groups.

CHAPTER 3

METHODS

3.1 The Research Problem

The research strategy is designed to examine how farmers make their agricultural practice decisions. Data from the Statistics Canada 1996 Census of Agriculture indicated that the majority of Saskatchewan farmers were not using many recommended BMPs. The primary objective of the research is to uncover why farmers do not use recommended agricultural practices that are said to protect water quality.

3.2 Methodology

The research uses a 'Rapid Rural Appraisal' (RRA) approach to gather field data in which farm units are the objects of analysis. A recognized methodology of the Food and Agriculture Organization of the United Nations (FAO, 2001), RRAs gather social and other kinds of descriptive data in a timely, cost-effective manner to create a purposive sample of key informants and indicative cases. Information gathered is normally qualitative, exploratory, and informed by a careful review of relevant literature. In this case, the multidisciplinary perspective came from a broad review of the literature and the input of two sociologists, a geographer, and a soil scientist acting as members of the supervisory committee. In this research, each farm unit is presented as a miniature case study in tabular format (see Appendix 1).

There are several reasons why the rapid rural appraisal approach was chosen over other methods for this project. First, it is a cost-effective research method that can yield useful results in a short time. It also allows the researcher to meet respondents face to face and be flexible with questioning. Taking clues from the conversation and the context, the researcher can probe for further explanations. Respondents have the opportunity to articulate their opinions and share their world-views with someone who is interested, as they are encouraged to think about familiar things in different ways. The social scientist therefore has the opportunity to uncover information that is difficult, if not impossible, to gather with standard quantitative methods such as the mailed survey.

In an ideal, large-scale, research project on agricultural practices and water quality in Saskatchewan, there would be ample time, and financial and human resources, to select and interview a random sample of several hundred of Saskatchewan's 55,000+ farmers. The procedure would involve a large research team conducting farm visits and personal interviews with farmers to discover what they know about agricultural practices and water quality. The rapid rural appraisal method of collecting and presenting data is comparable to a test sample for such a larger study. It is a methodology used to collect and analyze primary data to inform or test policy, or to indicate useful avenues for future research.

3.3 Variables

Farming methods known as BMPs are designed to increase agricultural production with a minimum of damage to the environment. BMPs are risk-reducing procedures designed to offset hazards to the environment created by intensive agricultural practices. The field research probes farmer views and perspectives on the use or non-use of BMPs and seeks to determine also whether present uses of BMPs serve as an accurate predictor or indicator of impacts on water quality.

Many BMPs for prairie grain farming are designed to prevent soil erosion and its associated effects on water quality. BMPs, in this context, include leaving crop stubble standing throughout the winter to catch snow and to prevent soil and water erosion in spring. Farmers with hilly terrain are encouraged to practice contour cultivation. Waterways around and through fields should be grassed to prevent excessive soil erosion and water contamination. Farmers are encouraged to plant or maintain windbreaks and shelterbelts of trees that slow winds and trap snow. Farmers without shelterbelts and windbreaks are encouraged to practice strip cropping to minimize the effects of wind erosion on soils. The use of minimum or no-tillage farming is a BMP designed to limit damage to topsoil and limit damage to water quality. The practice of summer fallow is not a BMP because it loosens soils and leaves it vulnerable to erosion by wind and water. Farmers are advised that weed control with agrochemicals is more effective than summer fallow and allows for continuous production (Harker, 1997).

The BMPs recommended to Saskatchewan livestock producers deal mainly with manure management to protect water quality. These measures include fencing livestock away from rivers, streams, dugouts, and areas around wells; constructing livestock watering systems that cannot be contaminated with manure; and safely managing the distribution of manure from livestock facilities back onto the land.

3.4 Sampling

The resource management practices of 30 Saskatchewan farms were the focus of the field research. The purposive cluster sample was chosen to reflect the diversity of farms and farmers in five rural municipalities (RMs) located in five different watershed drainage basins. A RM map is included in the appendix. Two of the sites, RM 74 (Wood River) in the Old Wives Lake Basin and RM 368 (Spalding) in the Quill Lakes Basin are involved with an ongoing New Rural Economy study as is the Okanese Indian reservation (IR82) in the Qu'Appelle River Basin. These sites were chosen because the sites are tied to a larger national research network (New Rural Economy, 2001). RM 366 (Kelvington) in the Lake Winnipegosis Drainage Basin, RM 216 (Tullymet) in the Qu'Appelle River Basin, and RM 271 (Cote) in the Assiniboine River Basin were added to the sample to diversify the areas under study. The Indian Reservation of Yellow Quill (IR90) was included as a case study along with the farms of the adjacent RM of Kelvington. The Cote Indian reservation (IR64) was included as a case study with the farms of adjacent Cote RM. The Okanese

Indian reservation was studied with the adjacent Tullymet RM. Each of the Indian reservations were purposely included in the study for comparison purposes.

The final sample of farms was identified by asking local RM administrators to recommend 10 -15 farms that represent diverse circumstances in terms of land base, work force, farm organization, and cropping systems. The administrators were given a list of different types of farmers that the researcher would be interested in meeting. After compiling a suggested list, the researcher attempted to contact each of the individuals by telephone, and an interview was requested with those that were reached. The final sample included six farmer/operators from each of the RMs selected. Interviews took place between June 12 and September 15, 2000.

3.5 Community Profiles

Table 3.1 in the Appendix highlights community profile data for the test site RMs and provides a quick summary and comparison of selected characteristics of the RM populations. In all the test areas except the Cote and Okanese Indian Reservations, the population decreased significantly between the Census of 1991 and 1996. The average age of the population in the RMs was 37.6. The average age on the Indian Reservations was 24.2. Agriculture is the main form of economic development on the three reservations but almost none of the Aboriginal people on the reserve are involved in the industry. The

farmland in each case is managed by a land manager under the band chief and band council but mostly rented out to Non-Aboriginals on a cash or crop share basis.

The data presented in Tables 3.2 and 3.3 in the Appendix are from the 1996 Census of Agriculture and describes farm characteristics and BMP usage in the RM study areas. Table 3.2 provides descriptions of farm characteristics. Table 3.3 indicates the usage of Best Management Practices. The key significance of the tables is the widespread use of commercial fertilizer and agrochemicals on cultivated acres without widespread use of BMPs such as grassed waterways, contour cultivation, strip cropping, shelterbelts, and direct seeding to reduce the risk of water contamination. Agricultural practices that increase production appear to be more important to the vast majority of farmers in the test site areas than agricultural practices designed to protect water quality.

3.6 Survey Instrument

The interviews featured a combination of closed-ended and open-ended questions designed to reveal land management and water stewardship risks associated with economic and social pressures, agricultural restructuring, and the protracted farm crisis. The survey instrument was designed to stimulate additional comments from farmers beyond the initial questions. The questions

sought to identify health and environmental concerns related to water quality in the context of the working landscape, and in the words of local farm operators.

The first draft of the survey instrument was field tested on two farmers in the RM of Kelvington in May 2000. The field tests revealed that several questions were too sensitive to be included. Both farmers expressed indignation when asked if they felt they were responsible for degraded water quality locally. Both also explained that they were unwilling to discuss financial details of their farms beyond the debt to asset ratio requested.

The final draft of the survey contained three sections (see Appendix K). The first section included thirteen farm profile questions that probed the organizational structure and social background of the farmers. There are three questions on drinking water dealing with source, testing, and treatment. The second section contained thirty-two questions based mainly upon questions from the 1996 Census on Agriculture. This section included questions on different land use practices, pesticide usage, and soil conservation measures. The third section of the survey contained eleven questions to gather information on particular farm practices known to have a close relationship to water quality.

The final draft of the survey instrument was submitted for review to the University of Saskatchewan ethics committee in early June. The ethics committee required a firm end date for the field research so that farmers would know that their participation in the study would be limited. Preferred start and end dates of the field research were included with the final draft of the survey

instrument. The ethics committee approved the survey instrument for use in field research between June and September 15, 2000.

3.7 The Interview Process

The field data collection began with a meeting with the RM administrator of Kelvington on June 14. After a brief description of the research project and a request for assistance, he provided twelve names of farmers who reflected a diverse range of farming operations within the Kelvington RM. Every person on the list was telephoned; however, it was impossible to reach several people. Out of the original twelve names, five interviews were conducted over the course of the following two weeks. During this time, a meeting was arranged and held with the land manager of the Yellow Quill Indian reservation.

On June 28, the field researcher drove to Madge Lake near Kamsack. The next day, a meeting was held with the Cote RM administrator who provided nine names to contact. Five of these people agreed to an interview. Each was visited and interviewed over the next four days. Sunday was a very good day to find farmers available for interviews. On July 4, the field researcher met with the person responsible for water quality on the Cote Indian Reserve and with the reserve's land manager.

On July 10, the researcher traveled to the RM of Wood River. A meeting the next morning with the Wood River RM administrator yielded ten names of

farmers to contact. Interviews were completed with six of these farmers over the course of the following week.

On July 17, the field researcher traveled to the area of Spalding. A meeting the next day with the RM administrator yielded eight names. It was fortunate for the field researcher that the weather was wet and cold because, as the meeting with the RM administrator was taking place, several of the recommended farmers walked into the administrator's office to inquire about different matters. A space was provided in the RM office for two interviews. A total of three interviews were completed in the first morning in Spalding. The disagreeable weather for farmers was good for social research as farmers had time to meet and talk. An additional interview was completed in the same afternoon and another two the next morning.

The field researcher traveled to the RM of Tullymet on August 2 and met with the RM administrator upon arrival. The administrator gave the researcher names of twelve farmers. As the weather was again wet, farmers were at home and willing to be interviewed. Three interviews, therefore, were completed by the end of the first day. By late afternoon of the second day in the RM of Tullymet, a total of five interviews had been completed for the RM with an interview with the chief of the local Okanese Indian reserve.

The lengths of the interviews varied, and notes were recorded by hand during the interview. Whereas a few farmers were interviewed in as little as thirty minutes, some interviews took several hours. Short interviews tended to be with busy farmers who although preoccupied, were willing to devote some

time to an interview. Short interviews were included as these busy farmers had much to say about agriculture, just not a lot of time in which to express their views. Some of the most insightful responses in the field research came from short interviews. Other interviews lasted up to several hours and provided opportunities to explore issues in greater depth.

After all of the interviews were complete, the field notes and responses to questions were transcribed using Microsoft Word software and organized into tabular case studies.

3.8 The Case Study Format

The data collected in the field yielded a diverse array of information, most of it qualitative, about a diverse set of thirty farms. As a method of organizing and presenting survey responses and additional field notes from each interview, the data are condensed and organized into tabular case studies. The format allows the researcher and the reader to quickly access information. Key farm characteristics can be understood in relation to the complex issues confronting the different farm operations. To ensure confidentiality for respondents, each farm was given a number and the names of the RMs were replaced with numbers. Place names of nearby towns and bodies of water were removed from the presented data to further protect respondent confidentiality.

Several categories in the case study table present responses to questions on water quality. With regards to drinking water quality, in each case the

researcher assigned levels of low, moderate, and high awareness to the farmer being interviewed. Respondents who had recently tested their drinking water were assessed as possessing a "high awareness" of water quality. Farmers who believed that they knew the quality of their drinking water without recent testing to support their opinions were assessed as having a "moderate awareness". Farmers with no idea about the quality of their drinking water were assessed as having "low awareness".

The BMPs used and not used on each farm are identified in the case studies. Based on responses to these and other questions, the researcher assigned levels of low, moderate, and high with respect to farmer awareness of the relationships between agricultural practices and water quality. A high level of awareness indicates that the farmer recognizes the relationship. A moderate level of awareness indicates that the farmer is aware of some aspects, and a low level of awareness indicates that the farmer does not recognize or acknowledge the relationship between agricultural practices and water quality.

Categories in the case study format present the organizational, economic, social, and institutional factors that farmers identified as influences of their resource management decisions. In addition, a category entitled 'water quality concerns' identifies the water quality concerns, if any, of each of the farmers interviewed.

3.9 Summary

This chapter provides details of the methods used in the research project. The methodology of rapid rural appraisal is defined and described as an informed inquiry designed to generate exploratory and qualitative social data in a timely and cost-effective manner. BMPs that apply to prairie farms include measures designed to limit soil erosion on farms with crops and to promote safe manure management on farms with livestock. The research sites are identified and described with secondary data from Statistics Canada. The development of the survey instrument is described followed by a description of data collection in the field. Finally, the tabular format of the case studies is described in which the field data is organized not only as an efficient way to present data but also as an analytical tool that facilitates comparison and holistic assessment.

CHAPTER 4

THE FIELD DATA

4.1 Introduction

This chapter presents a description and preliminary analysis of the primary data gathered in the field research. An overview of the characteristics of the sample is presented in Tables 4.1, 4.2, and 4.3 of the Appendix and each farm is presented as a detailed miniature case study in Tables 4.4 to 4.33. The description of farms in the Tables 4.4 to 4.33 are organized to allow the voices of farmers to emerge so that their views, usually silent in scientific inquiry, can be included and studied.

Out of the total sample of thirty farms, twenty-four are family farms, three are incorporated, and three farms belong to Indian reservations. The size of farms range from 4 to 8064 hectares. The commodities produced range from grain and oilseeds to spices, bedding plants, beef, pork, and breeding stock. Four farms in the field research produce certified organic grain.

The farmers interviewed ranged from 25 to 79 years old with 48 as the average age. Seventy percent of the farmers interviewed had inherited or purchased the farms of their parents. Forty percent of the farmers interviewed had at least one member of their immediate families earning an off-farm income.

While several farmers in the sample don't seem to care about the effects of their practices on water quality, others say they care and yet do not implement BMPs, while still others say they care and conduct their agricultural practices in accordance with recommended Best Management Practices. This study searches for reasons behind these responses and attempts to discern patterns and trends for further study. The data is organized using categories of influential factors identified in the review of the literature.

Without a careful analysis, it might seem logical to blame water quality degradation on the actions or inactions of individual farmers because, ultimately, farmers make their own resource management decisions. When rural water quality is degraded farmers and their neighbors may be among the first to suffer the consequences. Blaming farmers alone for practices that lead to degraded water quality, however, can be interpreted as a means of shifting societal responsibility for risky and hazardous agricultural practices. This is related to Ryan's (1972: xiii) "generic formula for *Blaming the Victim*—justifying inequality by finding defects in the victims of inequality". Farmers may not have as many resource management options as they would like to have, or as others may presume. This study identifies influential external factors that come up consistently throughout the case studies. Questionable agricultural practices appear to be at least partially determined by social factors that interact in complex ways. Polluting or destructive practices, may thus appear to be "logical" in the context of circumstance.

In the case studies, as in the literature, cluster groups of factors seem to influence the resource management decisions of farmers. Individually and collectively, each group of factors is dynamic and interactive. Figure 5.1 in the Appendix provides an illustrated theoretical framework of how factors which may in the first instance be economic, institutional, organizational, or social, collectively influence the agricultural practice decisions of farmers. Farmers in the sample very seldom made use of actual water quality data when making their resource management decisions. In the absence of actual water quality data, various external and internal factors become more influential.

4.2 Economic Factors

The field research indicates that economic factors, both beyond and within the farm gate, are strong influences on how farmers choose their agricultural practices. Economic factors beyond the control of farmers include market prices for farm commodities, land prices, interest rates, cash rent and crop share lease terms and conditions, and equipment costs. The ability of farmers to choose agricultural practices is also connected to the economic security or lack thereof, of their own farming operations. The farmer must evaluate and accommodate land base, debt loads, production capabilities, and input costs. Farmers in the sample with limited security and high payments were primarily concerned with economic survival and felt they had less choice in their practices than farmers with little or no debt to service. Economic factors identified individually in the farmer interviews establish a framework of

economic risk for all agricultural practice decisions. It is in this context that decisions that may possibly degrade water quality are made.

Farmers in the sample cited the pressures of adapting to or coping with volatile markets as strong influences on decision making. In recent years, low market prices for many farm commodities in recent years have added to the economic risk of farming. Farmers stated that low prices for their farm products affect how they choose their farming methods by forcing them to make most resource management decisions on a financial basis. The agricultural practices farmers use must generally make or save them money. Many resource management decisions on farms in the sample, therefore, are primarily based upon seasonal and short-term financial and production exigencies rather than on the long-term health of agricultural resources or rural environments.

High costs of land, buildings, machinery and inputs add to the overall risk of farming. High capital and operating costs and small profit margins affect farmer perceptions of the economic risks involved in changing farming methods. Farmers commented that input costs on farms are significantly higher than ten years ago, yet most farm commodities are the same price or lower. Farmers reported that farm fuel, equipment maintenance costs for items like belts and bearings, and the cost of seed and chemicals have continually risen while farm commodity prices have stayed the same or decreased in real terms (indexed for inflation). The increased costs of farming coupled with diminishing returns on agricultural investments have forced farmers to reassess

farming practices carefully. Agriculture practices that increase or preserve profit margins receive more attention than those that do not.

High input costs and low commodity prices contribute to marginal returns on farm investments. Returns on investment are rendered more variable and difficult to predict or control due to uncertainties of weather and market prices. Without a more adequate rate of return, some farmers reported that they might not be able to continue farming in future years. Several reported that they have been living very directly off equity by selling land. Many of the agricultural practice decisions that farmers make are determined by economic requirements rather than by concern, or lack thereof, for their environment.

Farmers with high debt operate with more financial risk than those with very little or no debt. Third and fourth generation farmers on the same land are the most likely to have little debt. Younger farmers typically carry heavier debt loads than older farmers. Farmers with high debt loads tend to perceive the risks associated with changing farming practices as large. Six farmers with high debt to asset ratios stated that they had little interest in changing their farming methods if it involved any significant purchase of equipment.

The greater the financial strength of the farms in the sample, the more the farmers seemed able to adapt their practices to changing market conditions. Farms in the sample that have been in the same family for several generations are generally larger and more financially secure than farm enterprises that have been started more recently. Several lifetimes of accumulation of land, capital,

and knowledge on the same farm seemed to give farmers a strategic business advantage over newer farmers. Farmers in more secure financial situations were more likely to employ BMPs than were farmers experiencing financial difficulty. This seems to indicate that the long-term economic and environmental sustainability of farms is linked to intergenerational continuity both as an economic and as a social factor.

Among the livestock farmers interviewed, water quality was important because of the recognition that quality of water can affect feed to weight gain ratios. The managers of the two intensive hog operations in the sample were very concerned about the quality of the water available for their animals. One manager reported that unless his water is 'safe for babies' he would have production problems. Both hog barns have water treatment facilities and both have arrangements to inject hog manure into the fields of surrounding farms in an effort to reduce the risk of local water contamination. Economic and other pressures in the agriculture industry, in this instance, influenced these farmers to install water treatment systems and to more carefully dispose of animal waste. The primary impetus may be economic but the effects are both enhanced water quality in the barns and waste management procedures that help protect water quality in the local environment. Of course, the long-term impacts of heavy manure applications may also represent a delayed risk for water quality.

Four conventional farmers in the sample disclosed that they would prefer to reorganize their farms as organic operations not only for the higher prices paid for organic products but also to feel better about how they farmed. Each

gave the same reason why they did not change: their present farm operation could not afford the several year transitions and reorganization required for certified organic production.

In this limited sample, the non-organic farmers operating relatively large-scale farms with low debt-to-asset ratios were more likely to use caution when disposing of agrochemical containers. Farmers with financial strength were also more likely to retain wetlands that act as natural water filter systems. Several of the farmers with high debt-to-asset ratios expressed the desire to retain natural wetlands and treed areas but cited economic pressures as the reason they drained wetlands and cleared forested areas. One family farmer, deep in debt, indicated that although he doesn't like to drain wetlands on his property, he is forced to because he pays municipal taxes on that property and can not afford to pay taxes on "unproductive" land.

4.3 Institutional Factors

Farmers in the sample recognized political decisions (and indecision) over policies and programs as institutional factors that limit many of their own resource management decisions. Farmers had a lot to say about various functions of local, provincial, and national governments. Many of their comments were negative. Family farmers were most vocal in their criticism. Several suggested that government efforts to support the agricultural industry often excluded their farm operations and added to an uncompetitive climate

that sometimes limited their own resource management options. This suggests that farmers, especially hard pressed family farmers, are subject to a form of political alienation. They see themselves as suffering from taxation without adequate representation of their interests. Farmers expressed disappointment with government for not providing adequate long-term strategic direction for the agriculture industry. This lack of planning contributes to uncertainty on farms. It is this uncertainty that further influences farmers to make short-term decisions that may degrade water quality.

Several farmers claimed that low international farm commodity prices caused by foreign government subsidies are being ignored by the federal and provincial governments. They indicated that the federal government has the right to take the USA and EU to the WTO for unfair trade subsidies but does not because other sectors might suffer the consequences. These farmers felt that both the federal and provincial governments are not on their side. As a form of retribution they tend to ignore government programs unless there is an immediate and significant economic incentive for compliance or participation.

Many of the farmers sampled indicated that the quality of life in their rural communities is being degraded. One farmer remarked that Saskatchewan must be the only place in the developed world that is dismantling its infrastructure. Farmers spoke of frustration with government because of many local schools, hospitals, and businesses closing or relocating to larger communities.

In each of the RMs, several farmers identified ghost town communities where they formerly sold grain or livestock, bought groceries, got mail, went to church, played sports, and socialized with their neighbors. Virtual ghost towns like Perigord, Daphne, Coté, and Woodrow still appear on road maps and local farmers still identify their sense of community with these places even though the villages no longer exist.

A Spalding area farmer stated that the Spalding area lost its hospital a couple of years ago. When asked where someone would go if they had a heart attack, he replied, "Six feet under, because you won't make it to Melfort" (a town nearly 60 kilometers away). Another farmer near Ituna complained that when he phoned his local bank, someone in Mississauga, Ontario answered the phone.

Several farmers complained that they felt they were being abandoned in the countryside by governments and businesses that only cared about large producers. In the meantime, they pay their taxes and have had to live with disappearing rural services, poor roads, and high charges for shipping grain. Farmers in the sample seemed to have little time for government agency suggestions on how to farm in an environmentally-friendly manner since they perceive government, in general, to be acting only in the best interests of the urban population.

Several farmers stated that federal government income assistance programs NISA and AIDA unfairly pay out to farmers who do not require assistance to survive and ignore those farmers who really do need financial help.

Farm income support programs are based upon production levels that are a function of scale of farm operations. The larger the farm, the more income support. The smaller the farm, the less support. The net effect is that small or moderate-sized but financially troubled farms, which require income support to carry on, receive much less than larger producers who often do not desperately require assistance. Although several of the sampled farms were in serious financial difficulty, most did not qualify for assistance. One woman who identified herself as a 'farm wife' in the sample explained that their 'AIDA' cheque helped to save their farm from bankruptcy. She pointed out, however, that many of her neighbors who did not need the money, received assistance, and bought new half tons trucks that she referred to as "AIDA trucks".

Several farmers suggested that government subsidies linked to volume of production might be detrimental to the environment and water quality. They suggested that income support programs based upon production levels force farmers in financial difficulty to exploit their marginal land, which can lead to soil erosion and threatened water quality. Two farmers suggested that farm income support programs be redesigned to protect rural environments. The figure of $10 per acre per annum as a stewardship fee to retain natural wetlands and wooded areas was brought up independently by two farmers indicating that they had probably read about or heard the idea from another source. Although the provincial government has since initiated a land conservative fund of $15 per acre per annum to compensate farmers to retain wetlands and woodlots, the limit is fifty acres, which amounts to a rather token program with a maximum

financial incentive per farmer of $750 per year. Several farmers mentioned that past government programs encouraged farmers to drain wetlands and now they are being encouraged to keep them. Such mixed or changing messages lead some farmers to view recommended practices with skepticism.

Several farmers explained that they have learned over time to be cynical about government initiatives that have little follow-up, and which expect the farmer to assume all the expenses and risks. Among these farmers, federal and provincial government policies and programs are perceived as being out of touch with rural reality and are only taken seriously if they offer obvious and immediate financial benefits.

A cattle rancher stated that the people at Saskatchewan Agriculture and Food mean well, but that their advice on raising cattle is often wrong for his cattle farm. Several grain farmers stated that the practice of no-till farming, which has been promoted by government agencies to stop soil erosion, is not appropriate for their land. One farmer stated that he resented being a 'guinea pig' for government employees carrying out experiments in agricultural policy, programs, and practices. He indicated that he had answered the federal and provincial government calls for agricultural diversification. He took advantage of a program to help establish a spice crop but when he had production problems, he found that he was on his own without advice or assistance. He had to conduct his own research and lost a lot of money. Another exasperated farmer asked "Diversify to what?"

Government authority and jurisdiction over water quantity and quality were unclear to many farmers in the sample. Some farmers were concerned that Sask Water, the crown corporation responsible for water in Saskatchewan, did nothing for them. They also resented that they had to ask permission from Sask Water before diverting surface waters or drilling a well because all water development projects in rural areas require this advance permission. Several farmers in the sample stated that they ignore this procedure and drain land or dig dugouts without Sask Water approval. These actions modify the local terrain and have the potential to negatively affect water quality. According to RM administrators, unauthorized drainage of wetlands is widespread in several of these jurisdictions.

On the Indian reservation farms in the sample, the land is held in trust by the federal government for each reserve according to the federal Indian Act. This limits many resource management decisions. Land managers on the reserves indicated that access to credit to purchase agricultural equipment and commercial inputs is severely hampered by the inability of the reserve to borrow against its land base. Agriculture is the main industry and main source of revenue on each of the three reserves, but hardly anyone on the reserves is involved in the industry. Each of the Indian reserves depends on revenue generated from the rental of reserve land to off-reserve farmers. Although the elders and administrators of each reserve would like to have more direct control of their land and water resources, they cannot afford to change the present system because it consistently generates revenue without expenditure. In the

meantime, water quality on the reserves is at potential risk due to the agricultural practices of off-reserve farmers who rent reservation land.

The Saskatchewan Agriculture Operations Act allows farmers to farm without monitoring the effects of their practices on local water quality. This legislation is the same for both small family farms and large intensive livestock barns. Some guidelines are in place for Intensive Livestock Operations (ILOs), and BMPs are promoted to grain and livestock farmers by both the federal and the provincial government. However, there is no binding legislation designed to protect the environment from agricultural practices. This is an example of a structural contradiction. Government legislation protects the right of farmers to pollute water quality while at the same time, it uses other programs to try and encourage farmers to use agricultural practices not harmful to the environment.

Several farmers, including those on rural pipelines with water from chlorinating treatment plants, noted the lack of public funding for research into rural water quality. Many farmers mentioned, as well, that with all the agrochemicals being used in their local areas, it would seem prudent to do regular and comprehensive water quality testing. Public funding of water quality testing in all RMs in the sample, however, has been reduced in the last two decades.

Several farmers made positive references to the activities of the Prairie Farm Rehabilitation Agency (PFRA), especially regarding the agency's past promotion and subsidization of dugouts and the current trees for shelterbelts program. Several farmers indicated that a long-term government plan for the

agriculture industry needs to be formulated and communicated to farmers directly, so they can more accurately plan and choose the agricultural practices that are best for the future of their farms.

4.4 Organizational Factors

How farms are organized in scale, business structure, commodities produced, level of specialization or diversification, and the labor requirements of agricultural production are interrelated organizational factors identified in the field research that influence the agricultural practices of farmers thereby creating conditions with the potential to modify water quality. Organic farmers in the sample, for example organized their land use, production strategies and labor in different ways than commercial input grain farmers. The managers of intensive livestock facilities in the sample organized their agricultural practices differently than those farmers with free-range herds of livestock. Different production strategies involve different agricultural practices that present different risks to water quality. The variations are not always clear. Small farm are not necessarily more environmentally friendly than larger farms.

In this sample, the managers of incorporated farms were more likely to use recommended BMPs and appeared to have a better idea of the actual local water quality than their family-farmer neighbors. As hired managers, they have shareholder obligations, and one of these obligations is to ensure that environmental regulations are complied with at least so far as required to avoid

prosecution or precipitation of a lawsuit or other forms of organized resistance. The family farmers in the sample were under no obligation to anyone but themselves in ensuring environmentally safe water practices.

Land tenure relationships seemed to involve different risks to water quality. Land managers of farmland on Indian reservations placed some restrictions on farming practices for the land they rented out to protect local environmental values including water quality. On one reservation, however, off-reserve farmers renting reserve land blatantly ignored several of these stipulations. For example, they sprayed chemicals under windy conditions so that trees and vegetation in shelterbelts were killed. They could have waited for the wind to die down or sprayed leaving a strip to compensate for the wind but they did not. Those who rented farmland on the reservation used agricultural practices that are not as environmentally friendly as the owners would have preferred.

The scale and type of farms seemed to be an indicator of farmer ability to mitigate economic and environmental risk. Farmers operating the larger farms were generally financially better off because of their operation size even though farm commodity prices are low. The small farms were also doing relatively well. These farms generally had low debt and lower operating costs. Most of the small-scale farmers had at least one person in their families with an off-farm income, thereby reducing the financial risk that affect choices in agricultural practices. Farmers producing both grain and livestock seemed able to manage their resources in tandem to compensate poor prices of one farm commodity

with the higher prices of another. The financial strength, or rather their lack of economic vulnerability, seemed to give these farmers more choice in their agricultural practices.

The farms most likely to be in real financial trouble in the sample were the medium-size grain farms. These farmers were strongly reliant upon grain or oilseed production for income, and low commodity prices were pushing them to the brink of insolvency. At best, several medium-sized grain farmers admitted, they were starting to live off the equity that they had built up in their farms. According to them, this situation cannot carry on over the long term. Almost every resource management decision is crisis management for these farmers. Environmental concerns including water quality are the least of their worries. Economic survival is their top priority.

Many of the family farmers sampled expressed the desire to farm differently but explained that they could not afford to change their farm practices or to reorganize their farming operations. For example, farms producing cereal grains, oilseeds, or legumes cannot easily change to the production of other farm commodities without incurring additional costs. Switching to cattle production from a strictly grain operation, as one farmer did, is a costly process with financial risk. Investments have to be made in equipment and in fencing. Grain farmers with off- farm incomes reported that they could not take on livestock because they could not balance job commitments with feeding schedules and other animal husbandry duties. Several farmers with cattle and grain reported that they could not easily switch

to just crop production because their pastureland is unsuitable for crops. Some specialty farms were limited in their production options by the size of their land base or the lack of financial strength of their farms.

The four organic farmers in the sample accept some BMPs like grassed waterways and shelterbelts but reject others like continuous, no-till cropping because the practices involve the use of agrochemicals. Organic farmers are very conscious of their resource management decisions, including those that affect water quality, because their fields and surrounding areas are monitored for chemicals. The organic farmers interviewed regarded themselves as interacting with their biophysical environment, whereas conventional farmers in the sample more often tended to regard their farms as businesses in which they were in control of the natural environment. The organic farmers in the sample based their agriculture practice decisions primarily upon the health and productive capacity of their soils. They interpreted the use of agrochemicals by their neighbors as a possible threat to their organic certification and therefore their livelihoods. Organic farmers in the sample seemed to be more innovative and curious about new farming methods that they could utilize to control weeds or increase production. As one organic farmer stated, “Farming with chemicals is easy. Being an organic farmer is hard.”

Labor requirements on farms seem to influence some agricultural practices and impact on water quality. Large-scale farmers utilize large machinery to maximize labor efficiency. Large, powerful tractors pulling wide, deep tillage cultivators enable farmers to cultivate small wetlands and to farm

right up to bodies of water. The efficiency of using labor saving technology and equipment on farms adds to the risk of water quality degradation by putting high-risk marginal land and riparian areas into commercial production.

4.5 Social Factors

Social factors identified as influential in the field research illustrate that interacting human relationships have profound and complex influences over the agricultural practice decisions of farmers. Social factors include farmer sense of identity and the stage of life he/she is in, family traditions, gender, age, level of social isolation, the presence or absence of an heir, and retirement strategies. Each of these social factors influences how farmers make their resource management decisions, which, in turn, have the potential to affect water quality. For example, when farmers feel that they are forced to choose between the economic survival of their farm unit for their children to take over, or protecting water quality in their local environments, the choices of agricultural practices can be painful.

The number of generations that one family has been on the same land seems to be a deep and powerful structural and motivational factor on how the land is managed and organized. Farmers who inherit land have strategic economic advantages over farmers who are buying land. Farms that have been in the same family for several generations were, on the average, more financially secure than the newer operations. On most of the oldest family farms, the

farmers retain some wetlands and marginal land for local wildlife rather than exploiting all areas for production. One family farmer, standing beside the stone house his great grandfather built, noted that living in the country meant sharing life with local elk and deer populations. He reported that he was proud that his family had always left space for wildlife on their farm. This attitude reflects not only an intergenerational concern for the local natural environment, but also the financial stability in which a wider rage of agricultural practice choices are available.

When one farm family owns a parcel of land over several generations, knowledge of the land is passed from one generation to the next. A long history of land ownership gives farmers a sense of 'knowing' the land and of positioning practices within a long-term vision for the land. Future generations are considered, and this translates into concern for practices affecting soil and water quality. These attitudes are significantly different, for example, from those evinced by the ILO farm managers interviewed; their main concerns seemed to focus on short-term production and on short-term environmental liability.

Gender differences became apparent in the sample even though gender was not initially posited as an important social factor. Women who participated in the interviews showed more concern than men for health issues related to the use of agrochemicals and for the general health of the environment in which they lived. Several women interviewed spoke out about their concern about agrochemicals. They spoke about a need to find more natural ways to farm,

even as (in several cases) their husbands disagreed with them openly in the course of the interview. One woman indicated that she was worried that agrochemicals would enter their drinking water, but her husband defended the use of agrochemicals as the main practice that allows them to have good crops and to keep farming.

On the three Indian reservations in the sample, water quality is linked to agricultural practices of off-reserve farmers renting reserve farmland. The elders of each First Nation warned that the use of chemicals by off-reserve farmers is slowly poisoning their land. On each reserve, they advocate pursuing economic development strategies that return the land and water to a more natural state; however, each reserve is dependent on the income from the rental of farmland. The economic reality, e.g. the absence of credit for operational expenses and equipment, limits the ability of the bands to determine their own land use. The use of farm chemicals and commercial fertilizer by renters in this example indicates that a landowner's ideology of environmentally-friendly farm resource management can become subordinate, by economic necessity, to the need to rent out the land. Farmers in the sample who rent land tended to be less concerned with the health of the soil and local water quality than farmers who owned their land. Several farmers who both owned and rented land admitted to using different practices on each. Farmers renting on one of the Indian reserves of the sample applied agrochemicals that produced visible damage to the trees and wetland vegetation along the edges of fields. The band

council that rents out the land had asked farmers to farm with buffer strips along the edges of fields but this request was frequently ignored.

Most farmers in the sample belong to at least one producer or marketing organization. Group membership is one of the main ways in which farmers receive new information about agricultural practices that are relevant to their production strategies. Membership in groups gives farmers contact with other farmers experiencing similar situations. Membership in groups allows farmers who are geographically isolated to receive scientific and market information relevant to their particular interests. Prime examples from the field research were the organic farmers interviewed, each of whom belonged to organic farmer associations. As a group, they were very well informed and connected to similar information on agricultural practices despite living in different areas of the province.

On the majority of farms, older farmers were more cautious about change and more financially risk-averse than younger farmers were. Several older farmers indicated that they had always practiced summer fallow and did not want to change their methods so close to retirement. Although several young farmers said that they would like to switch to organic farming when they are older and have paid off their land and equipment, the older farmers in that enviable position mostly did not want to so radically change the way they farmed so close to retirement. This indicates that farmer choices of agricultural practices are complex and sometimes contradictory, and that age, as an important social factor, can contribute to diverse outcomes.

Farmers in the sample who have heirs prepared to take over the farming operation choose different agricultural practices than those who do not. The biggest difference between these two sets of family farms is that those with heirs are generally in expansion mode despite, (or perhaps, because of) the uncertain farm economy. Family farms without heirs were not likely to expand and instead were in production-maintenance modes. Farms with an inheritor typically used intensive agricultural practices but also were more likely to be using those BMPs that mitigate risk to water resources. In contrast, agricultural practices on farms without an heir tended to change slowly and BMPs were less of a concern.

Overall, there is a sense of cynicism about the future of farming among the family farmers sampled, even among those who are presently doing well. Many family farmers stated that although they would like their children to take over their farms, they wished for a better life for their children. Several family farmers planned to use the equity in their farms as funds for their retirement instead of turning the farms over to their children. Pessimism about the economic future of farming seems to influence farmers to be non-receptive to the promotion of conservation measures designed to protect the long-term health of water quality.

4.6 Environmental Concerns of Farmers

Rural life is more than farming for profit and the link between the environment and the quality of life for farmers became apparent in the field research. Farmers generally recognized that they affected the environment with their agricultural practices but they tended to interpret these affects in different ways. Three farmers in the sample who utilized agrochemicals also preserved portions of their land for wildlife habitat. Six farmers using commercial pesticides and fertilizers expressed concern with their own farming methods including possible affects on their health and on the health of wildlife in their immediate environment.

Each of the four organic farmers and three of the conventional crop farmers interviewed stated that commercial fertilizer and pesticide usage are affecting local natural habitat and wildlife. Five farmers in the sample were concerned that the fertilizers and chemicals they were using were carried off the fields with run-off into their own water sources and into water used for drinking at lower elevations in their watersheds. Almost all farmers in the sample expressed concern with their own drinking water quality but few had tested their water.

Several older farmers in the sample told of reduced numbers of wildlife and fish in local areas since agrochemical farming began. One farmer asked, "Where have all the jack rabbits gone"? He attributed their reduced numbers to

agrochemical use and wondered aloud if their reduced numbers are an indication of agro-pollution in the environment.

Several younger farmers in the sample expressed an interest in switching to organic farming but felt that they could not due to the risk of changing their agrochemical farming practices. They felt that they had little choice in their production-oriented, high input, cereal and oilseed enterprises. Organic certification requires at least three years in which they cannot use agrochemicals. In this period, yields would likely be lower and they would not receive certified organic prices to make up for the loss of volume. Their production methods and machinery are entrenched in the agrochemical regime. They deemed changing their methods as too risky even though they acknowledged that their farming practices affected the local environment and that viable alternatives were available.

The organic farmers in the sample each pointed out that local ecosystems around their farms are changing due to the effects of agrochemical agriculture. Each of the organic farmers stated that the potential for surface and ground water contamination by pesticides on their farms is increasing as long-life agrochemicals accumulate in the soils of neighboring farms. Organic farmers were especially concerned that over spray from neighboring fields could compromise their cropping systems, their organic certification, and possibly, their livelihoods.

Eighteen conventional farmers expressed worry over unsafe agrochemical applications of their neighbors. Two farmers reported being

sprayed by aerial sprayers. Others reported drift of agrochemicals with wind that affected their crops or gardens and worried aloud that this could potentially affect their health.

Twenty-one farmers from the sample stated that rural people need more information on water quality. Two farmers suggested that there is a need for greater transparency and accountability of government and agribusiness, and suggested that water quality information such as environmental audits and assessments of intensive livestock operations should be available to the public. Several suggested that this should happen at the local level of government.

One farmer suggested a restructured RM system designed around watershed basins for more efficient water quality management. Another farmer went further, suggesting that water quality and quantity would be managed most efficiently on a watershed basis and that Saskatchewan needs a fifty-year plan for water so that water quality, drainage, and jurisdiction are clearly outlined.

An organic family farmer in the sample complained about the odor of a large hog farm near her own farm and voiced her concern about the manure disposal at the facility as well as her distrust of corporate farming. The owner/manager of the hog farm, also interviewed, said that although environmentalists have legitimate concerns, a public forum is not the place to debate environmental issues because people do not generally have the knowledge to make informed decisions. He said that people elect governments that hire experts to make these recommendations. In his opinion, government

has two responsibilities with respect to the hog industry. The first is to insure that environmental monitoring is done properly. The second is to make sure that all the relevant information on environmental assessment is available to the public. He indicated that the government's role is hampered by its dual role of promoting the industry and regulating it. He felt that the public has reason to question the credibility of the government as an environmental authority, and to question how the actual environmental risks of ILO sewage facilities have been represented, and he sees this dual role and related skepticism as contributing to his problems with neighboring farms.

Health concerns about water borne disease were present in each of the five RMs in the sample and on each of the three Indian reservations. One farmer wondered if gallstones and Parkinson have been linked to water quality in rural areas. One farmer blamed his terminal cancer on contaminated water quality. Another, who has bad arthritis and has had neighbors die of cancer, wondered aloud if the water was to blame. There seems to be insufficient data available to the public about water quality and its relationship to human health. In the absence of data, farmers are left to speculate on the relationships between agricultural practices, water quality, and health. In the meantime, more agrochemicals are applied to fields and more ILOs are being established in rural areas.

Most farmers interviewed did not know the quality of their local water. Several farmers cited the cost of water testing as too expensive. For drinking water, rural water quality testing in Saskatchewan is the responsibility of

municipal water treatment plants or individual users who must pay to test comprehensively for nitrates, bacteria, and common pesticides. Due to what farmers perceived to be high costs and the necessity of regular testing, none of the farmers in the sample conducted tests for pesticides in drinking water. Several farmers tested for bacteria and nitrates and several others have never tested their drinking water. When it comes to rural water quality data, most farmers in the sample are operating in an information vacuum.

4.7 Summary

Although several farmers in the sample acknowledged that protecting rural water quality is important, most farmers sampled were more concerned with other issues such as keeping their farms economically viable. Farmers felt caught in a protracted farm income crisis made more difficult by the inability or unwillingness of Canadian governments to intervene beyond immediate disaster relief measures. Agricultural practices are increasingly influenced by decisions taken outside of local rural areas, as are political decisions that affect the agriculture industry. Farms are organized in different ways for different reasons. However, the economic pressures associated with the farm income crisis and government inaction is straining the ability of traditional farm organizations such as the family farm to make resource management decisions that protect water quality. Even farmers who expressed a concern for local water quality and environmental integrity sometimes found themselves unable

to translate this concern into BMPs or other measures to protect the environment.

In the sample, multiple factors are shown to influence resource management decisions. The farmer's stage of life emerged as an important influential factor of how farmers make their agricultural practice decisions. One of the most influential social factors of agricultural practices seems to be the intergenerational continuity of farms within the same family. Gender differences that emerged in the field research suggest that some women on farms care more about the environment and water quality than men on the same farm who are more often pre-occupied with production concerns. Renters will sometimes act with less regard for water quality in the environment than owners of land who wish to transfer the land to the next generation. This is particularly evident on Indian Reservations where ideologies of land-use are difficult to implement through a landlord-tenant relationship. Although the field research discovers that farmers perceive links between water quality and quality of life in rural areas, the factors that influence resource management decisions are multifaceted, and farmers will choose agricultural practices for a variety of reasons.

CHAPTER 5

THE SOCIAL ECOLOGY OF RESOURCE MANAGEMENT

5.1 Introduction

As agricultural production intensifies and farmers organize their farm units according to new economic, institutional, and social realities, water quality in rural areas may very well become an indicator of how well farmers are coping with rapid social change. The increasing market pressure of the agriculture industry tends to encourage farmers to place profits before the wellbeing of both social and natural environments. The result is a degraded social ecology that becomes increasingly determined by market pressure.

5.2 Summary of Key Findings

The strongest apparent influence for farmers' resource management decisions is economic necessity, or more accurately, farmer perceptions of links between resource management and profitability. Economic factors that directly affected farmer choices of agricultural practices appeared to be primarily connected to short-term economic risk mitigation.

The research revealed that changing agricultural practices introduces financial risks to farmers who may be strongly averse to risk because of their financial situation or age. Farmers operating with high debt, for example, were especially reluctant to change agricultural practices. They felt that they were at

their risk threshold and that to change their practices constituted excessive additional risk. Several farmers explained that they were too preoccupied earning a living to worry about water quality.

The First Nations farms in the study illustrated how economic requirements overpower deep cultural ideologies for responsible land and water stewardship. In each of the three Indian reservations, the leaders dislike the intensive agricultural practices of the off-reserve farmers who work their land. Each reserve relies so heavily on the income that these rental arrangements generate, however, that to change these arrangements for the long-term protection of the land holds unacceptable short-term economic risks.

Farmers in the study voiced grievances about failed government programs and a lack of government concern for farmers. Several farmers found contradictions in government policies and stated that they will not do anything the government suggests unless they have to. All levels of government seem to have credibility problems with most family farmers in the sample. Among family farmers in general, government is perceived as supporting agribusiness instead of individual farmers. Based upon the information gathered in this study and the opinions of farmers in the sample, it is apparent that farmers perceive support of economic development at the expense of the environment and of rural communities as the dominant orientation of governments at the provincial and federal levels.

The provincial Agriculture Operations Act that releases farmers from liability of environmental damage if they follow voluntary BMPs presently

protects both small-and large-scale farmers in Saskatchewan from environmental liability. The successful promotion of voluntary conservation measures to farmers in this framework is unlikely because the provincial government protects the agriculture industry with virtual 'right to pollute' legislation and does not act with any strength to enforce the voluntary measures designed to protect the environment including water quality.

The organic farmers and several of the conventional grain farmers in the sample indicated that BMPs for the use of agrochemicals are not well suited to their own resource management strategies. They explained that no-till farming methods, for example, require chemical summer fallow in which all or selected plant life on fields is exterminated with agrochemicals. Several farmers complained that this BMP might be extremely harmful to microorganisms in the soil, local bio-diversity and to water quality. This is one example of how BMPs can be viewed as inherently problematic by certain farmers. It was interesting to note that the organic farmers in the field research are pursuing agricultural practices that they believe to be more environmentally friendly than some BMPs. There seems to be a demand among farmers for government programs to subsidize the several year transitions to organic production. Policy and programs with this intent would send a message to farmers that there are alternative production strategies that may contribute to resilience of the environment instead of a slow but sure degradation. These types of transition programs could also help to send a message to farmers who are looking for long-

term direction. That message is that one day their livelihoods may depend upon the health of their environment.

The age of the farmers in the sample and the presence or absence of an heir seemed to be additional key factors in determining farmer choices of agricultural practices. Older farmers in the sample were less likely to change their ways to adopt BMPs unless a younger family member was also involved in the decision making process. While older farmers may have higher levels of site-specific resource management knowledge, younger farmers tended to be more aware of the latest trends in agricultural production techniques. The combination of the two types of knowledge on the same farm seemed to produce a mix of agricultural practices that facilitated increased production levels with BMPS to mitigate the associated risks to protect rural water quality. Attempts to influence the agricultural practices of farms with a successor should appeal to concern over the long-term productivity of the land and environment including water quality.

Gender differences emerged in the field research to indicate that farm men and women sometimes have different priorities when contemplating resource management decisions. In several cases, the opinion of the woman living on the farm swayed the typically male-dominated agricultural practice decisions and in other cases it did not. In very general terms, farmwomen were primarily concerned with the health of their families whereas, farm men focused on production. These conflicting sets of priorities were noted several times in the field research.

5.3 Avenues for Future Research

There are several useful avenues for future research on the topic of agricultural practices and water quality. The most obvious would be to use this study as a starting point for a full-scale survey of rural Saskatchewan resident knowledge with respect to agricultural practices and water quality. In the ideal research model, social, economic and agronomic information would be correlated with water quality data from corresponding areas where both point and non-point sources of water contamination have been identified. Another avenue of research would be to monitor the adoption of BMPs by farmers over time. This could be accomplished by comparing the quantitative Census data used in this study with data generated by the Census of Agriculture in the future.

A participatory study of water quality that combines the collection of actual water quality data at the farm level with the education of rural children and their parents would be beneficial. This sort of study, combined with a public awareness campaign that teaches rural people how to protect water quality, would directly address the problem of degraded water quality as the causes of it are studied. This research could and should begin with the premise that untreated rural drinking water is likely unsafe for human consumption.

5.4 Summary

Data from the 1996 Census of Agriculture and the field research conducted in this study indicate that agricultural practices that increase production and labor productivity are being adopted by farmers in large measure. Practices that are designed to limit damage to the environment are adopted more selectively and slowly, or are ignored completely. In the literature review and in the field research, four groups of influential factors—economic, institutional, organizational, and social—were identified as framing farmer choices with respect to agriculture practices. Market pressures reinforced with a lax regulatory framework encourage farmers to organize their farms and social identities to support agricultural practice decisions that can be harmful to water quality. Degraded water quality, therefore, can be interpreted as a consequence of unchecked industrial agricultural development.

Most often, the agricultural practice decisions that farmers choose make ample sense to them. They often observe their own decisions are the most rational response to conditions both external and internal of their farm operation, conditions that may or may not be subject to their own control. The agricultural practices that farmers choose are the result of their socialization, of how they have grown to interpret their own production experiences. A causal explanation would postulate that to change agricultural practices either the social identities of farmers or the conditions that influence their decisions, preferably both, must change. Otherwise, agricultural practices will continue to

increase the potential for water quality degradation until that potential is realized.

CHAPTER 6

IMPLICATIONS FOR POLICY

6.1 Introduction

Although it is reasonable to assume that Saskatchewan's rural population will not grow significantly in the near future, it is likely that agricultural practices will become more intensive and that the pressure to water quality will increase as has happened in Europe and in the United States. These issues may be compounded if climate changes or temporary droughts or flooding put more pressure on water resources and water quality. Until the health of people, the health of environments, and the economic development of human and natural resources are addressed and engaged in an interdisciplinary and holistic way, the unsustainability of current agricultural practices will likely intensify.

6.2 Suggestions For a More Sustainable Agriculture

As Falkenmark et al. (2000) argue, 'water quality problems' have human and social origins and water solutions will require a human and social understanding of the landscape through which the water flows. To promote water quality in the future, government will have to take the lead by providing regulatory frameworks in which agribusiness and individual farmers contribute to a culture of farming with long-term economic and environmental goals that are not mutually exclusive.

Several of the conventional farmers in the sample indicated that they believe science and technology can and will cure any damage caused by agricultural practices. This is evidence of the blind faith some people tend to put in conventional wisdom until a paradigm shift comes along. It seems that until farmers receive more comprehensive, objective, and unqualified information that include impacts on the long-term productive capacity of their land and the human health risks associated with their present agricultural practices, they will likely continue to farm as they have. Until farmers are presented with solid data that convinces them that the long-term degradation of the productive capacity of the environment is taking place, their practices are not likely to change.

Neilson (1986) suggests that federal government agencies should provide an overall framework along with information and some financial support for provincial and local government efforts to promote conservation-based agricultural practices. Discussions with farmers in the sample about earlier PFRA programs that subsidized the cost of digging dugouts indicate the level of cost sharing should be at least 50% to ensure a high level of participation. A federal government sponsored initiative to deliver subsidized low-cost water testing to rural residents at least once per year would be a good start in addressing the problem of no data.

Cost sharing provides policy makers with an opportunity to disseminate information on agricultural practices and water quality. This information should be designed to appeal to both men and women as each may have

different concerns about water quality reflecting their particular spheres of activity and realms of responsibility. Rather than being genderless, Hassanein (1997) suggests that effective rural water quality policy should strive to identify differences between perceptions of men and women and use these insights to develop programs and information that are not exclusionary.

Rickson et al. (1999) suggest that water quality policy should appeal to men, women and youth, both 'inside' and 'outside' the farmhouse with an aim to raising awareness and facilitating discussion at the farm level on options for improving water quality. Falkenmark et al. (2000) suggests that solutions to water quality problems begin with a long view, including the education of youth about their future role in watershed management. The education of youth may help tomorrow's farmers to perceive agricultural practices as part of the process of ecosystem management. As Nassauer (1997) suggests, the farming practices a farmer employs are an indication of that farmer's sense of identity. Education may encourage farmers to change that sense of identity and expand the view of their roles to both agricultural producers and stewards of the environment.

Rosaasen and Lokken (1994) suggest that it is the responsibility of policy makers to inform the public about the health of their ecosystems and to provide projections of long-term health risks associated with the continuation of present agricultural practices. This is not happening in Saskatchewan. Truly sustainable agriculture is possible but only if people begin to question the ability of conventional agriculture to continue to provide sustainable livelihoods for rural populations (Schaller: 1994). The World Water Council (2000) warns that

agricultural practices, as a main polluter of water globally, must be changed to conserve the quantity and quality of drinking water. Brown et al. (2000) agree and argue that governments should begin to manage ecosystems in a holistic way with a combination of regulatory frameworks and incentives for agricultural practices or risk the future health and productivity of natural resources.

6.4 Conclusions

Farming in Saskatchewan is as variable and diverse as the land and the people farming it, but a common feature is that most farmers have their own drinking water supply. Most farmers sampled in this research do not know the quality of their drinking water because they have not tested it. Chociolko and Leiss (1994) remind us that often the problem with analyzing the effects of agricultural practices on water quality is that there is not sufficient data to make the analysis.

Rural residents need access to research-based information and information delivery systems that link changes in farm management practices to changes in various parameters of water quality. This will likely be a most important educational and motivational tool. People will modify (or insist on modification) of agricultural practices if they can see demonstrated connections between mitigation practices and improvement to water quality. Policy makers designing information delivery systems for farmers should bear in mind that

many farmers are not highly educated (only 2 farmers in our sample had a university education). Information designed to reach farmers and persuade them to farm differently has to be accessible to people who may not have a high school education.

Policy designed to preserve water quality should appeal to farmers' sense of responsibility for their environment and the effects of their agricultural practices upon it. If farmers are uninterested in their environment, Nassauer (1997) suggests that the first business of policy is to educate farmers that their own health and their long-term economic and ecological sustainability may be directly related to the agricultural practices they employ.

Better, more comprehensive public water quality data would aid in identifying the sources or causes of water degradation and this could establish a framework to measure the environmental impacts of farming practices. It seems that there is no immediate interest by either government, corporate actors in the agro-food industry, or farmers themselves to provide the public with water quality data. Publicly accessible water quality data could cause farmers to question the legitimacy of their practices and, significantly, certain central tenets of the dominant industrial model of agriculture.

Publicly accessible water quality data could become problematic to farmers who are presently protected from environmental liability. Farmers with this information may be forced to change certain intensive agricultural practices to safeguard their water quality and that of their neighbors. Undoubtedly, many

would choose to farm differently, perhaps without so many commercial inputs, rather than risk the liability of degrading local water quality.

Agricultural production would probably slow under a polluter-pays model of water quality management. That would not suit the interests of agribusiness corporations, farmers caught up in a high-input-high-risk production process, or governments that support the agriculture industry. However, in the context of over-production, it seems rational to investigate such options as has now happened in several European states where a focus on the multi-functionality of agricultural areas has led to new rural development strategies.

The risks associated with agricultural practices and rural water quality can be reduced, however, farmers, corporate interests, and government officials must redirect their attention to longer-term goals that pose little or, at worst, manageable risks to the environment. Agricultural practices hold the potential for environmental consequences that may already be affecting the health of rural populations. Decision makers in government and industry should recognize this and provide farmers with the information they need in an easily accessible manner, for example, advertising on rural radio stations.

Efforts to influence farmers to implement BMPs and other more ecologically sound agricultural practice decisions must address present and future economic, institutional, organizational and social realities. Commercial industrial agriculture is here to stay. It has become essential to food production for urban populations. Under the capitalist mode of production, the present

system of commercial agriculture is as important as the protection of private property. This does not mean, however, that commercial agriculture must continue to potentially threaten water quality unchecked. The long-term sustainability of these present conditions requires a critical examination and understanding of how agricultural practices impact upon the environment so that food production can continue at increased levels in the future. A sustainable social ecology in agriculture calls for a long view of production and consumption requirements within productive social and natural environments.

Government can influence industry to protect the environment. All that seems to be needed is a political will. Incentives for farmers to protect water quality can be worked into virtually any legislation that applies to agriculture. An example would be a five-year program to subsidize farmers to establish buffer strips with trees around fields. After the subsidy program ends, the trees and buffer strips would help to preserve water quality long into the future.

The future of responsible agricultural practices rests upon research into what influences the behavior of farmers. In this regard, social research is an important component of the study of rural resource management because it adds social concerns, processes, and responsibility into what has traditionally been a cost-benefit analysis. Research designed to better understand the resource management decisions of farmers and the effects of these decisions on the environment should consider the complex interplay of economic, institutional, organizational, social and ecological influences on the dynamic agricultural practice decisions of farmers. Given accessible and thought

provoking information on their practices, farmers will respond to new information on agricultural practices and water quality in a variety of socially embedded, but nevertheless, creative and proactive ways (Parent:1996). Social scientists and policy makers should listen carefully to the multiple concerns of farmers because farmers can change their minds and their practices. Future social research needs to discover convincing arguments to engage farmers in environmental protection in which they recognize that water quality is in their best interests. A true social ecology of resource management includes farmers and their families in ecosystem management where farmers are allies for shared ecological restoration and preservation.

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Appendix

Map of Saskatchewan Rural Municipalities

Available on the Internet at the following address:

www.municipal.gov.sk.ca/mrd/pdfs/maprmbounds.pdf

Table 3.1 Community Profiles

RM or IR	1996 population	% change in pop. from 1991-1996	land base in km_	people/km_	average age	number of families	average # of people in family	% of pop with university education	% of people working in agriculture
Kelvington	668	-12	904	0.7	36	165	3.4	7.7	51
Wood	437	-10	837	0.5	37.6	120	3.2	12.3	40
Tullymet	331	-12	554	0.6	38.2	85	3.1	10	48
RM of Cote	687	-9.6	866	0.8	38.5	190	3	12.8	21
Spalding	681	-11	825	0.8	37.6	185	3.3	6.7	36
Yellow	429	-11	44	9.8	24.5	50	4.5	0	4
Cote IR	529	8.8	65	8.1	25.4	75	3.7	4.3	0
Okanese	135	19.5	57	2.4	22.6	22	4.3	0	0

Source: 1996 Statistics Canada Census Data

Table 3.1 Community Profiles

RM or IR	1996 population	% change in pop. from 1991-1996	land base in km_	people/km_	average age	number of families	average # of people in family	% of pop with university education	% of people working in agriculture
Kelvington	668	-12	904	0.7	36	165	3.4	7.7	51
Wood	437	-10	837	0.5	37.6	120	3.2	12.3	40
Tullymet	331	-12	554	0.6	38.2	85	3.1	10	48
RM of Cote	687	-9.6	866	0.8	38.5	190	3	12.8	21
Spalding	681	-11	825	0.8	37.6	185	3.3	6.7	36
Yellow	429	-11	44	9.8	24.5	50	4.5	0	4
Cote IR	529	8.8	65	8.1	25.4	75	3.7	4.3	0
Okanese	135	19.5	57	2.4	22.6	22	4.3	0	0

Source: 1996 Statistics Canada Census Data

Table 3.2 Farm Profiles

RM	Number of farms 1996	Total acreage	Average farm size in acres	% acreage owned	% acreage rented	% of farmland in crops	% of farmland in summerfallow	% of farmland in pasture
Kelvington	208	191, 712	922	62	38	60	9	18
Wood River	153	203,103	1327	63	37	61	30	7
Tullymet	147	140,728	957	69	31	59	20	12
Cote	187	177,637	950	52	48	68	6	18
Spalding	205	180,183	879	57	43	73	14	6

Source: 1996 Statistics Canada Census of Agriculture

Table 3.3 Best Management Practices in RMs

RM 1996	% of farmland seeded in 1995	% of land seeded with fertilizer	% of land seeded with herbicide	% of land seeded with insecticide	% of land seeded with fungicide	% of farms using manure fertilizer	% of farms with permanent grass cover	% of farms keeping stubble over winter	% of farms using strip cropping	% of farms with contour culivation	% of farms with grassed waterways	% of farms with windbreaks or shelterbelts	% of farms using no till before seeding
Kelvington	52	87	72	3	4	13	39	2	2	4	15	19	10
Wood River	60	61	77	2	3	12	18	0	54	13	13	15	18
Tullymet	58	77	82	18	4	22	15	1	1	7	5	11	19
Cote	63	88	87	6	7	7	28	2	2	9	19	19	5
Spalding	73	89	87	9	5	16	11	1	0.5	3	4	17	6

Source: 1996 Statistics Canada Census of Agriculture

Table 4.1 Characteristics of the Field Sample

Total number of farms (n)	Type of farm	Range of size in Hectares	Average land base in Hectares	Types of farm by commodities produced
30	24 family farms	16-2240	743	grain, oilseeds, beef, spices, fruit, bedding plants
	3 incorporated farms	4-1792	1862	grain, oilseeds, beef, pork, hog semen,
	3 Indian Reservations	4000-8064	6021	some beef, mainly cash rent for land to grow grain

Table 4.2 Characteristics of the Field Sample (2) n=30

Age of farmers	Number of Family Farms With More Than One Generation On the Same Farm	Number of Farmers With University Education	Number of Farms With an Off-farm Income	Number of Farms that Hire Off-farm Labor	Percentages of Debt to Assets
Range: 25-79 Average Age: 48	21	2	12	4	6 farms: 0 debt, 2: 5%, 3:10%, 2: 15%, 1: 20%, 3: 30%, 1: 40%, 2: 50%, and 10 farmers would not say

Appendix H

RM manager Interview request form

On the telephone, I mentioned a research project known as Agriculture Practices and Water Quality: The Social Ecology of Resource Management. The research is being funded by the Agri-Food Innovation Fund administered by the PFRA. I am using the data collected for my Masters thesis of the same name in the Sociology of Agriculture and Development at the College of Graduate Studies at the University of Saskatchewan. If you would like confirmation of this or to receive more information, you may contact my supervisor, Bernard Schissel on (306) 966-6924.

Sociology is the study of groups of people. As a rural sociologist, I am interested in farmers in general and in their resource management decisions in particular.

I am asking for your assistance in identifying approximately twenty farmers in your RM as potential participants in this study. I would like to speak with any farmers that are experiencing water quality problems including contaminated drinking water, alkaline or salinity problems, and/or problems associated with excessive runoff.

To help you make your suggestions, I would like to speak to several of each of the following types of farmers:

- Managers of large corporate grain farms
- Managers of intensive livestock operations
- Certified organic farmers
- Exotic animal farmers
- Farmers that have off farm employment
- Mixed grain/livestock farmers
- Farms that are managed by women and /or Aboriginal people
- Alternative living farms
- Local watershed association members

Thank you for your assistance.

Randall Kehrig

APPENDIX I **AGRICULTURE AND RESOURCE MANAGEMENT STUDY**
DEPARTMENT OF SOCIOLOGY
University of Saskatchewan

Case Study Consent form

You are being invited to participate in a research project conducted by Professor B. Schissel and Randall Kehrig, a graduate student in Sociology at the University of Saskatchewan. This study is called *Agricultural Practices and Water Quality: The Social Ecology of Resource Management*. Its main purpose is to examine resource management decisions of Saskatchewan farmers concerning water quality. This study gives you the opportunity to reflect upon your farm in various ways and to voice your opinions on a wide range of matters concerning your farm and the agriculture industry. The potential benefit of this study to society in general is better, more concise, information about prairie farms that will inform government policy designed to enhance and promote sustainable agriculture.

You are being invited to spend approximately twenty minutes today to fill out a short questionnaire and to answer resource management questions posed to you by the interviewer. You may be asked to review the material and to answer other questions in additional short interviews this summer. You will be asked for your name and your telephone number. This information will be held in confidence by the researcher. Your farm will be assigned a number for reference. Some of the questions are personal and we assure you that all answers will be kept strictly confidential. In no way can any connections be made between a particular individual and a particular question. You do not have to answer any question that you do not wish to.

After this study is completed, a summary of findings will be available upon request. If you have any questions or concerns about this study, you may call and leave a message at the Department of Sociology at 306-966-6924.

If anything changes in this part of the study, the researcher will let you know. If you have any questions about this form or this study please ask the researcher or telephone the Office of Research Services (306) 966-4053.

If you are willing to participate in the research project, please sign below and on the copy provided for your own records. You may withdraw at any time. Your participation is voluntary. After signing in, the researcher will proceed with the introductory questionnaire. The instructions are straightforward and should pose no problems. You are being asked to participate in at least one one-hour interview today and in no more than two more one-hour interviews between June 15 and September 15, 2000. Once again, thank you for your participation.

Date:
Participant name:

Participant's signature_____

_____
Randall Kehrig
Graduate Student, Dept. of Sociology
University of Saskatchewan

Thank you for your participation in this study.

Part One- Personal Profile Questions

1) What is your ethnic background?

2) How many generations has your family been in Canada?

3) How many generations has your family been on this farm?

4) How would you classify your farming operation?

5) What is your age?

6) What is your marital status?

7) How many children do you have?

8) Do you plan for your children to take over this farm after you retire?

9) To what clubs or organizations do members of your family belong?

10) What is the approximate debt to asset ratio of your farm?

11) What is your source of drinking water?

12) When was the last time that you had your drinking water tested?

13) What type of filter do you use for your drinking water?

Part Two – Best Management Practices

(As defined by questions from the 1996 Statistics Canada Census of Agriculture)

1) Total area of farm _____acres (_____hectares)
2) Area owned _____acres (_____hectares)
3) Total area rented or leased from others _____acres (_____hectares)
4) Area rented or leased from governments _____acres (_____hectares)
5) Area rented or leased from other sources _____acres (_____hectares)
6) Land in crops _____acres (_____hectares)
7) Summerfallow _____acres (_____hectares)
8) Tame or seeded pasture _____acres (_____hectares)
9) Natural land for pasture _____acres (_____hectares)
10) All other land _____acres (_____hectares)
11) Use of irrigation _____acres (_____hectares)
12) Use of commercial fertilizer _____acres (_____hectares)
13) Use of herbicides _____acres (_____hectares)
14) Use of Insecticides _____acres (_____hectares)
15) Use of Fungicides _____acres (_____hectares)
16) Manure application using a solid spreader _____acres (_____hectares)
17) Manure application using an irrigation system _____acres (_____hectares)
18) Manure application using a liquid spreader (on surface) _____acres (_____hectares)
19) Manure application using a liquid spreader (injected) _____acres (_____hectares)
20) Total land prepared for seeding _____acres (_____hectares)
21) Tillage incorporating most crop residue into soil _____acres (_____hectares)
22) Tillage incorporating most crop residue on the surface _____acres (_____hectares)
23) No tillage prior to seeding _____acres (_____hectares)
24) Weed control on summerfallow land, chemical only _____acres (_____hectares)
25) Weed control on summerfallow land, tillage only _____acres (_____hectares)
26) Weed control on summerfallow land, tillage and chemical combination _____acres (_____hectares)

Do you have any of the following:

27) Permanent grass cover_____
28) Winter cover crops for spring plow down_____
29) Contour cultivation_____
30) Strip cropping_____
31) Grassed waterways_____
32) Windbreaks or shelterbelts_____

Part Three- Farming Practices

1) How often do you test your soils and water?
2) Do you have soil erosion on your land? What do you do to combat it?
3) Do you have salinity problems on your land?
4) Are you concerned about water quality?
5) Are you affected by runoff from other farms?
6) Does runoff from your farm affect your neighbor's farms?
7) Do you base any water usage decisions on the potential impact downstream neighbors?
8) With livestock, do you test for excessive nitrates in livestock water or for possible contamination of your own water?
9) If you use chemicals, what do you do with the empty chemical jugs when you have finished with them?
10) Do you triple rinse and puncture chemical jugs before disposal?
11) What is your management strategy for wetlands on your property?

Table 4.1 RM 1 Farm Number 1

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
Family farm	cereal grain	720 (1800)	3	54, female, married	0	Would not say but indicated it was very high

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
rural pipeline	municipal chlorinatior	never	moderate	winter stubble, grassed waterways, strip cropping,	half acreage in summerfallow	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
Both husband and wife work full time on the farm. The farm is almost bankrupt with no access to credit. The farmers would like to switch to organic production but cannot afford the transition away from their present practices.	The farm's dire financial situation made the purchase of commercial fertilizer impossible this year. The farmers were able to purchase some herbicides. They almost lost their farm recently to the Farm Credit Corporation for default of loan payments.	Farm stress lines are ineffective in helping farmers. Only their religious faith and local church give them hope. She blames rural depopulation and the declining opportunities for young people in rural areas on large farms getting bigger as the smaller ones go broke.	Funds from an AIDA cheque recently saved their farm from bankruptcy. She finds that Ag. Income support payments are more beneficial to large farmers who do not need the support to survive. Although AIDA saved their farm from bankruptcy, she believes that government helps large farms more than the many struggling small family farms.	She doesn't like the use of pesticides because she thinks that rural drinking water quality is being jeopardized by them.

Table 4.2 RM 1 Farm Number 2

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
Family farm	cereal grains	448 (1120)	3	33, female, married	2	0%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
bottled water for drinking and rural pipeline to farm	municipal chlorinatior	never	moderate	winter stubble	half acreage in summerfallow, pesticide application next to local reservoir	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
The husabnd works full time on the farm and the wife works part time in a local office. The farmers have recently purchased an air seeder and are slowly moving towards adopting no till farming practices and continuously cropping.	The farmers use fungicides and insecticides when necessary to protect their investment into their crops. The farm is changing rotations to continuous production because the farmers think it makes economic sense to maximize production in this way.	This farm family has no plans to help their children take over the farm because they don't think it will provide a viable way of life in the future. The farmer thinks that her neighbors don't trust the quality of water from the pipeline because she does not herself.	The farmer asked Sask Water about water quality testing for mercury and pesticides in the local reservoir which serves two towns and three rural pipelines. She was told that the water was not tested because this kind of testing was too expensive.	The farmer pointed out that many local people suspect that the municipal water supply is contaminated by pesticides from a river that feeds the resevoir. However, ther is no data available to prove or disprove this perception.

Table 4.3 RM : Farm Number 3

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
Family farm	registered seed grain	1792 (4480)	2	50, female, married	4	20%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
municipal well hauled to their own cistern	none on farm	don't know as they leave this to the RM	low	winter stubble, strip cropping, windbreaks, some no till, preserved	one third acreage in summerfallow	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	**Economic**	**Social**	**Institutional**	
Both husband and wife work full time on the farm. One of their sons farms with them.	They add value to their grain production by cleaning and selling registered seed.	They pay custom applicators to apply their farm chemicals because she was worried about her husband's health. She told me that farming doesn't offer young people a promising future. The quality of life in rural communities is getting worse.	Government doesn't seem very interested in rural communities, she said. The roads are getting worse. Farm income support programs support large farmers who do not need the assistance to survive while smaller farmers do not qualitfy for assisstance and are forced out of business.	The trees along a nearby river have been removed by neighbors so that land can be farmed right up to the river. She is concerned that farm chemicals and fertilizer can now run right into the river. Also, a local stream used to support fish but no longer does. She attributes this to unstable fertilizer and farm chemicals on nearby fields washing into the stream and killing the fish.

Table 4.4 RM 1 Farm Number 4

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
Family farm	cereal grains and finished steers in feedlot	2240 (5600)	1	50, male, widowed	3	15%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
rural pipeline	municipal chlorination	never	moderate	no-till before seeding, chemical fallow, strip cropping	none	fair

Structural Factors Influencing Agricultural Practices				Water Quality
Organizational	Economic	Social	Institutional	Concerns
The farmer farms with his eldest son who will take over the farm one day. The feedlot is empty throughout the summer but he buys up to 600 head in the fall. The farmer buys cattle from other farmers and finishes them for slaughter. This is his way of staying productive in the winter. Nine of the 35 quarter sections he farms are rented from other farmers.	The farmer grows the feed for the cattle of the feedlot. The farmer is concerned with possible loss of productivity and economic losses coming from the extensive soil erosion that he has on his farm. For this reason he has switched to no till farming.	The farmer belongs to the Cattleman's Association and to the Wheat growers Association where he gets much of his information on agricultural practices.	The farmer follows Saskatchewan Agriculture and Food recommended practices regarding the disposal of farm chemical containers.	He drains some wetlands but also preserves others that he uses as hayfields in the summer.

Table 4.5 RM 1 Farm Number 5

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
Family farm	cereal grains	1000 (2500)	2	52, male, married	2	would not say

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPS identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
rural pipeline	municipal chlorinatior	never	high	uses an air seeder and is moving toward no till farming.	some summerfallow	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
This farmer has no plans for his children to take over the family farm. He is in the process of changing his farming practices to continous cropping to combat soil erosion and to increase earnings.	The farmer identified agrochemical usage as a necessary but unfortunate aspect of grain farming.	The farmer belongs to the Sask Wheat pool and the United Grain Growers Association.	He believes that health concerns of rural people should move governments to regulate farm chemical applications. The farmer is suffering from cancer as are several of his rural neighbors. He said that more research has to be done on the affects of pesticides on human health.	The farmer said that local water quality is suspect due to damage from development and agrochemicals. He said the water is not tested for pesticides or heavy metals like mercury and local people drink the water and eat the fish in it.

Table 4.6 RM 1 Farm Number 6

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cereal grains	1920 (4800)	1	49 , male, married	2	50%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
bottled water	rural pipeline to farm has municipal chlorination	never	high	winter stubble and strip cropping	drainage of some wetlands	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
Of a total of the 1920 hectares of the farm, 768 hectares are rented. They reduced their rented acreage last year to reduce operating costs. He would like to switch to organic farming to reduce his input costs but doesn't think he can afford the transition to organic production.	The farm fertilizer and chemical bill this year was in the six figure range for the first time. He says that his debt to asset ratio is really too high for comfort.	The farmer wants to help his children to take over the farm if they decide they want to.	The farmer doesn't think that government is focusing on helping farmers. He claims that even local government tries to avoid its responsibility to citizens by not guaranteeing the quality of water in rural pipelines.	This farmer believes that there are too many farms operating right next to a local river. He is convinced that the reservoir water that feeds the local rural pipeline is contaminated with nitrates from cattle manure and pesticides.

Table 4.7 RM 2 Farm Number 1

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cereal grains	480 (1200)	5	61, male, married	3	0%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
rural pipeline	municipal chlorinatior	never	moderate	reduced tillage on some fields	some summerfallow, plows down stubble before winter	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
The pending sale of this farm will represent the end of a family tradition of five generations on the same farm. The farmer said that he farmed as his own father did but that a small scale grain farm is no longer feasible. He used to keep cattle but sold them several years ago.	The size of the farm is not large enough to generate sufficient production at current market prices to sustain the farm operation into the long term. Rather than taking on more land and more risks of production, the farmer plans to sell the farm and retire.	The farmer will not be passing the farm on to his children because the land base is no longer large enough to generate sufficient income to sustain a household. He wishes a better life for his children.	The farmer was critical of all levels of government. In his opinion, natural resource management in rural areas should be done on a watershed basis with local authorities structured to protect water quality by mandating agriculture practice regulations specific to local regions.	The creek next to his house used to contain fish and run 12 months of the year but now only runs for six weeks in the spring. The local river smells like a sewer and the fish in it have lesions. He blames these conditions on agricultural practices and the destruction of local wetlands.

Table 4.8 RM 2 Farm Number 2

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family owned greenhouse	bedding plants	64 (160)	1	46, female, married	2	10%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
rural pipeline	municipal chlorinatior	never	moderate	retains wetlands	none	high

Structural Factors Influencing Agricultural Practices				Water Quality
Organizational	Economic	Social	Institutional	Concerns
The farmer's husband has fulltime employment off the farm. She has been running the greenhouse for six years. They have eight horses and four colts as pets in their pasture.	The decision to live in the country was originally a lifestyle decision for this couple; however, with the greenhouse, living in the country has become a business decision. Although she doesn't like to use agrochemicals at all, she finds that she sometimes must to protect the investment she has in her plants.	The farm couple are very active in organizations including the local Horse Club, the local Chamber of Commerce and the Greenhouse Growers Association. They hope that one of their children may one day take over the greenhouse. She believes that everyone living in the countryside should be concerned with the quality of their drinking water.	The farmer stated that the local rural pipeline water has made their greenhouse business viable and kept up the value of their property.	The farmer is concerned with how her neighbors' farming practices may affect local water quality and her greenhouse. She worries that neighboring farms applying agrochemicals or aerial spraying in the area may drift into her greenhouse and ruin her stock. She is concerned that manure from a local cattle rancher's cattle may contaminate the high water table in the area.

Table 4.9 RM 2 Farm Number 3

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cattle	560 (1400)	1	44, male, married	3	would not say

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
rural pipeline	municipal chlorination	never	moderate	winter stubble on feed field, fenced off waterways, retains wetlands	some summerfallow	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
Farmer purchased grain farm and converted it to pastures for rotational grazing of between 600 and 800 cattle annually. He makes use of local community pastures for summer grazing, seeds his own pastures, and utilizes extra wires on good fences to prevent lost time chasing escaped cattle. The farm raises calves that are grown to steers and sold to finishing yards in Alberta.	To keep operating costs low, the farmer keeps all labor requirements to his own family and farms with a minimum of equipment. The farm generated nearly one million dollars annually in sales during the previous year.	Everyone in the family is responsible for work on the farm.	The farmer believes that much of government advice on how to manage cattle production is well intentioned but wrong. He uses the example of how Sask Ag and Food advise farmers on when and how to pasture animals. He claims that their recommended practices are not as good as the methods he grew up with in Alberta.	The number one priority for cattle farmers is a safe water supply. He is concerned that neighbors upstream fence cattle in along streams while he fences them out. He is afraid that local use of anhydrous ammonia fertilizer is killing the soil and is an unstable nutrient that washes away too easily in heavy rains and may contaminate his cattle water supply.

Table 4.10 RM 2 Farm Number 4

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	Charlais cattle and certified organic cereal grains	640 (1600)	3	55, female married to male, 67	5	10%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
rural pipeline	municipal chlorinatior	never	moderate	grassed waterways protected from cattle, windbreaks, solid manure fertilization of fields, green manure	none	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
Organic farm without commercial fertilizer or chemicals. The cattle herd is registered as breeding stock.	Both organic grain certification and registered animals add value to the farm's production.	The farm couple hope that one of their sons will take over the farm. They spoke about the limited opportunities for youth in rural areas and lamented the fact that most of their children had to move away to secure a livelihood. This farm couple is very active in community organizations.	The farm wife identified a lack of institutional incentives for farmers to add value to their production as the reason that farmers continue to farm as they always have. Because of this, the farm income crisis continues and the health of the environment is jeopardized.	The use of agrochemicals and commercial fertilizers have increased the production of their neighbors but have affected the health of the local environment and have not solved the farm income crisis. Risks to water quality are the result.

Table 4.11 RM 2 Farm Number 5

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	grains, oilseeds and cattle	1300 (3250)	4	34, male, married	2	40%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
133 foot well	reverse osmosis	1995	moderate	winter stubble, grassed waterways, treed shelterbelts, no till	cattle in pasture are not fenced off from the river	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
Three family households live from this farm. The farmer interviewed farms with his father and uncle. They have crops and 300 head of cattle. Each year approximately 140 steers are sold to finishing feedlots in Alberta.	The farm is diversified with significant revenue streams coming in from both the crop and cattle operations. The debt load of the farmer interviewed is high but owed to his father and uncle who also farm with him.	This is a family farm that adopted agricultural strategies and practices designed to increase production to support three households of the same extended family.	The farmer hopes that the recommended practice of fencing cattle away from a river in his pasture does not become mandatory.	The farmer feels that his feedlot is a safe distance from the nearby river. He drains some wetlands but retains others. He leaves marginal land to natural habitat for wildlife in the area, which he says is thriving.

Table 4.12 RM 2 Farm Number 6

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
Indian reservation	grain land rented out, some cattle	8064 (20160)	Since 1874	land manager 47, male, married	2	0%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	chlorination water treatment plant	regularly	high	cattle fenced off from river, windbreaks	irresponsible use of agrochemicals by renters of land	high

Structural Factors Influencing Agricultural Practices				Water Quality
Organizational	Economic	Social	Institutional	Concerns
Treaty land is in-alienable meaning that it is held in trust by the federal government and cannot be borrowed against. This Indian reservation doesn't have the resources to purchase equipment to farm. Farmlands is rented out to off reserve farmers for $35 per acre annually.	Without the ability to secure farm credit, the Indian reservation is obliged to allow off reserve farmers to farm their land. Several residents of the reserve own a few cattle that live in the pasture. The band council would like the reserve to farm its own land and to change the farming to organic but cannot afford the loss in revenue from off reserve renters.	There are many social problems on the reserve. Hardly any of the reserve population is involved in agriculture even though it is the largest source of revenue to the reserve. The elders warn that the off reserve farmers are poisoning the land with agrochemicals.	The finances of the Indian reservation are in third party management. Changes to agriculture policy or income support payments to farmers seem to help off reserve farmers but not the reservation. A local dam affected the productive capacity of land both on and off reserve but only off reserve farmers were compensated.	There are restrictions on aerial spraying and on which agrochemicals can be used on the reserve. The use of agrochemicals is killing local trees and affecting the habitat and diets of local insects and birds.

Table 4.13 RM 3 Farm Number 1

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	certified organic grains	512 (1280)	3	45, male, married	3	0%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	none	many years ago	low	grassed waterways, treed shelter belts, habitat for wildlife on property, retains wetlands, green manure	none	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
Family farm with all members of the family at home working on the farm. They grow garden vegetables and poultry for their own consumption. Their fields are small and they follow a green manure regime for fertilization and to combat soil erosion.	As an organic farm with no debt, the operating costs of the farm are very low and the grain produced is sold for a good price compared to conventional crops.	The farmers belong to the Saskatchewan Organic Directory and the Wood Lot Association. They are planting trees for their children to harvest one day. They view their farm as a lifestyle choice and not just a business.	The farmers feel that conventional farmers are receiving income support to over produce grain at the expense of healthy rural environments. Government programs like AIDA make no sense to them. More support should be given to agriculture with growth potential like organic farming.	The farmer is worried that the pesticides used by his neighbors may one day affect his organic certification. He worries about chemical residues that travel in the air and through ditches neighboring his property.

Table 4.14 RM 3 Farm Number 2

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	goat milk, poultry and vegetables	16 (40)	1	25, male, common law	2	15%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
municipal water hauled on to property	reverse osmosis	not tested	high	compost pile for processing manure	well for livestock water is at lower elevation than animal pens and could easily be contaminated	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
Farmer is raising 23 goats, 9 ducks, 100 chickens, and 18 turkeys on a small parcel of land. He is trying to buy more land to grow adequate feed and to expand his grazing space. He grows vegetables in the winter in an indoor hydroponics garden. He has off farm, full time employment at a neighboring farm.	The farmer is just starting his farm with money received from an inheritance. He generates very little revenue. He has found that his hydroponics garden is costly to operate and he may stop doing it.	The farmer likes living in a rural community but admits that there are few options for employment. He tries to create his own income opportunities on the farm. He belongs to the Canadian Goat Breeders Association.	The farmer believes that government should be devising programs to encourage young farmers to start meat and vegetable farms to produce food to suit local and regional markets. Without government support for these types of farms, small farmers are too often forced off the land.	One corner of the farmer's land borders a provincial park where government planes sprayed for caterpillars this summer. He is concerned that aerial spraying of insecticides may contaminate his livestock's water.

Table 4.15 RM 3 Farm Number 3

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cereal grains, bison for breeding stock	640 (1600)	1	57, male, married	2	0%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	charcoal filter	never	low	retains wetlands	some summerfallow	low

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
This is a retirement farm for this couple. One of their children will probably take it over when they get too old to farm. The farm has crops and 170 bison that are raised for breeding stock. There are twenty wild boars on the farm that they raise for meat.	The farm has been built up over the years with no debt and is operated with minimal input costs to minimize risks. Agrochemicals and fertilizers are used sparingly. The farmer is unhappy that he has to hire help to care for the bison herd.	The farm belongs to the Canadian and American Bison Associations. The farm was meant to be a retirement farm but the farmer is surprised at how much work is involved.	The farmer stated that the bison industry in Saskatchewan is hampered by a lack of facilities for processing, inspecting and exporting bison meat.	The farmer stated that bison will drink almost any kind of water and that he doesn't worry about the drinking water for their household because it is far away from the animals.

Table 4.16 RM 3 Farm Number 4

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cereal grains and oilseeds	704 (1760)	4	26, male, common law	1	30%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	none	18 years ago	low	contour cultivation, grassed waterways, retains habitat and wetlands	some summerfallow	low

Structural Factors Influencing Agricultural Practices				Water Quality
Organizational	Economic	Social	Institutional	Concerns
The farmer has off-farm income in the oil patch during the winter. He said that the farm could not survive without it.	The farmer feels that his present land base is too small to generate enough revenue for the farm to exist without his off farm income. Given the small profit margins in oilseed and cereal grain production, he is considering renting out his land and getting a year round fulltime job.	The farmer's wife thinks that they should seriously consider organic production to keep costs down but the husband does not agree because he views it as a lifestyle and not a business decision.	The farmer has significant acreages of wetlands and natural habitat which he would like to either make productive or receive money for retaining it in a natural condition. He suggested that he would be encouraged to preserve it for a $10/acre subsidy.	The farmer's wife feels that agrochemical usage in the nearby countryside will one day contaminate their well and she worries about the health risks to her family.

Table 4.17 RM 3 Farm Number 5

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cattle, oilseeds and cereal grains	464 (1160)	2	34, male, common law	4	30%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
aerated dugout	inline charcoal filter	more than 9 years ago	low	some winter stubble, grassed waterways, treed shelterbelts	some summerfallow, drains wetlands, incinerates farm	low

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
The mixed grain/livestock operation keeps the farmer and his family busy year round. He said that he would like to be an organic farmer primarly for the better prices of commodities but can not afford the transition.	He uses his cattle production to subsidize his grain production. Due to the low prices of grain he is considering using his equity in grain producing land and equipment to secure credit to purchase more cattle.	As much of his farm is on a hillside, the farmer has been involved in disputes with several of his neighbors who have blamed him for causing both flooding and shortages of water downstream.	He stated that he has never earned very much in the 9 years that he has been farming so he doesn't qualify for income support programs based upon previous earnings. He believes a better income support package would be based upon acres owned.	This farmer thinks that genetic engineering of plants is good for production but has produced volunteer canola on his farm that require stronger agrochemicals to kill. The addition of more agrochemicals to fields bothers his conscience.

Table 4.18 RM 3 Farm Number 6

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
Indian reservation	rental of farmland for production of oilseeds and cereal grains	6000 (15000)	Treaty 4 since 1874	land manager 38, male, married	1	0%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
stream fed reservoir	chlorination water treatment plant	regularly	high	management of rented land left to off reserve renters	management of rented land left to off reserve renters	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	**Economic**	**Social**	**Institutional**	
This Indian reserve rents most of its land to off reserve farmers because it does not have the equipment or access to credit to manage input costs. There is some pasture land on the reserve and some reserve members grow their own vegetables or raise some livestock for their own use.	The revenue from renting farmland is the main source of income to the reserve. On reserve farming is mainly of a subsistence nature.	No one on the reserve is directly involved with the work involved on the land rented for crop production even though there is high unemployment on the reserve.	The reserve members feel powerless in determining how their land base is farmed due to provisions of the Indian Act restricting the use of Indian reserve land.	The water reservoir that feeds the water treatment plant receives sewage effluent twice per year from the a town 15 km upstream. After being treated, the water is safe to drink however is only consumed by those who can not afford to buy bottled water.

Table 4.19 RM 4 Farm Number 1

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family owned corporate ILO	20,000 hogs per year and cereal grains for feed	600 (1500)	4	32, male, married	3	would not say

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	chlorination and filtration	regularly	high	manure injection, winter stubble, shelterbelts, retains wetlands	none	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	**Economic**	**Social**	**Institutional**	
Family owned corporation structured to facilitate the intergenerational transfer of assets. The farm includes feed grain production that supplies an intensive livestock facility.	Water quality is important because it can influence the health of animals and their feed to weight ratios. For this reason, the water for the barns is treated with an expensive water treatment system. Manure from the barns is injected as fertilizer into the farm land.	The farmer's neighbors have complained to the RM administrator that this hog operation smells and that it is polluting the environment. Although the hog barn buys feed grain in the area at a premium, many local farmers choose to sell to the local elevator instead.	The farmer believes that the government has two responsibilities in the hog industry. The first is to insure that the science of monitoring hog barn facilities is done properly and the second is to effectively communicate this information to the public. The farmer feels that the government isn't doing either properly.	The farmer stated that his barns do not pollute local water quality. As a job creating industrial complex, he says that his barns are more environmentally friendly than other industries and gave the example of pollution from the Husky Oil Upgrader in Regina.

Table 4.20 RM 4 Farm Number 2

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cereal grains/spices	768 (1920)	1	53, male, married	4	50%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
municipal well hauled into above ground cistern	none	never	low	no summerfallow	drains wetlands, plows down stubble before winter.	low

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
This has been a family farm since 1969. Half of the land farmed is rented. Spice production has been an experiment in diversification for this farmer.	The farm carries an extremely high debt load. The farmer admits that this directs and restricts his decision making.	There are no plans to help the children take over the farm when the farmer retires. He doesn't see a bright future in rural Saskatchewan and thinks that his children should move away. He says that he farms differently because his children will not be taking over.	The farmer complained that government programs directed towards agricultural diversification are not followed up well. He has had to learn about changing his farming practices by himself. He is bitter that he pays taxes but feels that government does not really help family farmers.	This farmer is financially stressed and drains wetlands to maximize his tax expenditure. He admits having a moral problem doing this.

Table 4.21 RM4 Farm Number 3

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	certified organic cereal grains	940 (2400)	3	47, female, married	1	would not say

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
town water hauled to farm yard	chlorination treatment plant in town	didn't know	moderate	windbreaks, retain most wetland and natural habitat for wildlife, green	none	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	**Economic**	**Social**	**Institutional**	
More than one half of the land being farmed is rented from other farmers. All of it is certified organic.	The farm couple chose organic production because it has an element of value added right in the certification process. They have successfully sued a neighbor who hired an aerial spray plane that accidentally dropped agrochemicals on one of their certified organic fields.	The farmer believes that intensive livestock operations are the result of degraded opportunities for people living in rural areas. In the past, she said, most farmers had their own hogs and chickens but now most do not. They have either specialized and expanded or have had to leave farming. This family farm has no plans to pass the farm on to their only child.	The farmer feels that as government services such as health care and education leave rural areas, the few remaining people on the land use more agrochemicals on their fields, and grow more livestock in large climate controlled barns. She perceives that government inaction in rural areas contributes to intensifying agriculture and environmental pollution.	This farmer believes that ILOs cause air pollution. She believes that agrochemicals are building up in her neighbors' fields and may soon threaten local surface and groundwater supplies.

Table 4.22 RM 4 Farm Number 4

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	grain/fruit	240 (600)	3	47, male, married	1	0%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	none	never	low	no summerfallow	drains wetlands, removed treed shelterbelts	low

Structural Factors Influencing Agricultural Practices				Water Quality
Organizational	Economic	Social	Institutional	Concerns
The farmer has off-farm income in the oil fields of Alberta that sustains the farm household. The land is mostly rented out to another farmer on a crop share basis. The fruit orchard was planted recently in an attempt to diversify the farm income.	The farm is essentially a lifestyle farm that was inherited and is sustained by off farm income. Wetlands on the farm are drained and broken for crop production. The farm has been in continuous crop production for 10 years with each year producing an income.	There are no plans to pass the farm on to their child. The farmer is involved with some of the land practice decisions of the farmer who rents the land. He leaves the choice off what to grow and what agrochemicals to use to the farmer who rents.	The farmer indicated that he thought that PFRA programs to promote dugout construction were a good idea. He thinks that the programs lost popularity when Sask Water became involved and the participation costs to farmers increased.	The farmer believes that the current application rates of agrochemicals are affecting the quality of groundwater and that the damage will become apparent too late to fix it.

Table 4.23 RM 4 Farm Number 5

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cereal grains, oilseeds and beef	1200 (3000)	2	56, male, married	5	5%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	charcoal filter	15 years ago	low	manure for fertilizer, numerous treed shelterbelts	some drainage of wetlands, some summerfallow	low

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
This family farm generates revenue from both crop production and 80 cattle that are kept on 200 acres of seeded pasture.	The farm has a very low debt load, but is not large enough, in the farmer's opinion, to ensure a profitable future. The farmer says that he will sell the land and use the money for his retirement.	The farmer is approaching retirement and will sell the farm to provide he and his wife a retirement income. His children are not interested in taking over the farm.	The farmer is upset with government advice to diversify farm operations. His neighbor lost money raising emus. He asks " Diversify to what?"	The farmer is concerned with the water quality on his farm but he says that he won't be for long because he will soon sell the land, move away, and retire. Water quality, as this farmer points out, is relative to time and place.

Table 4.24 RM 4 Farm Number 6

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cereal grain	128 (320)	3	52, male, common law	4	5%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	none	1998	moderate	winter stubble, treed windbreaks	none	moderate

Structural Factors Influencing Agricultural Practices				Water Quality
Organizational	Economic	Social	Institutional	Concerns
This farmer has full time off farm employment. The land is rented to a farmer who continuously crops the land. The farmer allows his tenant to make resource management decisions.	The farm has a very low debt load. The only source of income is crop share rent.	The farmer wants to pass the farm on to his daughter. He belongs to the Canola Growers Association and the Pulse Crop Association.	The farmer believes that governments should conduct more research into the affects of agriculture practices on water quality.	The farmer noted that all the fish in a nearby lake died one year of dissolved oxygen depletion that he attributed to farm fertilizer in the water.

Table 4.25 RM 5 Farm Number 1

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
Indian Reservation	grain, oilseeds on rented land, beef	4000 (10000)	Since Treaty 4 in 187	chief, 54, female, married	3	0%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	chlorination plant	regularly	high	restrict aerial spraying, retain habitat and wetlands	none	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
The farm is divided into grazing pasture for 300 reserve owned cattle and 14 bison, natural habitat, and cropland that is rented to off reserve farmers.	Revenue from the cash rental of reserve land to off reserve farmers is the primary revenue for the Indian reservation. In the future, the chief of the Indian reservation would like to organize reserve residents to farm the land without agrochemicals.	There are 250 people living on this reserve but only four are actively involved with agriculture. Most of the young people are not interested in farming. The bison herd of 14 animals are raised for use in traditional ceremonies.	The reserve receives different levels of government support but must put a top priority on expenditures promoting human health. There is a need to invest in water delivery systems for increasing the livestock herds but the reserve must use the funds it has to promote human health.	The reserve has placed a moratorium on breaking land. As a community, the reserve places a high priority on preserving natural habitat and wildlife. They have leased some land to Ducks Unlimited to be used as habitat for water fowl.

Table 4.26 RM 5 Farm Number 2

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	cereal grains and oilseeds	400 (1000)	1	59, male, married	2	30%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	charcoal filter	1976	moderate	winter stubble, shelterbelts	some summerfallow	moderate

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
This family farm depends on the husband's off-farm income in an office. The family has lived on the farm for 25 years. One third of the land farmed is rented from other sources.	The farmer is starting to continuous crop some of the fields to earn more from the land.	There are no plans to turn the farm over to the children. When the farmer retires, the farm will be sold and the equity will be managed to provide the farm couple with a retirement income.	The farmer takes advantage of government programs that he is able to qualify for. He takes advantage of PFRA trees to use in shelterbelts that prevent wind erosion of his soil.	The farmer retains 100 acres of wetlands for habitat. He has some problems with beavers causing flooding on his land.

Table 4.27 RM 5 Farm Number 3

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
Family owned corporate farm	cereal grains, oilseeds and beef	1792 (4480)	4	75, 43 and 23 year old males, each married	5	would not say

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	gravel bed filter	one month before interview	high	manure fertilizer, no till farming, winter stubble, grassed water ways, cattle fenced off from dugout.	none	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
This family owned and operated grain/livestock farm employs 3 generations of the same family. The youngest farmer has off-farm income as a farm chemical applicator. The farm has 175 cattle. The corporate structure allows the farm ownership to be shared and transferred from one generation to the next.	The farm is mostly continuously cropped to maximize production. Manure from the cattle operation and from a local hog barn is used for fertilizer in the fields which helps to bring down the farm's commercial fertilizer costs.	This is an intergenerational farm that takes advantage of the knowledge of experience of the grandfather and the hard work and energy of his son and grandson.	This farm family follows the latest developments in agriculture as recommended by government agencies and tries those suitable for their farm. If they like the practices or technology, they make it part of their operation.	They drain very little of the wetlands on their property.

Table 4.28 RM 5 Farm Number 4

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	certified organic grains	66.4 (166)	4	79, male married to female, 75	4	0%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	none	10 years ago	low	windbreaks	some summerfallow	moderate

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
This farm has been in the same family for 4 generations. The farm provides an income supplement to the pensions of the elderly farm couple.	These farmers grow their own vegetables. Crop input costs are minimal.	The couple farm with their daughter and son in law who both have off farm employment in Regina. This is a retirement farm for an elderly couple.	The farmer believes that organic farmers require legal protection from the agrochemical applications of their neighbors. Although he has recourse with aerial spraying over his land, he is legally unprotected from field overspray from neighboring farms.	The farmer thinks that agrochemical usage is fundamentally dangerous to the production of food and water supplies.

Table 4.32 RM 5 Farm Number 5

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
corporate ILO	hog semen	4 (10)	none	farm manager- 32, female, single	0	did not know

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	permanganate filter, soon to be installed chlorination unit	every six months	high	manure is given to local farmers for injection into the soil.	none	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
Corporate owned artificial insemination stud farm with 100 boars in operation since 1995. There is one manager/operator on the farm.	The farm produces 200 liters of hog semen per week in units of 80ml for use in artificial insemination procedures in sow to farrow ILO hog barns. Recent water tests revealed high levels of bacteria, so a water treatment system was purchased and installed to safeguard the health of the animals.	The farm provides liquid hog manure to local farmers for use as fertilizer at no charge.	The farm benefits from government support of the hog industry and timely publicly funded research into artificial insemination.	Recent tests of the well water on the farm revealed high counts of coliform bacteria. This prompted the farm manager to purchase a chlorination system that will soon be installed.

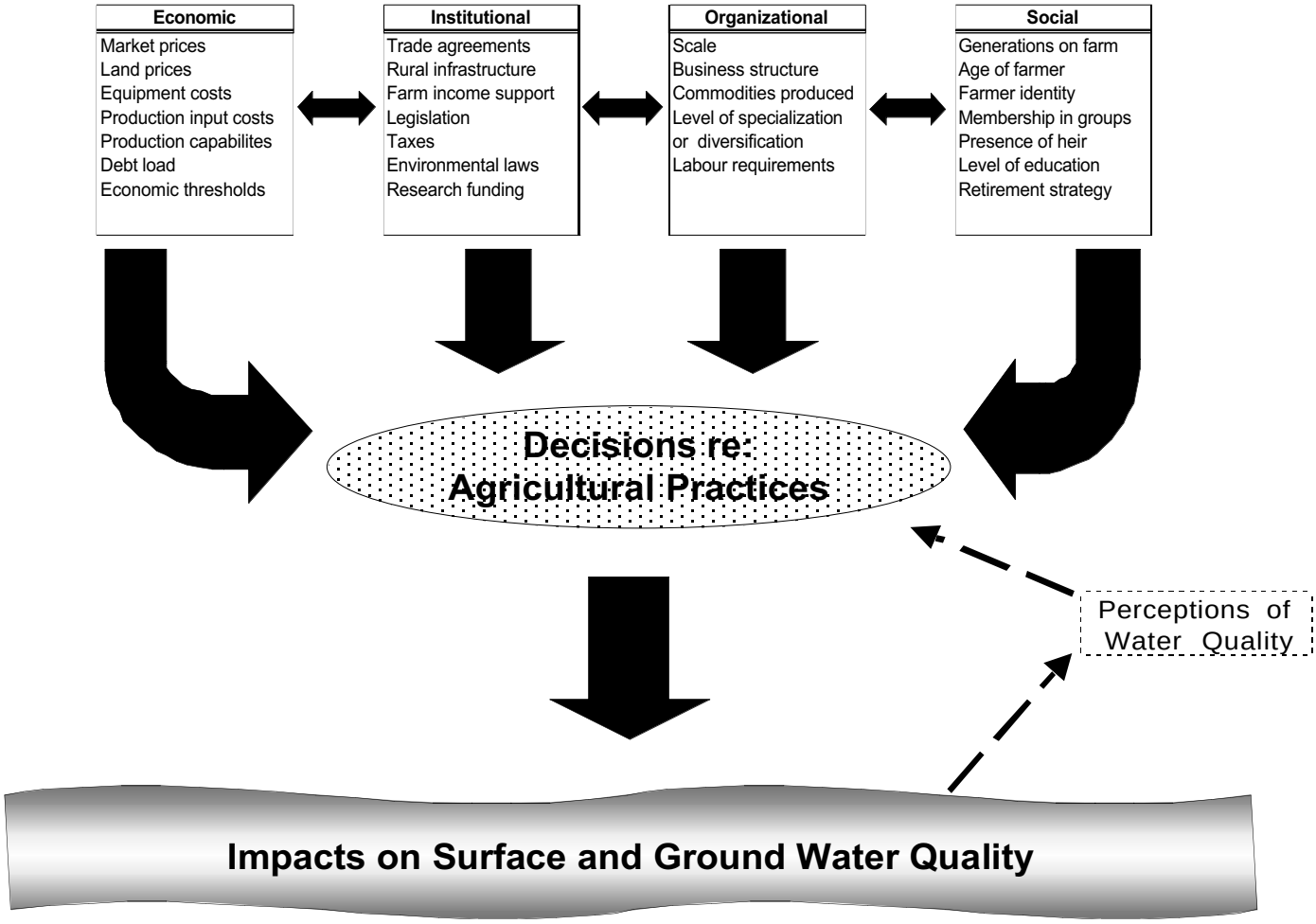
Table 4.30 RM5 Farm Number 6

Farm Description	Commodities produced	Size in Hectares (Acres)	Number of generations farm in family	Age, gender, and marital status of farmer respondent	No. of children	% of debt to value of farm assets
family farm	beef and cereal grains	584 (1460)	2	51, male, married	3	10%

Source of drinking water	Type of water treatment	Last time water tested	Awareness of own household water quality	BMPs identified	Potential resource management problems identified	Awareness of ag. practice affects on water quality
well	air injection sand filter	annually	high	direct seeding, cattle fenced off from low lying areas	none	high

Structural Factors Influencing Agricultural Practices				Water Quality Concerns
Organizational	Economic	Social	Institutional	
This cattle/grain farm is owned and farmed by two brothers. They keep 80 cattle and raise calves to sell for finishing before slaughter.	The farm has been continuously cropped since 1981. The farmer applies cattle manure to fields for fertilizer and grows all the feed they require for the cattle. The farmers use a PFRA pasture for their grazing requirements, preferring to keep all of their land in crop production.	The conditions of the environment are coming more dependent on markets than with people. The example he gave were ILOs that are built in spite of opposition from local communities.	The farmer felt that the government is more interested in corporate welfare than in helping rural people protect their livelihoods. He feels that government is far too bureaucratic to offer substantial solutions to the present agriculture price crisis.	The farmer has witnessed agrochemicals being drained from a sprayer onto a public road. He feels that people have to be better educated about agrochemical usage and how it can affect water quality and human health.

Figure 5.1 Influential Factors of Agricultural Practices Affecting Rural Water Quality



The Sociology of Agricultural Practices and Water Quality in Saskatchewan:

An Annotated Bibliography

By Randall Kehrig

Annotated Bibliography

This annotated bibliography contains brief summaries of the multidisciplinary material reviewed by the author while completing a Masters thesis on the sociology of agricultural practices and water quality. It is an extensive review, but by no means comprehensive. The material is divided into the three following sections: 1.Books and Chapters; 2.Journal and Periodical Articles; and 3.Research Reports, Government documents, and Miscellaneous Publications. Entries are listed alphabetically by author(s). Significant quotes are presented with page numbers from the original material.

1. Books and Book Chapters

Anderson, Glen, Ann E. De Bossu and Peter J. Kuch. 1990. "Control of Agricultural Pollution by Regulation" Pp. 63-101 in *Agriculture and Water Quality: International Perspectives* edited by Braden, John B. and Stephen B. Lovejoy. Boulder, Colorado: Lynne Rienner Publishers Inc.

These authors argue that several measures are universally accepted as excellent ways to reduce soil erosion and water quality degradation from farming practices. As populations in North America increasingly become urbanized and rural populations lose their political influence, water quality needs of urban populations will eventually force regulations on farming practices approaching European models. The article outlines some difficulties of establishing environmental water control and describes European examples to suggest changes to current practices.

One of the major problems of implementing environmental performance standards for farmers is that non-point water pollution is difficult to source. This makes monitoring difficult, and without direct solid data farmers are unwilling to change their practices especially if the new practice threatens the efficiency of their production. To improve water quality near intensive livestock operations, an impermeable waste storage facility where waste can be treated before release into the environment or removed is the preferred practice. To improve water quality near crops, buffer strips of vegetation or trees around fields helps to reduce soil erosion and preserve water quality by acting as a filter system.

In Europe, regulations controlling the potential pollution of drinking water have protected dense populations living around and near agriculture. In the Netherlands and in Germany, wells for drinking water are protected from agricultural discharges by mandatory buffer strips. In the first and second buffer strips surrounding wells, pesticides and fertilizers are prohibited. In the outer buffer strips, limited use of certain chemicals is allowed. In Germany, all agricultural spray equipment must be tested and approved by the federal government for safety of operation. In Sweden, aerial spraying of pesticides is banned, as are applications in ditches and along fences outside of fields. In many European countries, the sale and use of pesticides are highly regulated. Intensive animal operations are also regulated by the number of animals per operation and the distance away from other buildings. Storage of animal wastes from intensive livestock operations is highly regulated in the Netherlands, Denmark, France and Germany. Regulations apply to the spreading of animal wastes in Austria, Germany, Denmark, and Finland.

The chapter ends with a chart comparing the differences in water quality regulation of European countries.

Bailey, G. W. and T.E. Waddell. 1978. "Best Management Practices for Agriculture and Silviculure: An integrated Overview". Pp. 33- 56 in Best Management Practices For Agriculture and Silviculture, edited by Raymond C. Loehr, Douglas A. Haith, Michael F. Walter, and Colleen S. Martin. Ann Arbor, Michigan: Ann Arbor Science Publishers Inc.

Bailey and Waddell provide criteria for Best Management Practice (BMP) selection. The first step in identifying a possible BMP in a particular area is to conduct an environmental assessment to determine the extent of point and non-point pollution of rural water quality. If contamination is found, then possible Best Management Practices should be evaluated for agronomic and environmental effectiveness, economic feasibility, social acceptability, and the ability of institutional policy to promote the BMP.

Barr, Neil and John Cary. 1992. "The Dilemma of Conservation Farming: To Use or Not Use Chemicals" In Lawrence, G., F. Vanclay and B. Furze (Eds.). *Agriculture, Environment and Society: Contemporary issues for Australia*. Melbourne: MacMillan.

The authors caution that rigid chemical pest management strategies in agriculture are inherently unsustainable because nature is in a constant state of flexible adaptation and argue, "Inflexible commitment to any idea or ideology is the first step to unsustainability" (p. 255). To support their claim, Neil and Cary chronicle the development of chemical use in agriculture in Australia from the end of world War II to the present day and present an analysis of sustainable agriculture in general and of Integrated Pest Management (IPM) in particular.

Batie, Sandra S. 1986. "Why Soil Erosion: A Social Science Perspective". Pp. 3-14 in *Conserving Soil: Insights from Socio-economic Research*, edited by Stephen B. Lovejoy and Ted L. Napier. Ankent, Iowa: Soil Conservation Society of America:

The problem of soil erosion and degraded water quality is presented as a consequence of existing private property rights which exempt farmers from effective regulation of point and non-point pollution sources. Many farmers pride themselves on living close to nature and

they conduct their farming activities in accordance with sound environmental management techniques. Others do not and continue to pollute. As soil and water degradation will affect future generations, the author believes that property rights should be amended to allow strict regulation of private property farming practices for the public good instead of proposing voluntary conservation practices.

Braden, John B. and Stephen B. Lovejoy. 1990. "Overview" in *Agriculture and Water Quality: International Perspectives* edited by Braden, John B. and Stephen B. Lovejoy. Boulder, Colorado: Lynne Rienner Publishers Inc.

The main obstacles to pure water with agriculture practices are identified. The first is that every production system has by-products and agriculture is no exception. The second is that switching to more environmentally friendly processes requires either higher costs or less production both affecting the economic bottom line of the farming operation. Thirdly, solving one problem of a polluting source in agriculture may create other problems or unforeseeable consequences.

In terms of designing agriculture policy to ensure water quality, other considerations limit the effectiveness of policy. Inhibiting the effectiveness of policy are property rights of landowner and tenant farmers, the fact that water pollution from agriculture is difficult to source, that access to water contaminated by intensive farming practices is a relatively new phenomena, and that adequate information of water quality and the cost of treating it are difficult to project.

The authors argue that the main pollution in agriculture is not from large corporate farms but from many small family farm operations that have followed the advised farming practices of government. Many have also received income support making almost any policy or regulation on agricultural pollution politically sensitive.

Bultena, Gordon L. and Eric O. Hoiberg. 1986. "Sources of Information and Technical Assistance for Farmers in Controlling Soil Erosion". Pp. 71-82 in *Conserving Soil: Insights from Socio-economic Research*, edited by Stephen B. Lovejoy and Ted L. Napier. Ankent, Iowa: Soil Conservation Society of America.

This chapter examines the phenomena of no-till farming as an evolving technological process popular with farmers more for the efficiencies of scale that it enables rather than its conservation value. No-till farming has been an effective example of conservation policy that has been adopted by farmers for its economic benefits. Although the soil conservation benefits of no-till are of secondary or of no importance to

many farmers who adopt the practice, the result is desirable for conservation policy. Bultena and Hoiberg argue that lessons in conservation policy are most likely to be adopted when farmers perceive the primary benefit to be economic.

Burch, David, Roy Rickson and Ross Annels. 1992. "The Growth of Agribusiness: Environmental and Social Implications of Contract Farming." In Lawrence, G., F. Vanclay and B. Furze (Eds.). *Agriculture, Environment and Society: Contemporary issues for Australia*. Melbourne: MacMillan.

The sustainability of agriculture under the agribusiness model is questioned due to its effects on the environment and the social changes it has brought about in rural communities. The authors claim that agribusiness has changed the role of the farmer from one independent steward of the environment to polluting subordinate of international corporations. Sustainable agriculture under the agribusiness regime, they caution, may prove to be quite unsustainable in the long term. The authors find the current rhetoric of sustainable agriculture to be incompatible with agribusiness because the agribusiness model of farming includes intensive farming practices that degrade the environment, the work of people involved in food production, and their rural communities.

Buttel, Frederick H. 1982. "Agricultural Land Reform: Issues and Prospects". In *Land Reform, American Style* edited by Charles C. Geisler and Frank J. Popper. Motclair, N.J.: Allanheld, Osmun and Co.

Frederick Buttel analyses the differences in water policy that occur between different sizes of farms that operate under different structural conditions, and he concludes that successful policy must be cognizant of and accommodate, to some extent, a farm's economic situation.

Buttel argues that government is more concerned with the cheap food policy to control inflation in the larger economy than with adequate market price supports for farmers. As both family and corporate farmers experience higher input costs and lower prices for their produce, farmers look to increase their acreages to earn on volume of production what they previously earned on margin. The need for additional acreages of productive land is constant among large farmers, but land is in fixed supply. A high degree of risk when weather and pest conditions change from year to year and large capital investments for machinery that sits idle most of the year exacerbate the problem of relatively low profitability from agricultural investments.

Government programs including tax and commodity policies seem to have a larger positive impact on larger farms than smaller ones. This has given farmers the opinion that government is more behind large corporate farms than small farmers and rural communities.

Buttel, Frederick H. and Louis E. Swanson. 1986. "Soil and Water Conservation: A Farm Structural and Public Policy Context." Pp. 26-39 in *Conserving Soil: Insights from Socio-economic Research*, edited by Stephen B. Lovejoy and Ted L. Napier. Ankent, Iowa: Soil Conservation Society of America.

The authors assert that conservation policy should be merged with farm income support programs to reward farmers for effective management of natural resources rather than overproduction of commodities or acres under cultivation. They explain that the prolonged farm crisis brought on by rationalization of the agriculture industry does not create ideal conditions for conservation measures to be implemented. Their main point is that government conservation policy must often assume a lesser priority than policy designed to support rural farm incomes.

They explain that effective conservation policy should combine micro level farm analysis with a macro level analysis that examines the socio-political and economic environment in which these polices are to be implemented. The identification of contradictions between the micro and macro approach and the resolution of these contradictions would make rural land and water conservation policy more effective.

Farming has become a high volume, low profit margin business, with periods of price instability and high costs, which force farmers to have short term planning horizons. The high risk involved in farming leads farmers to discount long-term benefits of soil and water conservation. Farmers often use fertilizers and pesticides to reduce the effects of risks related to climate, insects and plant diseases, but these practices may degrade soil and water. Because soil and water degradation from farming often occur downstream and are not always visible to farmers on their land, a financial incentive to protect land and water quality must be created for farmers.

Chociolko, Christina and William Leiss. 1994. *Risk and Responsibility*. Montreal, Canada: McGill-Queen's University Press.

The book explores the many dimensions of risk assessment and responsibility for *risk*, which is described as "rooted in *the fear of falling victim unfairly to uncompensated loss"* (Italics in original). The authors suggest that long-term effects on human health are unknown to the

companies that manufacture and market agrochemicals as well as the government agencies that are supposed to safeguard public health.

Science is used to develop profitable uses of chemical compounds and for testing of harmful by- products. If accurate data for decision-making were available, these authors argue that interests of both profitable business and human health could perhaps be accommodated. They explain that four risk management approaches are used in Canada to determine risk levels. They are: Cost-Effectiveness analysis (CEA), Risk-Benefit Analysis (RBA), Benefit-Cost analysis (BCA); and Socio-Economic Impact Analysis (SEIA). Each of the above requires regular reliable data to be operationalized. The problem with analyzing the effects of water and soil conservation measures or even water quantity and quality is that there often is not sufficient data to make the analysis. The absence of data does not indicate that environmental problems do not exist. In the case of agricultural pesticides, the book uses the case history of the banning of daminozide by the US Environment Protection Agency (EPA) to illustrate that once approved for general use, it is the responsibility of the government agency to prove that the pesticide is unsafe and should be banned. Canada's practice of following the American EPA's lead is also highlighted. An important lesson from the case studies included in this book is that often an accumulation of chemicals occurs over time in soil, water, and in human tissue resulting in possible adverse human health effects many years later. The 'We didn't know' excuse may soon become more commonplace as a full generation of farmers using agrochemicals is now approaching retirement.

Coote D. R., E.M. MacDonald and R. DeHaan. 1978. "Relationships between Agricultural Land and Water Quality". Pp. 79-92 in Best Management Practices For Agriculture and Silviculture, edited by Raymond C. Loehr, Douglas A. Haith, Michael F. Walter, and Colleen S. Martin. Ann Arbor, Michigan: Ann Arbor Science Publishers Inc.

The timing of the application of agricultural pesticides and fertilizers determines how much enters ground and surface water. Contamination of water quality can be reduced by reducing commercial inputs, matching the quality, quantity and the timing of fertilizer applications with requirements of the plants and by providing barriers for surface runoff.

Dubgaard, Alex. 1990. "Programs to abate Nitrate and Pesticide Pollution in Danish Agriculture". Pp. 117-129 in *Agriculture and Water Quality: International Perspectives* edited by Braden, John B.

and Stephen B. Lovejoy. Boulder, Colorado: Lynne Rienner Publishers Inc.

In Denmark, several policies have been instigated to protect water quality in rural areas. These include restrictions on the drainage of wetlands, the banning of burning straw, regulations regarding the storage of manure, taxation of fertilizers and pesticides, government assistance to farmers switching from conventional to organic farming and the retirement of environmentally sensitive land.

Duncan, Colin A.M. 1996. The Centrality of Agriculture: *Between Humankind and the Rest of Nature*. Montreal, Quebec: McGill-Queen's University Press.

The central premise of this work is that the biosphere of planet earth is composed of complex biological systems and that human beings, as a species, are dependent upon the health of the biosphere for agricultural production to grow food. This relationship is presented as fundamentally more important than industrial production which produces waste and often threatens the reproductive capacity of the biosphere.

Duncan proposes an agriculture that not only acts as a monitoring agent of environmental health but that can also serve as a restoring mechanism to the natural productive processes of nature. The author's ultimate objective is to provide insights on how to manage the socio-economic developments in society that allow subordinating the needs of industry to those of ecologically sensitive agriculture. He outlines how this could be accomplished by restructuring governments and local production to 'bioregions' such as watershed areas, which could facilitate the most efficient use of water for populations, agriculture and industry.

In the interest of sustainable natural resource management, the state could assume the duties of regular environmental monitoring and maintenance within the bioregions including protection of the local water cycle, renewal of organic matter in the soil, re-forestation along riparian areas. Recognizing the earth as one large ecosystem with many interrelated bioregions each supported by plant and animal life all affected by human populations, Duncan argues that if humans do not manage ecosystems and bioregions, then ecosystems and bioregions will begin to determine limits to human development.

Commercial input agricultural practices are problematized as being developed for short-term benefits with little regard for long term affects to bioregions. No till farming with agrochemicals and antibiotics and steroids in intensive livestock operations are shown as examples affecting the productive ability of soil. The author questions the long-term effects of these industry and government promoted practices and

suggests that we do not know what the effects will be on local bioregions over time. Concern is expressed over the destruction of microorganisms and earthworms in the soil and the loss of birds and small animals in local habitats. Arguing that farming is more than an input-output industrial process, he insists that this driving philosophy in the industry must change so that agriculture can become a sustainable industry.

Ervin, David E. 1986. "Constraints to Practicing Soil Conservation: Land Tenure Relationships. Pp. 95-107 in *Conserving Soil: Insights from Socio-economic Research*, edited by Stephen B. Lovejoy and Ted L. Napier. Ankent, Iowa: Soil Conservation Society of America.

Land tenure relationships and conservation policy are analyzed, and it is found that farmers who own land and farmers who rent land utilize different land use practices. Owners tend to be more conscious of the long-term effects of their farming practices and are more likely to utilize conservation farming methods. As soil and water quality on rented land tends to become more degraded than land farmed by owners, policy should ensure that there are short-term economic incentives for renters to employ conservation policy.

Fletcher, Jerald J. and Wesley D. Seitz. 1986. "Information Needs for Conservation Decisions." ". Pp. 55- 70 in *Conserving Soil: Insights from Socio-economic Research*, edited by Stephen B. Lovejoy and Ted L. Napier. Ankent, Iowa: Soil Conservation Society of America.

The authors present ten information needs for effective conservation policy planning and implementation. They caution that if any of these points are ignored in policy formation, there is an increased likelihood that the policy designed to protect soil and water quality will be ineffective. Information that needs to be considered to create effective conservation policy include:

1. Economic cost-benefit analysis of alternative farming practices.
2. Estimates of how much productivity will be affected per farm if implemented.
3. Estimates of the economic impact of soil erosion in the watershed area in which the policy is applied.
4. The estimate of offsite costs of soil erosion and water quality degradation.
5. An understanding of how the effects of international trade affect farmers' soil conservation decisions.
6. An understanding of existing conservation policies and their alternatives.

7. Access to sources of information on conservation policies and their evaluation.
8. A range of possible future impact assessments on various conservation policies.
9. A feasibility assessment of technical, political, social, legal and economic implications of conservation policy.
10. A variability assessment of the conservation policy in practice in terms of range of possible outcomes with low variability being most desirable.

The complexity and uncertainty of the above points illustrate that conservation policy is at the best of times, a best guess scenario that requires constant re-evaluation. The main benefit of this list is to remind policy makers that their decisions have multi-dimensional implications and consequences.

Gertler, Michael E. 1999. "Sustainable Communities and Sustainable Agriculture on the Prairies." In *Community, Development, and Sustainability across Canada* edited by John T. Pierce and Ann Dale. Vancouver: UBC Press.

Michael Gertler argues that sustainable agriculture must include social as well as ecological diversity and that truly sustainable agriculture should begin with a recognition that farming is the process of growing food for ourselves or for the animals that we consume. In the past, there has been very little planning of the farm economy on the prairies; and Gertler explains that for sustainable agriculture to succeed on all levels in the future, comprehensive rural planning must occur.

Social and environmental consequences of economic decisions should be questioned in advance of policy implementation. Gertler argues that small profit margins and high pressure from the farm commodity marketplace are driving technological innovations that are not tested for their environmental or social impact.

The specialization of agricultural production trends of recent decades has transformed self-sustaining mixed grain and livestock family farms into market and government dependent single commodity producers. The popularity of government programs promoting the intensification of livestock operations at taxpayers expense is questioned on economic, ecological and ethical grounds. Precision farming and zero tillage practices are a means of perpetuating a high commercial input-farming regime under the guise of environmental protection when in fact; more chemicals are applied to soil than ever before.

Heffernan, William D. 1982. " Assumptions of the Adoption/Diffusion Model and soil conservation." Pp. 254-269 in *Future Agricultural Technology and Resource Conservation* edited by Burton C. English, James A. Maetzold, Brian R. Holding, and Earl O. Heady. Ames, Iowa: Iowa State University Press.

While optimistically believing that technology has the potential to maximize farm production and to promote sustainable water and soil conservation in rural areas, this chapter asks who will choose the technologies used and asks about the long-term effects of these choices on the environment.

The contrast between urban and rural populations' different notions of environment is outlined and conservation policy designed by urban people and implemented by rural populations is shown to often fall short of expectations due to unexamined or unexpected intervening variables. The need to provide the direction and resources that enable rural populations to choose environmental protection policies that directly affect themselves and their communities is emphasized. Better long term use of resources are probable if more information about the causes and effects of agriculture practices on water quality are obtained and distributed to farmers so that farmers can make informed decisions about farming methods.

Heffernan, William D. 1982. "Structure of Agriculture and Quality of Life in Rural Communities." In *Rural Society in the U.S.: Issues for the 1980s* edited by Don A. Dillman and Daryl J. Hobbs. Boulder, Colorado: Westview Press.

Heffernan investigates the structure of agriculture and the quality of life in rural communities and finds that they are affected by policy not intended for agriculture. While arguing that very little is known about the broad macro-social implications of agriculture policy because it has not been scientifically studied at length, Heffernan finds that numerous long-term studies have documented that as family farms become fewer and corporate farms develop, the quality of life in rural areas decreases.

Corporate farms are generally distinguished from family farms by the separation of capital, management and labor. In corporate type farm structures, the owners and managers are usually more involved in local community and political activities than their farm workers. Land that is owned is subject to more soil conservation based farming practices than rented land. Agriculture practices are becoming similar in different regions of the country. The notion of convergence in industrial society is applied to agricultural production everywhere in the U.S.

Jackson, Laura L. 1998. "Large-Scale Swine Production and Water Quality" Pp. 103- 119 in *Pigs, Profits and Rural Communities* edited by Kendall M. Thu and E. Paul Durrenberger. Albany NY: State University of New York Press.

Laura Jackson argues that economic valuation policy must not alone determine agriculture policy. Economic policy can be insufficient in analyzing environment and social consequences of production, and environmental policy applied to intensive hog farms should be designed on the principle that what we do not know may affect us the most.

Farmers are able to exceed their ecological limits by using technology and industrial processes designed to increase production. The by-products of this process can be negative impacts on rural environments including degraded water quality. Rather than the industry demonstrating environmental safety, the government, which also regulates and supports the industry, is the guarantor of environmental safety of intensive livestock facilities. Credibility issues become apparent especially when public data on water quality is sparse. In addition, water quality degradation takes place over time, may have multiple causes and is not always immediately evident from existing data. The term *nonpoint source pollution* (italics in original) is problematic as it shifts responsibility of water degradation to a vague nonentity. Jackson argues that the term should be replaced with the term "land use pollution", which would stigmatize farmers who do not follow sound environmental practices as land use polluters.

Improved technology and management techniques may be able to 'mitigate 'but not solve intensive hog barn waste problems. Excessive nutrients in ecosystems from hog barns can upset ecological balances with serious ecological and economic consequences. Intensive farming in the Netherlands is profiled, as is damage to the Gulf of Mexico at the mouth of the Mississippi River from hog barn discharges upstream.

Reliable and regular data is essential for policy formation and implementation over time. Nutrients in and out of ecosystems should be examined in policy formation for hog barns. Alternative livestock production models should be examined based on environmental sustainability and supported if they are more ecologically viable than intensive farms.

Kumm Karl-Ivar. 1990. "Incentive Policies in Sweden to Reduce Agricultural Water Pollution" Pp. 105-116 in *Agriculture and Water Quality: International Perspectives* edited by Braden, John B. and Stephen B. Lovejoy. Boulder, Colorado: Lynne Rienner Publishers Inc.

Several incentive policies from Sweden are discussed including a tax on farm fertilizer and pesticides, extension services to help with manure management and the subsidization of creating woodlots on cereal crop fields. The forestation subsidy approach was introduced in 1988 for land with a high risk of soil erosion and water degradation. The program encouraged farmers to plant spruce and birch trees but the results were disappointing as many farmers were unwilling to plant trees because doing so would jeopardize their income support for grain production. Financial incentives were insufficient for most farmers to start woodlots on their grain land. For successful programs, grain subsidies would have to be reduced or woodlot subsidies increased to provide higher financial incentives.

Lawrence, Geoffrey and Frank Vanclay. 1992. "Agricultural Production and Environmental Degradation in the Murray-Darling Basin." In Lawrence, G., F. Vanclay and B. Furze (Eds.). *Agriculture, Environment and Society: Contemporary issues for Australia.* Melbourne: MacMillan.

The paper is a discussion of conservation efforts employed by government agencies to induce farmers to adopt soil and water conservation practices in the Murray-Darling Basin in Australia. The authors found that farmers' ability to undertake environmentally sound practices is often limited by structural conditions in which farming takes place. In this particular instance, conservation efforts are in direct opposition of other government programs designed to increase food production in the area. These government programs provide no incentive for farmers to follow through on conservation efforts.

Libby, Lawrence W, and William G. Boggess. 1990. "Agriculture and Water Quality: Where We Are and Why" Pp. 9-37 in *Agriculture and Water Quality: International Perspectives* edited by Braden, John B. and Stephen B. Lovejoy. Boulder, Colorado: Lynne Rienner Publishers Inc.

Although water quality and water quantity are different concepts, these authors argue that they are fundamentally linked because water quality is often a function of water quantity and both are part of the larger problem of water allocation.

"Water is a primary pollutant delivery and transport medium" (p. 11); the agriculture production process generates manure, fertilizers, pesticides, and soil particles that can degrade both ground and surface water on site and downstream. Water degraded from agriculture

production processes may contain excessive nutrients that feed algae blooms, which deprive fish of oxygen. The EPA estimates that an average of 1.8 million fish are killed annually in the US from pesticides, excessive nutrients or livestock effluents. Of this total, it is estimated that 1.2 million fish annually are killed from pesticide exposure alone. Pesticide detection in water supplies is expensive. Although there is some public concern with the effects of pesticide exposure in drinking water to human health, there have not been any studies that attribute large-scale human health problems with pesticides in drinking water supplies. It has been impossible to identify the problem(s) for drinking water that may exist because of pesticide use because appropriate data is not available. The data that does exist does not always identify the source of non-point pollution. Enforcement of regulations on agriculture water pollution, therefore, is difficult, expensive, and impractical. The alternative to regulation is incentives to farmers to voluntarily reduce agricultural pollutants by changing farming practices. However, these measures often involve a reduction in output that is unacceptable to many farmers concerned with economic survival or maximizing profits.

A possible solution known as 'acquisition' is to use public funds to purchase farmland from farmers where there is a high risk of water contamination from agriculture practices and lease it to the same or other farmers under strict land use policies. There seems to be a need of more education of the affects of farming practices on water quality. Often the results of farming practices become evident downstream and are not obvious to farmers. On the topic of policy, the authors conclude, "In the final analysis, good policy is acceptable policy, and standards of acceptability vary with demographics, problem urgency, information, and even the persuasiveness of a few individuals". " All policy prescriptions are value based, implying who should pay, whose options are expanded, and whose options are confined to achieve observable change" (p. 28).

Biotechnology through genetic engineering offers possible solutions to achieving the same or better yields in crops and intensive livestock operations with less externalities or water pollution. Forecasting models that deal with possible environmental and social impact assessments should be included with economic forecasting models so that policy makers have the complete information they need when designing water policy. In terms of relevant information for water policy:

> Serious knowledge gaps exist in at least four key areas. First, our ability to detect and measure chemical concentrations far exceeds our understanding of their significance. Second, the effects of low-dose, extended exposure toxicities are very difficult to evaluate, particularly when the resultant health problems are characterized by long latency periods. Third, the toxicities of mixtures of chemicals and the synergistic effects of combined chemical

exposures greatly complicate evaluation of the potential health impacts. Finally, information is scarce on the cost and efficacy of alternative control strategies, particularly given the site-specific nature of many contamination problems. (p. 30)

The biggest challenge of water policy of the future is how to value human life or human health because when either are affected, the cost to fix the pollution may be great to productive processes. The challenge for policy makers "is to find cost-effective ways of assessing water quality supply relationships in order to determine cost/benefit trade-offs and to prioritise water quality solutions" (p. 31); and policy makers must be cognizant that "A water quality standard imposed on all users evenly imposes very different impacts on different users" (p. 34).

Martin, Peter, Shane Tarr and Stewart Lockie. 1992. "Participatory Environmental Management in New South Wales: Policy and Practice." In Lawrence, G., F. Vanclay and B. Furze (Eds.*). Agriculture, Environment and Society: Contemporary issues for Australia*. Melbourne: MacMillan.

A government 1986 conservation initiative known as Total Catchment Management (TCM) is analyzed for its effectiveness in watershed management. The focus of the program is participatory, integrated resource management with legislation promoting local regional committees in which farmers can meet with representatives of government agencies. Initial results have been mixed as local farmers and other rural residents report that their views are often ignored and that government representatives have a tendency to preach conservation policy at local meetings. Farmers who note the contradictions of government policies that promote conservation and those that promote increased agricultural production have been frustrated. Local participation in the TCM groups, therefore, is a consultation process where expert knowledge possessed by the government dominates local knowledge of rural land users. While there is rural appreciation for a forum to express their views on government policy, a partial redistribution of resources to the grassroots level is needed before the TCM program can be more effective.

Miranowski, John A. 1986. "Macroeconomics of Soil Conservation." Pp. 15-25 in *Conserving Soil: Insights from Socio-economic Research*, edited by Stephen B. Lovejoy and Ted L. Napier. Ankent, Iowa: Soil Conservation Society of America.

The affects of macro-economic factors on the adoption of conservation farming practices such as no-till farming in the USA are discussed. Forces such as export demand, real interest rates, and commodity prices for farm produce often seem to override conservation farming policy. Cost-of-sharing, or government subsidies to encourage changing farm practices, are observed as working only when the returns of the farmer's investment exceed the farmer's cost of participation in implementing the policy. Miranowski recommends that future conservation policy should use technological advances to reduce the cost of conservation practices and therefore make recommended practices more attractive to farmers.

Nielson, James. 1986. "Interorganizational Relations in Conservation Targeting Programs." Pp. 40-51 in *Conserving Soil: Insights from Socio-economic Research*, edited by Stephen B. Lovejoy and Ted L. Napier. Ankent, Iowa: Soil Conservation Society of America.

Nielson analyses a framework for different levels of US governments and local groups to work together in targeting conservation farm policy. He observes that the most effective organizations have local, state and federal support in terms of funding and human resources. When local groups contribute more funding, they have more voice in the program, and participants become more involved in implementing local conservation policy. Federal contributions in terms of providing an overall framework with information and some financial support for local and state empowerment seem to be the most effective in terms of conservation policy adoption.

Nassauer, Joan Iverson. 1997. "Agricultural Landscapes in Harmony with Nature". Pp. 59- 90 in *Visions of American Agriculture* edited by William Lockeretz. Ames, Iowa: Iowa State University Press.

Nassauer argues that for agriculture and human populations to be sustainable, harmony with nature should be pursued instead of mastery over it. Although science has given us many ways to examine and manipulate nature, it does not give us permission for wholesale experimentation on the environment with intensive agriculture practices.

Agriculture and its effects should be regarded as components of ecosystems along with soil, water, and energy conversion. If farmers are unaware or uninterested in their environment, the first business of policy is to educate the farmer that their long term economic and ecological sustainability may be directly related to the farming practices they employ. Policy designed to preserve water quality should appeal to

a farmer's sense of responsibility for their environment and the effects of their agriculture practices upon it.

The chapter encourages planting trees for shelter belts and riparian areas and farming not only for conserving soil and water quality but also to create beautiful rural environments that will appeal to urban tourists and swing public opinion to support ecologically friendly rural development.

Powell, Douglas and William Leiss. 1997. *Mad Cows and Mother's Milk: The Perils of Poor Risk Communication*. Montreal, Canada: McGill-Queen's University Press.

Numerous case studies involving the communication of the nature and consequences of environmental and health risks are presented to illustrate the complications of public risk assessment and communication. The main premise is that accurate information presented in a timely manner is the most effective way to acknowledge, control, and manage public risk. Prompt and effective transfer of information is rarely done and the results of withholding scientific inquiry from the public can be disastrous to government and industry.

The book concludes with ten lessons for effective risk communication practices in policy. They are (1) that the social amplification of risk occurs when information is unavailable or not presented to the public. (2) The government organizations that are responsible for regulation should be the organizations primarily responsible for initial risk communication to the public, however (3) industry is equally responsible for effective risk communication related to their products and services. (4) The organization responsible for the public risk should act early and often to inform the public. (5) Organizations should provide both ample point of sale information on risk of using their products and telephone numbers or Internet addresses for further information so that they are perceived to be hiding nothing. (6) Risk assessment strategies should include the latest relevant scientific information available and forthcoming. (7) Good risk communication practice does not blind the public with science. Communication should be straightforward and in easy to understand language. (8) Messages or communications that state there are "no risks" should never be used because of public distrust of previous false government and industry claims of safety. (9) Risk messages from responsible organizations should take an active role in engaging public debate on the risk at hand. (10) Good risk communication enables the smoother resolution of risk management. These lessons could be significant to water policy especially when water quality has been compromised due to agricultural practices.

Reichelderfer, Katherine H. 1990. "National Agro-environmental Incentives Programs: The U.S. Experience" Pp. 131-145 in *Agriculture and Water Quality: International Perspectives* edited by Braden, John B. and Stephen B. Lovejoy. Boulder, Colorado: Lynne Rienner Publishers Inc.

Reichelderfer explains that the success of environmentally friendly policy initiatives designed to protect soil erosion is determined largely by macroeconomic factors like interest and exchange rates that influence farmer behaviour. Soil conservation measures require time to be effective and often structural conditions like interest rates change the perceived value of environmentally friendly policy. If the benefits are variable over time, then the long-term success of the policy will also vary.

Reichelderfer outlines three main reasons that soil conservation policy in the U.S. fails. Fixed incentive programs are undervalued by changes to macro-economic conditions, programs have not been targeted to areas requiring the most attention, and commodity production incentive policies often override conservation policy by providing more attractive benefits.

Ring, Chester A. III. 1977. "The Water Supply Industry and Source Protection". Pp. 63- 89 in *Drinking Water Quality Enhancement through Source Protection* edited by Robert B. Pojasek. Ann Arbor, Michigan: Ann Arbor Science Publishers Inc.

Chester examines watershed management in early 1970's New England watersheds from a variety of perspectives including nonpoint pollution from agriculture practices. Although the ultimate goal of watershed management is to protect water quality by promoting best management practices throughout the watershed, the goal is observed as impractical if not unattainable. A process which combines policy promoting water quality protection along with adequate water treatment facilities for rural communities or individual households, is shown to hold the only real long-term promise for safe drinking water for rural residents

Rowe, Stan. 1990. *Home Place: Essays on Ecology*. Edmonton, Alberta: NeWest Publishers Ltd.

Rowe presents a collection of essays that demonstrates world-views and attitudes shaping uses of land. Human attitudes on commercial production of farmland have threatened the sustainability of future

production but may also one day threaten the human place in the ecosystem. Rowe argues that "Economic goals subvert conservation" as natural ecosystems are destroyed to make way for industrialized agricultural production.

Rowe suggests that agriculture practices be regarded as impinging directly upon the human environment. The challenge for ecology is to make humans understand that what they do to their environment, they do to themselves. He is cautiously optimistic and quotes John Crosby: "Ten years ago, we didn't know about environment, but now it's all around us".

Savory, Allan and Jody Butterfield. 1999. *Holistic Management: A New Framework for Decision Making*. Washington, DC: Island Press.

This book presents a framework for decision-making that strives for ecologically and socially sustainable agriculture. The main premise is that agriculture has vast potential for both development and destruction. The way to safe guard against destructive agriculture practices is to examine all alternatives in a holistic fashion considering not only local and global ecosystems, but water, mineral and energy cycles and possible effects to human populations.

The authors describe possible entry points for analysis but insist that the processes of analysis are interconnected and impossible to separate in a holistic analysis of agriculture practices. Explaining that "we could never manage a piece of land in isolation from the people who work it or the economy in which both the people and the land are enmeshed" (p. 15), two entry points are nevertheless outlined. A possible entry point of analysis is to determine where an environment is in a continuum from brittle to non-brittle meaning availability of water to plants, animals and soils. The animals and plants that occur naturally in the environment and those that are there now must be considered. A second entry point of analysis in a holistic evaluation of agriculture practices is an examination of the nature of the human population that exists within the environment in question.

The author problematizes Best Management Practices by showing them damaging ecosystems and the social fabric of rural communities. The use of pesticides and liquid nitrogen can be harmful to beneficial organisms in the soil and long-term data does not exist to suggest what will happen after years of Best Management Practices. The authors explain:

> Perpetual monocultures, inadequate rotations of monocultures, chemical treatments, and heavy machinery have become standard practice, but have so simplified soil communities and structure that, like a junky's worn-out body, the land demands

even harsher stimulation to produce the same high. (Savory, Allan and Butterfield)

It is important to remember that most biological activity in ecosystems occurs underground. The author cautions that we could be unknowingly poisoning the reproductive capacity of the land by using Best Management Practices that promote heavy use of agrochemicals and are supported by industry and government. Farmers who work and live off the land are forced into high commercial input regimes that contribute to the economic instability of farm families by increasing risk of returns. It is important to remember that plants, animals, minerals, water and humans in ecosystems are always in a state of constant and often dynamic change.

Savoy and Butterfield identify seven basic steps in holistic policy formation and analysis. They are as follows:

1. Identify the cause of the problem the policy seeks to address.
2. Loosely define the whole the policy encompasses
3. Form a holistic goal or identify the conditions that would exist if the problem did not.
4. Identify the actions proposed in the policy.
5. Test each of the actions identified to see if they would lead to achieving the holistic goal.
6. Modify the policy if necessary
7. Determine what criteria to monitor to ensure that the revised policy, once implemented, will be successful. (Savoy, Allan and Butterfield)

As the main production method of food for society, sustainable agriculture is a fundamental necessity for social stability. The authors predict that in time more people will recognize that sustainable agriculture is synonymous with sustainable society.

The importance of holistic management of agriculture is illustrated with the example of how eroded soil from farming and silt in irrigation canals were contributing factors in the disability of the ancient Mesopotamian civilization to grow enough food: "The demise of the Mayan civilization in the jungles of Central America was largely due to silt from de-forested catchments that filled the channels draining the marshes in which their raised-bed crops were grown" (p. 426).

Schmidt, Kenneth D. 1977. "Protection of Ground Water from Nonpoint Sources of Pollution" Pp. 257-273 in *Drinking Water Quality Enhancement Through Source Protection* edited by Robert B. Pojasek. Ann Arbor, Michigan: Ann Arbor Science Publishers Inc.

Schmidt explains that the long term monitoring of water quality is obviously a necessity of water quality policy but is rarely done because there are few short-term benefits. The public should be told about the quality of their water in an easy to understand way so that eventually political support for regular water quality testing can be achieved. The information should be presented in a forum where interdisciplinary teams of scientists can access the information, manipulate it and communicate the results of their research with other scientists and the public. The chapter is especially hard on hydrologists who have failed to establish these types of interdisciplinary forums.

Segerson, Kathleen. 1990. "Incentive Policies for Control of Agricultural Water Pollution" Pp. 39-61 in *Agriculture and Water Quality: International Perspectives* edited by Braden, John B. and Stephen B. Lovejoy. Boulder, Colorado: Lynne Rienner Publishers Inc.

Segerson explains that the goal of agriculture policy dealing with pollution causing water degradation is to reduce externalities without affecting production. Incentives and regulations, or 'carrot and stick' approaches of water policy are discussed. Best Management Practices (BMPs), which are designed to minimize soil erosion, also preserve water quality. Sometimes policy offers farmers financial incentives to change their farming practices over to the BMP model. However, the bulk of the cost as well as the risk in changing a productive process for an unknown are on the farmer. There is no 'first best' policy option to reduce point and non-point pollution from agriculture. The chapter concludes with a water quality package of policies that includes three parts:

> (1) A set of input taxes designed to reduce pesticides and fertilizer use and raise revenue; (2) mandatory regulation of soil erosion targeted toward water quality, which could be couple with cost-sharing provisions financed by the input taxes; and (3) regulation of pesticide and fertilizer use and explicit (possibly partial) farmer liability for remaining ground-water contamination, with the possibility of purchasing pollution liability insurance. (Segerson)

Obviously, the author sees little benefit for incentive programs alone in reducing the causes of water degradation.

Swanson, Louis E., Silvana M. Camboni, and Ted Napier. 1986. "Barriers to adoption of soil Conservation Practices on Farms". Pp. 108-118 in *Conserving Soil: Insights from Socio-economic Research*, edited by Stephen B. Lovejoy and Ted L. Napier. Ankent, Iowa: Soil Conservation Society of America.

Macroeconomic factors such as agricultural policies and programs designed to maximize farm production affect farmer decisions to adopt conservation based farming methods. Because the same agency will often promote contradictory practices, the authors conclude: "The relative ineffectiveness of past programs to resolve the soil erosion problem may be, in part, a function of the inattentiveness to structural constraints" (p. 118).

Swanson, Louis E., Silvana M. Camboni, and Ted Napier. 1986. "Integration of
Social and Physical Analysis: The Potential for Micro-targeting". Pp. 121- 132 in *Conserving Soil: Insights from Socio-economic Research*, edited by Stephen B. Lovejoy and Ted L. Napier. Ankent, Iowa: Soil Conservation Society of America.

The authors point out that a weakness of environmentally friendly policy research is the lack of sufficient data to link soil erosion and water degradation to the source and to specific socio-economic conditions within watersheds. This condition may be remedied by analysis of specific sites that are representative of the watershed using an integrated hydrologic response simulation model with socio-economic analysis. Identifying soil types, popular farm practices, local typography and conditions of the local economy and population allow for construction of models that can be compared and contrasted.

Uri, Noel D. 1990. *Agriculture and the Environment*. Commack, New York NY: Nova Science Publishers.

Uri explains that the use of agricultural chemicals and soil and water degradation are becoming environmental hazards with a public recognition on a par with air pollution and pollution from industry. Despite concerns, there are many unknowns about the effects of degraded water on human health as well as other organisms in the environment.

The ability to effectively manage natural resources for agricultural production requires adequate data (that often does not exist), a coherent presentation of the data and an analytical framework upon which to act on it. More data on the three main causes of water quality impairment in the United States, which are sedimentation, eutrophication and pesticide contamination, are required.

Although taxes on commercial inputs do not seem to reduce the use of agrochemicals and fertilizers, they do raise revenues that can be used to clean up pollution. Biopesticides may provide better pesticides that do not degrade water quality, but farmers will only adopt these innovations if it makes economic sense to do so. Soil erosion and water degradation

affect the water of society and have recently become the focus of cross-compliance legislation in the US.
Uri provides the example of the Food Security Act of 1985, which ties eligibility to farm aid programs to conservation farming practices. The estimated cost of soil erosion to the USD in 1997 is estimated at $29,700,000,000. Although the appropriate use of conservation practices may reduce this figure, there are limiting factors that restrict their adoption. These include "a lack of information, a high opportunity cost associated with obtaining information, complexity of the production system, a short planning horizon, inadequate management skills, and a limited, inaccessible, or unavailable support system".

Although the increased requirements of fertilizer and pesticide application are identified as potential water quality contaminants of recommended no-till farming practices, Uri explains that we do not have the data to accurately make this assessment.

Unger, D. G. 1978. "Improving Water Quality in Agriculture and Silviculture". Pp. 11- 16 in Best Management Practices For Agriculture and Silviculture, edited by Raymond C. Loehr, Douglas A. Haith, Michael F. Walter, and Colleen S. Martin. Ann Arbor, Michigan: Ann Arbor Science Publishers Inc.

According to the Assistant Secretary of Agriculture in the US, rural water quality management rests upon 4 principles which are (1) a voluntary approach in which farmers are given (2) financial incentives within (3) an integrated local and national government policy framework that recognizes (4) that other agricultural programs affect water quality. Unger suggests that more research and monitoring of water quality are essential for water quality policy. Without hard scientific data, policy attempting to positively influence water quality is guesswork.

Vanclay, F. 1992. "The Social Context of Farmers' Adoption of Environmentally Sound Farming Practices." In Lawrence, G., F. Vanclay and B. Furze (Eds.). *Agriculture, Environment and Society: Contemporary issues for Australia*. Melbourne: MacMillan.

This work emphasizes that land and water quality degradation is not a technical problem but a social one influenced by structural conditions created by the economy and supported by the state. By blaming farmers for environmental degradation based on their farming practices, governments shift blame for rural pollution from the structural conditions they create or support on to individual farmers.

As land and water conservation is a long-term process, often the results are not visible within the short time periods in which democratically elected governments exist. Often, conservation efforts by one government are abandoned by the next administration leaving farmers to wonder if they should voluntarily change their practices at all. Much of the pollution generated by farmers is off-site and difficult to determine in short periods.

Vanclay suggests that farmers are conscientious stewards of their environments. However, their acceptance or rejection of government initiated conservation measures has more to do with structural conditions surrounding agriculture instead of their own psychological dispositions.

Van Es, J.C. 1982. "Dilemmas in the Soil and Water Conservation Behaviour of Farmers". Pp. 238-253 in *Future Agricultural Technology and Resource Conservation* edited by Burton C. English, James A. Maetzold, Brian R. Holding, and Earl O. Heady. Ames, Iowa: Iowa State University Press.

Van Es argues that since public funds are not available to provide adequate financial incentives to all farmers to adopt environmentally friendly resource management practices, conservation policy will remain largely voluntary except in human health disaster situations. Farmers will have to become active participants in the formulation of local conservation policy for them to want to volunteer. Thus, he argues, it is the role of national and state governments to provide the framework that empowers local organizations to promote best management practices that suit the local environment.

Journal and Periodical Articles

Allen, Douglas W. and Dean Lueck. 1998. "The Nature of the Farm." *Journal of Law and Economics* vol. XLI Pp. 343-385.

This paper explains why and how small family farms have resisted the transition to agro-industrial production processes that include a corporate separation of capital, labor and management. A main reason is that corporate capital finds seasonal production inefficient because uncontrollable environmental factors such as weather present high risk. Family farms able to control the growing environment by irrigation or indoor production of plants or animals tend to adopt the corporate farm model. Secondary reasons for the continuation of the family farm model

of production are that the labor of family members can be exploited to reduce production costs and that farm equipment technology allows one farm to raise a substantial amount of produce.

Allen, John C. and Kevin Bernhardt. 1995. "Farming Practices and Adherence to an Alternative-Conventional Agriculture Paradigm." *Rural Sociology* 60(2): 297-309.

A statewide study in Nebraska reveals that the two paradigms of (1) production first and (2) environmentally friendly farming practices exist and influence how farmers make their resource management decisions. However, only non-producers subscribed to the purest form of each view with producers taking both environment and production into consideration. The study shows groups of people forming around individuals sharing the same or similar points of view.

Anosike, Nnamdi and C. Milton Coughenour. 1990. "The Socio-economic Basis of Farm Enterprise Diversification Decisions" *Rural Sociology* 55(1): 1-24.

Anosike and Coughenour point out that economic theory that views farmers as profit maximizers fails to recognize the numerous social goals they also have as fathers/mothers, husbands/wives, and members of rural communities. Although resources available to the farmer determine many farm decisions, other factors such as the age of the farmer and the level of her/his education also influence farming practice decisions.

Benson, Chris. 2000. "Tracking E.coli on the farm". *Western Producer Farming supplement*. Volume 3 No. 7. Pp. 28 –29.

Several months after the Walkerton Ontario tragedy of June 2000, Benson, an environment consultant, finds that although there is a public perception that intensive livestock operations are responsible for soil and water contamination, most problems occur due to poor management of smaller scale operations. A surface and groundwater contamination risk assessment is presented for different types of manure storage and application sites. It is important that soils, surface and groundwater be regularly monitored to enable informed decision-making.

Berry, E. Helen, Richard S. Krannich, and Thomas Greider. 1990. "A Longitudinal Analysis of Neighboring in Rapidly Changing Rural Places". *Journal of Rural Studies* Vol.6, No. 2: 175-186.

This article finds that neighboring dynamics, or social interaction, in rural areas is more a function of social factors such as social status, religion, ethnicity, ages of the population, and residential stability than structural economic and ecological factors. The relationships that children establish often become the basis for familiarity among their parents. In rural areas experiencing rapid demographic change, sustainable development policy or programs should focus on empowering neighborhood interaction.

Beus, Curtis E. 1995. "Competing Paradigms: An Overview and Analysis of the Alternative-Conventional Agriculture Debate." *Research in Rural Sociology and Development* Volume 6: 23-50.

Two paradigms, a conventional view and an alternative view, regarding modern agriculture in the US today are presented. The conventional view is production based. In this perspective agriculture is working well and science and technology will solve any production or environmental problems that arise. The alternative agricultural view suggests that agricultural production is harmful in social, environmental, and ultimately in economic ways and that farms should be smaller and less dependent upon technology.

Common ground between the two points of view is difficult to find because they are opposed in so many ways. Conventional agriculture views sustainability in almost purely economic terms with an emphasis on short-term production. The alternative paradigm primarily focuses on the long-term health and productive nature of rural ecosystems and the health and vitality of rural communities. It is difficult to say which paradigm is correct; however, the author finds that both perspectives are useful, if not necessary, in the progression of the agriculture industry. The implication for water quality policy is that it will be interpreted in different ways by farmers holding different perspectives. While women are more inclined to accept an alternative view of agriculture, large farmers tend to be more conventional than small farmers are.

De Sousa, Ivan Freire and Lawrence Busch. 1998. "Networks and Agricultural Development: The Case of Soybean Production and Consumption in Brazil." *Rural Sociology* 63(3) 349-371.

The paper describes how the application of actor network theory (ANT) transforms perceptions of processes of sustainable agriculture into

a fluid holistic web of interactions that include social, environmental, political and economic dynamics. According to ANT, nature is an active participant in agriculture as are farmers, international agribusiness firms, and ultimately consumers. By realizing the dynamics of international food networks, policy is able to use distant forces like the demands of environmentally conscious consumers to promote local and sustainable agriculture. The article uses the example of soybean production in Brazil, but suggests that canola production in western Canada could be a potential example.

Flora, Cornelia B. 1995. "Social Capital and Sustainability: Agriculture and Communities in the Great Plains and Corn Belt." *Research in Rural Sociology and Development* 6: 227-246.

Sustainable agriculture is discussed as a process with different interpretations at the local and community level. Involvement in the sustainable agriculture process at a community level gives participants the ability to see immediate results of their involvement even if the results are only to make them more interactive members of the local community. Local community discussion of sustainable agriculture practices empowers participants to distinguish and own the choices they make about their farming practices rather than feel victim to industry standards and government policy.

Gray, Ian, Tony Dunn and Emily Phillips. 1997. "Power, Interests and the Extension of Sustainable Agriculture" Sociologia Ruralis 37: 97-113.

This article argues that truly sustainable agriculture should recognize different and often contradictory viewpoints. The term sustainable agriculture has different meanings to different groups depending on their collective self-interests. Thus, sustainable agriculture may acquire different meanings in the same area. The agrochemical representative, the farmer, the environmental activist, and the local university extension agent may each have different interpretations of the meaning of sustainability. Interest groups in general view sustainability as the continuation of their material interests and philosophical points of view.

Common ground should be determined and used as a starting point for negotiations between groups engaged in local policy formation and application. Negotiations, therefore, would include representatives of the agrochemical industry as well as farmers and environmentalists. An example is presented of inviting groups such as Ducks Unlimited and

Monsanto to local watershed association meetings so that they may become active participants or sponsors of local water quality issues.

Gray, R.S., Taylor, J.S. and Brown, W.J. 1996. " Economic Factors contributing to the adoption of reduced tillage technologies in central Saskatchewan" *Canadian Journal of Plant Science*. 76: 661-668.

This economic comparison of no-till and conventional till farming practices found that crop yield and the price of glyphosate were key determinants of farmer decisions to adopt no-till. A result of the adoption of no-till was a significant increase of organic material in the soil. However, in this study, it was a secondary benefit. The emphasis on increased efficiency of no-till as a risk reducing measure for farmers is the primary reason that farmers will adopt the practice.

Hassanein, Neva. 1997. "Networking Knowledge in the Sustainable Agriculture Movement: Some Implications of the Gender Dimension". *Society and Natural Resources* 10:251- 257.

This article explains that women's voices have been traditionally silent in the gendered world of sustainable agriculture and argues that women have much to contribute to the generation of local knowledge that is shaped partially by social location. Rural women share and exchange knowledge in different ways than men. Rather than being genderless, effective sustainable agriculture policy should strive to identify differences between perceptions of men and women and use these insights to develop policy that is not exclusionary.

Hassanein, Neva and Jack R. Kloppenburg, Jr. 1995. " Where the Grass grows Again: Knowledge Exchange in the Sustainable Agriculture Movement". *Rural Sociology* 60 (4) 721-740.

This article explains that local knowledge generated in rural areas is largely determined by the worldviews of farmers and may at times be very different from the worldviews of policy makers. An exchange of local knowledge on sustainable agriculture practices is created when farmer's share problem solving information with other farmers in the area. Policy attempting to promote sustainable agriculture practices should strive to empower local grassroots organizations and create a forum to exchange local knowledge and policy objectives.

Heffernan, William D. and Judith Bortner Heffernan. 1980. "Impact of the Farm Crisis on Rural Families and Communities". *The Rural Sociologist* Volume 6 (3): 160- 170.

This Missouri study examines the effects of the farm crisis on rural communities with an emphasis on how debt affects not only the sustainability of a farm but also the mental disposition of the farmer and her/his ability to make resource management decisions. An economic assessment of farms carrying more than a 30% debt to asset ratio is that they face serious financial difficulties. These difficulties will adversely affect their ability to assume risk in implementation of conservation farm policy.

Hodge, Ian. 1991. "Incentive Policies and the Rural Environment" *Journal for Rural Studies*, Vol. 7, No.4, Pp. 373-384.

The costs and benefits of financial incentives and regulations designed to protect rural environments are compared and contrasted. A framework with both subsidies and regulations may be the best way for balancing the two approaches. Subsidies may be paid to farmers for adopting environmentally friendly farming methods and taxes as a form of regulation may be imposed on those who do not. Taxes, for example on pesticide usage, are relatively easier to administer than subsidies and they generate revenue instead of depleting government resources. Hodge argues that both conservation subsidy and tax policies will encounter difficulties if they are too rigid to be applied to site-specific locations. If policies are not easily adopted, local intervention will be required in the process, and this will increase administration costs beyond initial policy budget considerations.

Horowitz, John K. and Erik Lichtenberg. 1993. "Insurance, Moral Hazard, and Chemical Use in Agriculture." *American Journal of Agricultural Economics* 75:926-935.

This American study found that the use of crop insurance in the Midwestern states had a direct influence on corn farming practices. Farmers purchasing crop insurance were likely to use more pesticides and commercial fertilizer than farmers who did not. Farmers justified the extra expense of these inputs because crop insurance reduced economic risk. The article defined the term 'moral hazard' as the "possibility that insured people take fewer precautions against harm". In the case of crop insurance, this study found that those with it were more likely to use extra pesticides and fertilizers that may be harmful to water quality in rural areas.

INEWS. 1995. “Analysis blames U.S. subsidies for damage to environment.” *Western Producer*. September 7, p.58.

A report by Jonathon Tolman entitled “Harvest of abuse: The environmental legacy of farm subsidies” is described in this newspaper article. The report links US farm subsidies with degraded water quality throughout the US and suggests that government should reduce financial incentives for farmers to engage in intensive chemical agriculture practices by eliminating price supports. This recommendation of the report is downplayed by a spokesman for the American Farm Bureau Federation who says that the heaviest agrochemical users are vegetable and fruit growers who do not receive federal price supports.

Keenan, Sean P. and Richard S. Krannich. 1997. “The Social Context of Perceived Drought Vulnerability”. *Rural Sociology* 62 (1) 69-88.

A study in California finds that dependence upon existing rural water use patterns may create obstacles to creating more effective water policy. The central thesis of this article which analyzes the California study is that “perceptions of drought vulnerability depend upon individuals’ social status relative to the resource production system in their locality”. The interests of different rural social groups may undermine efforts to implement water conservation strategies. Those who perceive themselves to be most vulnerable may be uninterested in changing their farming methods in the interest of water conservation.

Lafond, G.P., D.A. Derkson, H.A.Loeppky, and D.Struthers. 1994. “An agronomic evaluation of conservation-tillage systems and continuous cropping in East Central Saskatchewan.” *Journal of Soil and Water Conservation* 49(4): 387-393.

The results of a five-year study suggest that conservation and continuous cropping practices are economically viable alternatives to summerfallow in East Central Saskatchewan. Water management is optimized by incorporating organic material from crops into the soil to slow evaporation and retain additional moisture for crops. Because topography and soil type can vary dramatically in one field, conservation practices may have to be applied on a site-specific basis to be the most effective.

Lockie, Stewart. 1997. "Chemical Risk and the Self-Calculating Farmer: Diffuse Chemical Use in Australian Broadacre Farming Systems". Current-Sociology Vol. 45, No.3:81-97.

Australian farmers admit to high levels of apprehension about using agrochemicals but find themselves unable to change farming practices because of what they perceive as the economic need to intensify their practices. Stewart explains that best management practices recommended by state agencies support the use of the farm chemicals without thorough examinations of the associated social and ecological costs. Farmers following the advised practices of government agencies are suspicious of who benefits the most from these policies. Best management practices are regarded by Lockie as best only because they represent the best possible compromise between farmers, the agriculture industry, the state, and the theoretical lack of effect on the environment.

MacArthur, Mary. 1992. "Bacteria, nitrates worse problem than pesticides". *Western Producer* August 20, Vol. 10(3).

MacArthur describes a 1990 study of rural well water in Ontario in which 40% of wells were found to be contaminated by unsafe bacteria levels found very low levels of pesticides in some rural water wells. The study concluded that farm practices have a distinct and definite impact upon ground water supplies. The study discovered that farmers who regularly test their soil are more aware of nitrogen fertilizer use and the dangers of leaching and are more likely to use safe farming practices and have safer drinking water.

MacArthur explains, that well water quality in Saskatchewan is described by scientists at the Saskatchewan Research Council as being highly variable. She concludes that there is a definite need for more data on a regular basis to monitor the effects of changing agricultural practices.

Makowski, T.J., A.J. Sofranko and J.C. Van Es. 1990. "Agroecological and Policy Influences on No-Till Adoption". *Society and Natural Resources* 3, Pp. 361-371.

The study examines policy promoting the practice of No-Till farming in two distinct areas of Illinois. Although many farmers in the study areas adopted No-Till farming methods, they did so for the efficiency of economic benefits and not because of environmental concerns. The 'resource-conservation' rationale was largely not accepted by the farmers. The article concludes, therefore, that future policy

designed to conserve natural resources should include immediate financial incentives. The article also suggests that technological solutions providing better economic efficiency on farms can function to protect the environment and should be supported by policy.

Mallin, Michael A. 2000. "Impacts of Industrial Animal Production on Rivers and Estuaries" *American Scientist* 88:26-37.

The devastating effects of sewage leaks from intensive livestock operation lagoons are described by an ecologist. Although sewage facilities for intensive livestock operations should pass environmental assessments, these assessments are usually based upon normal weather patterns. Problems arise when abnormal or severe weather such as hurricanes overwhelm sewage facilities that lead to surface water contamination. The contamination can kill fish and aquatic plants and jeopardize the ability of treatment plants to adequately treat water for drinking downstream. Hurricane Fran in 1996 led to the flooding of 22 intensive livestock lagoons with much of the waste travelling into the Cape Fear River where fish and other organisms were killed. Tests conducted in North Carolina found that animal waste facilities become unstable in periods of extreme weather. As intensive livestock facilities seem to be the way of the future, the author cautions that intensive livestock operations should be located in areas of minimal risk with well-designed waste management systems.

McEachern, Charmaine. 1992. "Farmers and Conservation: Conflict and Accommodation in Farming Politics". *Journal of Rural Studies* Vol. 8 No. 2:159-171.

McEachern concludes that successful water quality policy should be put through a social impact assessment process as part of its formation so that farmer opinions can make the policy more relevant. When different interpretations of farming are imposed upon farmers by outside agencies, there is a potential for conflict and non-compliance with conservation policies.

This case study of livestock farmers in the Upper Yorkshire Dales illustrates the differences of perception of conservation policies between farmers, environmentalists and employees of government agencies. Farmers represented themselves somewhere on a continuum between nurturing stewards of the natural environment and rural entrepreneurs and the study found that most farmers are to some extent both. However, academic debates, government policies and environmental activist media releases tend to focus on either end of the spectrum without recognition that most farmers care about their business and the

condition of the land and water on their farms. In this context, urban environmental or animal rights activists with no experience of rural life and agricultural production are perceived as pests that farmers must learn to deal with.

Seasonal farm production reinforced farmer attitudes that they work with nature. The freedom of working outside without a boss also gives farmers a sense of an emotional attachment to the land and their farming practices. Farming decisions are affected by macro-structural social conditions such as consumer preferences and economic and political developments. Farmers in the study expressed frustration with government agencies and urban environmentalists who did not consider farmer concerns.

Nowak, Peter. 1992. "Why farmers adopt production technology: Overcoming impediments to adoption of crop residue management techniques will be crucial to implementation of conservation compliance plans" *Journal of Soil and Water Conservation* 47: 14-18.

Nowak explains that farmers adopt or reject new technologies because they are either unwilling or unable to implement them. Using the example of a proposed residue management system, the responses of farmers are categorized. If the farmer is unable to adopt a new farming practice, Nowak explains that it is because of one of the following nine reasons listed. For each reason, Nowak suggests an appropriate solution for policy makers:

1. "Information is lacking or scarce." Solution: "Generation and distribution of the basic information to those needing it."

2. "Costs of obtaining information are too high." Solution: "Reduce the costs of obtaining needed information by increasing accessibility."

3. "Complexity of the system is too great." Solution: "Redesign or simplify the technology."

4. "Too expensive of a residue management system." Solution: "Subsidize the adoption decision or re-design a less expensive system."

5. "Labor requirements that are considered to be excessive." Solution: " Redesign the production technique to reduce labor requirements, or subsidize the hiring of adequate labor. "

6. “Planning horizon is too short.” Solution: “Redesign the system or subsidize a short term unprofitable decision.”

7. “Availability and accessibility of supporting resources is limited.” Solution: “Build the capacity of local assistance networks to meet local demands. Target the development of local assistance networks in the areas needing them the most. Develop methods to sell residue management systems on the basis of need, not on the ability to pay or ease of sales.“

8. “Inadequate managerial skills.” Solution: “ Focus assistance and skill-building opportunities on those farmers needing them most, not just on the most receptive farmers.”

9. “Little or no control over the adoption decision”. Solution: “ Determine who can make the adoption decision, and focus efforts on those persons or organizations. Also recognize that an adoption decision is often a family decision. Persuasion or assistance efforts need to address relevant family members. “

The farmer may be unwilling to adopt a new farming practice for a number of reasons. Nowak presents seven reasons why a farmer may be unwilling to adopt a new practice and what can be done to help the farmer change his or her mind:

“1. Information conflicts or inconsistency.” Solution: “ Work to develop a consistent information base. Where legitimate differences exist, offer explanations for these differences.”

2. “Poor applicability and relevance of information.” Solution: ”Generate and distribute relevant information on a local basis.”

3. “Conflicts between current production goals and the new technology.” Solution: “ Development of flexible residue management systems capable of being altered to meet unique farm conditions. Also, sensitivity to farm programs, the goals of which may be inconsistent with the objectives of the conservation technology.”

4. “ Ignorance on the part of the farmer or promoter of the technology.” Solution: “Determine the actual, not assumed, knowledge levels or assistance needs of potential adopters relative to those factors critical to adoption. Then design education programs based on farmer needs, not agency or business expertise.”

5. " Practice is inappropriate for the physical setting." Solution: "Specify the physical applicability of the technology, or design the technology to be adaptable to different physical settings."

6. "Practice increases risk of negative outcomes." Solution: " Risk can be addressed in two basic ways; either increase information so probabilistic outcomes can be calculated or subsidize the farmer to take the risk."

7. "Belief in traditional practices." Solution: "Demonstrating not only that the new way is better than the old way but also that the new way does not increase risk for the farm operation."

Nowak suggests that more time should be spent on examining why farmers are unwilling or unable to adopt conservation technology. Blaming the farmer for flawed policy is counterproductive. More emphasis needs to be placed on understanding the needs of farmers instead of trying to come up with reasons why they do not accept the 'wisdom' of policy.

Parent, Diane. 1996. " The Transformation of Work on the Family Farm." *Canadian Journal of Economics*. 44:421-434.

In this study of the intergenerational transfer of farm assets in Quebec, farmers are observed as reacting to new information in socially embedded ways.

Phillips, Emily and Ian Gray. 1995. "Farming 'Practice' as Temporally and Spatially Situated Intersections of Biography, Culture and Social Structure." *Australian Geographer* 26 (2): 127-132.

The article outlines how traditional holistic and integrated farming strategies have been replaced in agriculture by rational linear approaches to agricultural production. The structural conditions that now surround agricultural production are very much a product of this rationalization. Policy rooted in what is now conventional agriculture with heavy chemical inputs is insufficient in solving multidimensional environmental, social and economic problems. Sustainability under the present agricultural system refers more to a condition of capital and the government programs that support it than to rural environments or to the social groups that live and work on the land.

Potter, Clive and Matt Lobley. 1992. "Ageing and succession on Family Farms: The Impact on Decision-Making and Land Use". *Sociologia Ruralis* Vol. XXXII (2/3). Pp. 317-334.

The article discusses how policy options may be inserted into the process of the intergenerational transfer of land as baby boomer populations in rural areas approach retirement. Measures could be implemented that provide financial incentives for the younger farmer to benefit if certain farming practices are employed. The article relies on a life cycle analysis using primary data of farmers and their farming practices carried out in England and in Wales.

The presence or absence of an heir for the farm seems to determine farming practices. Farms with an heir are farmed more intensively near the transfer period whereas farms without an heir apparent slow down and approach a subsistence low input farming model reflecting the reduced needs and energies of older farmers. The study found that elderly farmers without successors have smaller farms than those with successors. Retirement for many farmers with successors is more a matter of stopping certain physical or demanding tasks than completely stopping work. The successor effect is that farming becomes more intensive near the elder farmer's retirement as more than one family now must make a living from the same farm operation.

Differences in land uses in successor and non-successor farms may be as significant as between farmers with different ages. Farmers without successors may be an ideal target for policy designed to take marginal land out of production by procuring it for wildlife habitat. These elderly farmers may also benefit most significantly for subsidies for preserving wetlands, re-planting riparian areas, planting trees. Being paid a subsidy for environmental land development could allow them to stay living in their home after they have retired from active farming.

Rickson, Roy E., Paul Saffigna, and Richard Sanders. 1999. "Farm Work Satisfaction and Acceptance of Sustainability Goals by Australian Organic and Conventional Farmers". *Rural Sociology* 64 (2) 266-283.

Using regression analysis of primary data, the attitudes of Australian organic and conventional farmers are compared. Each group often views the environment and the sustainability of their own farming practices with a different worldview than the other group. The larger the organic farm, however, the more the attitude of the farmer approached that of the conventional farmer. Organic farmers in general expressed higher levels of satisfaction with their farm work and brighter expectations for the future of their farms.

Rickson, Sarah Tufts and Peter L. Daniels. 1999. "Rural Women and Decision Making: Women's Role in Resource Management during Rural Restructuring". *Rural Sociology* 64(2): 234-250.

A study of Australian farmwomen found that many decisions on farms are gendered with men assuming responsibility for daily 'outside' decisions and women assuming responsibility for daily 'inside' decisions. However, long term planning of the farm and farming practices was generally discussed between both husband and wife with wives adopting a more environmentally friendly view of farming practices than men. The implication for policy is that views about natural resource management are gendered. Therefore, water quality policy should appeal to both men and women, both 'inside' and 'outside' the farmhouse with an aim to raising awareness and facilitating discussion at the farm level on options for improving water quality.

Rosset, Peter M. and Miguel A. Altieri. 1997. "Agroecology versus Input Substitution: A Fundamental Contradiction of Sustainable Agriculture." *Society and Natural Resources* 10(3): 283-296.

The article asserts that sustainable agriculture and agriculture characterized by commercial inputs are mutually exclusive concepts. Commercial input agriculture prevents many small farmers from being economically or environmentally sustainable. The concept of input substitution working under the 'law of the minimum' means that there is always only one single limiting factor to increasing farm production. New limiting factors appearing as a result of previous technological innovations can be overcome by new commercial inputs. For example, increased nitrogen causes plants to grow faster but may be directly or indirectly responsible for new insect problems that will require a new pesticide. It is a form of an almost sustainable 'technological treadmill' that benefits corporate interests more than farmers. An alternative and more sustainable form of agriculture uses alternative cropping practices and non-commercial inputs to enhance soil fertility, agricultural production and protection of crops from insects and disease. The present form of conventional agriculture puts farmers into high debt situations and reduces the 'functional biodiversity of agro-ecosystems" p. 289.

The pervasiveness of capital in the agriculture industry is examined. An analysis of capital expanding into the organic food industry and the development and sale of off farm inputs designed to increase organic production are detailed. Agro-ecology is a holistic version of agriculture that attempts to integrate the needs of the environment with those of rural communities, farmers and the urban populations they feed. The ideal goal is to maximize the use of energy to

produce crops by reducing inputs, reducing nutrient losses by preventing runoff, contributing to nitrogen in the soil by planting legume crops, producing food for local consumption, and by supporting small farms to become self sustaining economic units. The results for water quality in this idealistic scenario would be less contamination because of the need for less commercial inputs and more thoughtful use of the land thus preventing soil erosion and water quality degradation.

Salamon, Sonya, Richard L. Farnsworth, Donald G. Bullock, and Raji Yusuf. 1997. "Family factors affecting adoption of sustainable farming systems". *Journal of Soil and Water Conservation*. 52(2): 265-271.

The low adoption rate of conservation land use practices in a study of 60 Illinois farm families is identified as a social problem. Of the group surveyed, one half practiced sustainable agriculture practices and the other half followed conventional farming methods. The groups have distinctively different social characteristics. The families using environmentally friendly farming practices have a history of environmentalism, do yearly experimentation on their farms, and are more prudent with resources than those who practice conventional agriculture. The study concludes that targeting conventional farm families that share one or more of these environmental practices would be an effective way to promote conservation farming methods.

Salamon, Sonya. 1985. "Ethnic Communities and the Structure of Agriculture". *Rural Sociology* 50(3): 323-340.

A study comparing American farmers of German or British descent in Illinois found that different ethnic values dramatically influenced farming practices. Farmers of German descent focused on mixed farming and increasing land holdings to facilitate inter-generational transfers of land while British descent farmers not 20 miles away concentrated on single crop production and short term profits.

Land tenure relationships were remarkably different. German descent farmers sought to own the land they farmed and British descent farmers were content with renting. The analysis concludes that German descent farmers are more likely to adopt soil conservation measures to preserve the land for their children than British descent farmers who are likely to change farming methods only with immediate financial compensation. Effective water quality policy, therefore, would likely have to by stress the long-term health of the land and water supply and provide immediate financial incentives for farmers to adopt conservation measures.

Shepard, Robin. 2000. "Nitrogen and phosphorus management on Wisconsin farms: Lessons learned for agricultural water quality programs". *Journal of Soil and Water Conservation* Vol 46: 63-68.

The use of Best Management Practices (BMPs) among Wisconsin corn farmers is studied to reveal that few farmers utilize BMPs in the way they were designed. Water quality degradation is observed as a result of agriculture decisions within an ecosystem setting; however, it is unclear how to formulate water quality conservation policy that appeals to all farmers within that setting. The analysis concludes that farmer input into the development of BMP programs may aid in their adoption and implementation.

Staff. 1993. "Reward farmers for preserving wildlife, say conservationists". *Western Producer* July 1 p 44.

Caroline Caza, of Wildlife Habitat Canada, identifies existing agriculture policies as the largest obstacles to truly sustainable resource management on Canadian farms. She explains that government policy designed to promote sustainable agriculture should provide a definition of sustainable agriculture and its goals in the short, medium, and the long term so that farmers have sufficient information on which to base their resource management decisions. Wildlife Habitat Canada has promoted the preservation of wildlife habitat on public and private land since its inception in 1984. The organization promotes the message that farmers should be financially compensated for preserving wetlands and woodlots.

Staff. 1993. "The environmental debate begins" *Western Producer* Vol. 70 (49) July 15. Pp. 47-48.

This article focuses on how governments are becoming aware of environmental issues surrounding agriculture policy, but at the same time are struggling to simultaneously address both the needs of struggling farmers and the environment. Governments in Canada prefer to promote and support voluntary conservation policy. However, that may be changing. In Ontario, local rural grassroots organizations have formed to access government funding designed for local farm groups that implement soil and water conservation plans. Additionally, in Ontario, due to pressure from local groups of farmers, a mandatory certificate course was installed in community colleges throughout the province to certify farmers who purchase or apply pesticides. Providing funding to targeted groups alone may initiate structural changes that would have been impossible to achieve by other means.

Vail, David J. 1982. "Family Farms in the Web of Community: Exploring the Rural Political Economy of the United States". *Antipode* 14 (3): 26-38.

Farmers make resource management decisions that are partially determined by the technology they can afford, their debt load, and the contract and price conditions they are able to acquire in the sale of their produce, often to large corporations. Family farms survive for a variety of reasons that include the following:

1. The ability to exploit self and family labor to reduce the costs of production to below corporate levels.
2. On most family farms, one or both adults have off farm employment, alternative sources of income, or diverse revenue streams.
3. In some cases, small family farms survive because they are too small to be regulated effectively by governments. An example is selling farm meat, eggs and vegetables in farmers' markets.
4. Some small farms squeeze into small niche market production that presents unsuitably high risks for corporate farms.
5. Technological innovations such as improvements to equipment mean that small farmers can raise crops or animals in automated ways thereby reducing the need for expensive outside labour.
6. Corporations have found it more profitable to extract the surplus value of family farm produce in the open market rather than risking corporate funds to produce it themselves.

Farming policy should recognize that there are local exchange opportunities among and between farmers, that local forms of government need to be more involved in policy formation and that grassroots organizations are an important social interaction point in rural communities.

Van Es J. C. 1983. "The Adoption /Diffusion Tradition Applied to Resource Conservation: Inappropriate Use of Existing Knowledge" *The Rural Sociologist* Vol 3 (2): 76-82

The classical adoption diffusion model of studying the disbursement of technological innovations to farmers is discounted as insufficient in studying how farmers choose to adopt or reject conservation policy. Structural and economic conditions are more likely to influence a farmer's decisions than their own psychological dispositions. Van Es concludes that the diffusion model which places farmers on a continuum scale from 'innovators' to 'laggards' may have been marginally appropriate for assessing the adoption of production based technology, but due to the multiple variables and long term benefits of adopting soil and water conservation techniques it is inappropriate for measuring the success or failure of conservation policy.

Van Kooten, G. Cornelius, Rita Athwal, and Louise M.Arthur. 1998. "Use of Public Perceptions of Groundwater Quality Benefits in Developing Livestock Management Options." *Canadian Journal of Agricultural Economics* 46:273-285.

This economic analysis of options to protect groundwater took place in Abbotsford, British Columbia in the early 1990's. The Abbotsford aquifer had tested positive for excessive nitrates on numerous occasions. Excessive nitrates are potentially dangerous to human health because nitrates can breakdown into nitrites and bind with other chemicals (amines) to create cancer-causing agents. The high concentration of nitrates was blamed on heavy rainfall washing intensive livestock operation farm animal waste into places where it could leach into the shallow aquifer.

The study focused on analyzing costs of treating water with manure composting to prevent leaching into the aquifer. The study concluded that the lack of public concern over compromised water quality did not warrant the imposition of strict and expensive regulation of manure from intensive livestock farms. This article suggests that the public does not fully understand water quality issues. When the public does understand water quality issues, it is more inclined to demand improved treatment facilities that provide immediate results compared

to restrictions on intensive farms that may or may not improve water quality over time.

Van Kooten, G. Cornelius, Ward P. Weisensel and E. de Jong. 1989. "Estimating the Costs of Soil Erosion in Saskatchewan." *Canadian Journal of Agricultural Economics* 37:63-75.

This economic analysis compares potential user costs and opportunity costs of soil erosion to farmers. Although soils have deteriorated over time, technological innovations have led to increased production and have therefore reduced the priority of soil conservation among farmers. Many prairie farmers, for example, continue the practice of summer fallow despite government efforts to get them to adopt no-till farming practices. Farmers continue to summer fallow because changing this farming practice introduces an economic risk. The soil conserving results from switching to no-till are part of a long-term process of land management without immediate visible results. Given the high input, low profit margin of farming, farmers are unlikely to change farming practices for long term conservation reasons unless given immediate and direct financial incentives. Because of the long term nature of soil conservation and the dynamic range of possible economic, technological, social and environmental variables, it is impossible to accurately project the opportunity cost of adopting or rejecting no-till farming practices.

Van Vuuren, Willem and Peter Ysselstein. 1984. "Impact of Tenancy on Land Management". *Journal of North-Eastern Agricultural Economics Council* Vol. 13 (1): 89-96.

This study follows changing land ownership patterns in Ontario over three decades and the authors conclude that soil management resource decisions and crop productivity are considerably influenced by land tenure arrangements. Renters tend to discount long term affects of their resource management decisions and therefore are not as inclined as owners to practice soil and water conservation practices.

Wilson, Barry. 1993. "Proposal suggests paying farmers to preserve environment" *Western Producer* September 2 Vol. 71(5): 15.

The newspaper article describes the recommendations of a report from the Manitoba government which proposes that farmer income subsidies based upon production be re-directed to paying farmers to adopt soil and water conservation strategies and for planting trees and

preserving wetlands. Robert Sopuck of the report committee emphasized that people of local communities should become involved in the redirecting of farming subsidies by becoming active in local and regional politics or else they will have programs designed for them and imposed upon them.

Whatmore, Sarah. 1993. "Agricultural Geography". *Progress in Human Geography*. 17 (1): Pp. 84-91.

Whatmore argues that on a global scale, it is no longer reasonable to distinguish agriculture from industry. Agriculture is a component of the agri-food industry in which capital is accumulated and farmers become workers with marginal autonomy within global food networks. Sustainable agriculture movements need to recognize the future productive capacity of physical and social environments. On an international and especially European level, there is recognition that environmental policy and sustainable agri-food network requirements should come together. No distinct model of incentive and/or regulation so far, however, has come close to solving the problem. Whatmore concludes by reminding policy makers that whatever policy they may put forward, it should not be gender biased.

Wolf, Steven A. and Spencer D. Wood. 1997. "Precision Farming: Environmental Legitimation, Commodification of Information, and Industrial Coordination." *Rural Sociology* 62(2): 180-206.

Precision farming refers to the use of technology such as Global Position Satellites (GPS) on farms to monitor and regulate the use of agricultural chemicals and fertilizers. This paper examines how GPS technology legitimates an agrochemical-farming regime that may have detrimental long-term effects to rural environments and social groups. Precision farming technology is examined as a substitution for local knowledge by capital intent on controlling the means of agricultural production. The rural social changes brought on by precision farming are described as a means of alienating farmers from their labour, reducing the number of people in the agricultural production process, and of furthering the industrialization of agriculture.

Wolfe, Jackie. 1995 "Approaches to Planning in Native Canadian Communities: A Review and Commentary on settlement Problems and the Effectiveness of Planning Practice. " *Plan Canada* Vol. 29 No 2: Pp. 63- 79.

Wolfe explains that the land claim settlements of the previous decades have given Aboriginal peoples more control over their own natural resources and have offered them the ability to pursue economic development in new ways. He notes, however, that this is a slow process in which various government departments still maintain overall control of the ability of native communities to decide their own strategies for economic development. The attainment of self-determination of Canada's Aboriginal communities is directly related to efforts to determine their own land use decisions. Because treaty land is in-alienable, it cannot be taxed, and it can not be used as collateral for economic development including agriculture. Land, for Aboriginal peoples, is an all-encompassing term including water, snow, ice and air. The term 'land' has immediate, intimate, and spiritual connotations that link Aboriginal peoples to their environment. Dividing land into private holdings is contrary to the natural traditional ways of aboriginal people.

Wright, Susan. 1992. "Rural Community Development: What Sort of Social Change?" *Journal of Rural Studies* 8: 15-28.

The author, a community development worker in rural England, chronicles her efforts to organize the population of a rural hamlet to facilitate the installation of a rural pipeline to supply safe drinking water. Wright concludes that developing local participatory action committees is a difficult process of managing competing and often-conflicting interests to achieve a common goal. One of the largest hurdles for the community worker in this situation is to bridge the gap between local and government interest.

Wright discovers vast differences of opinion between individuals of the local participatory group, and between the group and the local utility board and regional government who outlined the parameters of the project. The 'authorities' have the advantage of being able to define power and control in articulate, rational ways that are often mistrusted by local individuals. The role of the community development worker was to encourage local participatory involvement which would facilitate providing of a source of clean water to the hamlet. The result was that although water was eventually delivered to each household, the local residents felt that their input had been insignificant. Although the idea of a local participatory council inspired several other collective economic development initiatives, these initiatives eventually failed due to infighting of participants and/or to structural limitations of regional governments.

Baker, J.L. 1994. "Water Quality- Evaluation of the Impacts of Land Management on the Quality of Surface and Subsurface Drainage". Pp. 75-85 in *Sustainable Land Management for the 21st Century* edited by R.C. Wood and J. Dumanski. Proceedings of the International Workshop on Sustainable Land Management for the 21st Century. June 20-26. University of Lethbridge, Lethbridge, Alberta.

Baker argues that sustainable land management should be observed as sustainable natural resource management taking water, air and energy into consideration. How water transports excess nutrients and pesticides through and over the soil is well understood, but very little is done to monitor or check this process to avoid water degradation. Baker argues that monitoring water quality can be done most effectively on a watershed basis. Given as a possible conservation policy for Canada to consider is the US 1985 Food Security Act which financially compensates farmers for practicing soil erosion control on highly erodible land. Baker concludes that water quality monitoring in rural areas is necessary for evaluation of the effectiveness of conservation policy.

Batchelor, C. M., Rama Mohan Rao and K. Mukheree. 2000. "Watershed development- or should it be watershed management?" Land-Water Linkages in Rural Watersheds Electronic Workshop 18 September –27 October 2000. Food and Agriculture Organization of the United Nations. Rome, Italy. Retrieved October 24 2000. (http: www.fao.org/ag/agl/watershed/casest.htm)

This case study outlines the results of the Karnataka Watershed Development Project (KAWAD) in northern Karnataka State India and suggests that watershed development be considered in a fluid social context of watershed management. The starting point of any watershed management project should be regular, reliable data on water quantity, usage rates and water quality. The positive outcomes of the ongoing watershed management in the test area indicated the following benefits:

- Increases in net agricultural production on arable and non-arable lands;
- Development of village-level institutions,
- Substantial improvements in the livelihoods of some social groupings;

Implementation of an approach that has widespread political and public support. (http: www.fao.org/ag/agl/watershed/casest.htm)

The less positive effects of watershed management in the case study included certain groups capturing water resources at the expense of others, especially the poor. In addition, local village level institutions found that often their recommendations were not accepted at a legislative level. The focus on water kept coming back to improving water supply instead of maximizing water management. There was little communication and cooperation between upstream and downstream users of water, which negated some positive effects of upstream conservation measures. As well, local participants in the watershed management process became disillusioned when they discovered that water management solutions often took long periods of time to implement.

This case study made several recommendations including recognizing that local community water decisions should be made within the framework of water management principles of the entire watershed based upon typography and climate. Watershed management principles should be based on the long-term health and sustainability of the watershed and its population. Short-term fixes for political gain are to be avoided. A primary goal of watershed management should be the safe drinking water for all members of the population within the watershed. Resources should be mobilized to achieve this primary objective. Funding procedures for watershed management should be revisited regularly to ensure that all options are available to achieve the watershed management objectives. Instruments or mechanisms should be devised and implemented at an institutional level to provide incentives and disincentives to promote "equitable, efficient and productive use of water". Positive community action for watershed well being should receive legislative support. Finally, regular data should be collected and made accessible to the public regarding the quality and quantity of their water so they may participate in the watershed management process.

Boehm, Marie M. 1995. "The Long Term Effects of Farming Practices on Soil Quality, as influenced by Farmer Attitude and farm Characteristics." PhD dissertation. Department of Soil Science, University of Saskatchewan, Saskatoon, Canada.

Sustainable agriculture has multiple meanings. It can mean stable, profitable farming practices, enhancement and protection of the environment, and/or maintenance of rural communities and the family farm mode of production. Boehm argues that truly sustainable agriculture is actually a balance of all of the above.

Boehm's research found that family farms have survived because they can adapt to continuous years of no profits by cutting domestic consumption. Corporations, by their very nature, do not have this ability. Family farms also have the ability to generate great quantities of agricultural produce based upon the labour and machinery available to one family. The average farmer must make a living by selling her/his produce on the market and this process involves multiple land use decisions. Therefore, both society and the individual farmer determine land use practices. The social costs of farming practices often become evident downstream.

Boehm finds that efforts to educate farmers about the advantages of soil conservation have been relatively unsuccessful in changing farmer behaviour. In areas with a high danger of soil erosion, conservation tillage practices are more common than in places with conditions of less risk. Decision-making ability of farmers is best when there is more than one generation of farmer working the same land. Boehm finds that medium sized family farms appear to be the most sustainable. The combination of experience and education on these farms means that there is enough capital to secure credit for machinery and enough labor and capital, but the operation is not too big to be able to adapt to changing market conditions.

Boehm finds that the agriculture industry and structural factors created by government are as much the cause of water quality degradation as is the behaviour of individual farmers. For water quality policy to be successful, it should consider the structural conditions in which land use practices are made.

Brown, Mark M., Jonathan Lash, Klaus Topfer, and James Wolfensohn. 2000. A Guide to World Resources 2000-2001: People and Ecosystems. United Nations Development Programme, United Nations Environment Programme, World Bank. Washington, DC: World Resource Institute.

This report uses projected population growth and presents an environmental audit of the ability of the world's ecosystems to continue producing food, energy and fiber for the future. Ecosystems are divided into categories of agro, forest, freshwater, grassland, and coastal ecosystems. Each ecosystem is audited for its water quality and future production capability. The report suggests that governments should begin to manage ecosystems in a holistic way or risk the future productivity of natural resources. The report warns that unless a holistic approach to resource management begins soon, parts of the world exist that will not be able to sustain present populations within the next several decades.

Diamond, A.W. 1994. "Integration of Ecological and Biodiversity Concerns into Sustainable Land Management". Pp. 179- 187 in *Sustainable Land Management for the 21st Century* edited by R.C. Wood and J. Dumanski. Proceedings of the International Workshop on Sustainable Land Management for the 21st Century. June 20-26. University of Lethbridge, Lethbridge, Alberta.

Diamond argues that sustainable land management should create space for wildlife habitat because it promotes biodiversity of microorganisms, plants and animals and acts as a filter system for water contaminated by agriculture practices. Natural habitats are complex systems that fulfil many integrated functions beyond the linear production model of modern agriculture. Diamond argues that recognition of the human ignorance of complex natural systems should be justification enough to preserve aspects of the natural environment. Because less than 20% of the natural prairie landscape remains, it is important to protect what little is left. The example given is that less native prairie remains than the remaining portion of the Amazon rainforest.

Dumanski, J. and A.J. Smyth. 1994. "The Issues and Challenges of Sustainable Land Management". Pp. 11-21 in *Sustainable Land Management for the 21st Century* edited by R.C. Wood and J. Dumanski. Proceedings of the International Workshop on Sustainable Land Management for the 21st Century. June 20-26. University of Lethbridge, Lethbridge, Alberta.

Dumanski argues that technology has to be applied in a site-specific way so that the negation of ecological damage takes priority over short-term economic gain. Because technological innovations and farming practices in agriculture that were designed for productive land are now being used on all farmland, some marginal farmland has been put into production. Innovations such as commercial fertilizers and pesticides have made the land less marginal economically, but marginal land farmed using intensive farming practices is more likely to suffer soil erosion and cause water degradation than other land.

Elliott, E.T., H.H. Janzen, C.A. Campbell, C.V. Cole, and R.J.K. Myers. 1994. "Principles of Ecosystem Analysis and Their Application to Integrated Nutrient Management and Assessment of Sustainability" Pp. 35- 57 in *Sustainable Land Management For the 21st Century* edited by R.C. Wood and J. Dumanski. Proceedings of the International Workshop on Sustainable Land Management for

the 21st Century. June 20-26. University of Lethbridge, Lethbridge, Alberta.

Five principles are identified which provide a framework for sustainable land management. They are (1) the ecosystem is the unit of analysis and of management (2) Matter and energy flow through components of ecosystems. (3) The amount and timing of matter and energy flowing through components of ecosystems determines the structure and function of the ecosystem. (4) The movement of matter and energy through ecosystems is fluid, never static, and is constantly changing the components of the ecosystem. (5) Sustainability of an ecosystem is determined by how well its components function together.

Falkenmark, Malin, Jan Lundqvist and Leif Ohlsson. 2000. *New Dimensions in Water Security: Water, society and ecosystem services in the 21st century*. Land and Water Development Division. Food and Agriculture Organization of the United Nations. Rome.

This paper presents an analysis of water policy alternatives for both rural and urban populations. It discounts the traditional water-supply-management paradigm as inadequate in determining future water policy, arguing instead that water policy should also consider social and institutional dimensions. It explores the consequences associated with withdrawal of water from natural sources; the relationship between land use and water quality, the social requirements associated with drinking and agricultural water and the institutional arrangements that will become necessary given the "impending water crisis" on a global scale.

The paper provides alternative conceptualizations of water quality and quantity problems. These include the water screw analogy that conceptualizes water quality problems and levels of water scarcity as "the turns of the water screw". Initially, water scarcity is recognized as a natural resource supply problem that can be solved by increased usage made possible with technical or engineering solutions. The solution is more water. The second turn of the water screw recognizes that water supplies are finite and focuses on water "end use efficiency". The focus is on getting the most out of the water resources available for users by promoting water conservation practices throughout watersheds. The focus becomes getting more use per drop of water. The final turn of the water screw is when both water scarcity and conservation practices do not meet the water needs of society and begin to affect human health and development potential of populations. In this stage of the analogy, water quantity and quality can affect populations in overtly instrumental ways. Human health considerations related to water quality and quantity become obvious. At this final turn of the water screw, the

probability of retrogressive social change is increased due to lack of adequate water supplies. This paper focuses on getting more value per drop of water, and argues that this can have tremendous social implications to marginal groups in society.

In this paper, solutions to effective water management include considerations of the water uses and requirements of the population of the whole watershed in question rather than a site-specific approach. In addition, land use and water quality policy objectives are interdependent concepts requiring full consideration of local topography and the local hydrological cycle.

The social challenges facing water policy are two-fold. In a world of increasing water scarcity due to population increases and water usage, how is water to be allocated within watersheds and which groups of society will have priority? Will the groups that provide the most 'value' to society such as industries which employs people be given higher priority than subsistence farmers who produce for their own limited consumption? How will these kinds of social measures be formulated, integrated and superimposed onto traditional supply-management water policy?

This paper has an explicit recognition that increased agricultural production has definite and often-dramatic affects on water quality. Water is conceptualized as being 'blue' if from natural ground water sources, 'green' if it is collected rain water, and 'virtual' if it represents water savings gained by imported food rather than domestic irrigated agricultural production. Land use affects blue water used for irrigation, but green water as well as blue water both leach through the soil carrying chemicals and fertilizers. The production requirements of modern agriculture requires large fields of monoculture crops that utilize concentrated amounts of commercial chemical and biological inputs that may dramatically affect local environments.

The paper recognizes that worldwide food production and rural developments are undergoing 'drastic structural change'. Policy has to recognize that government institutions, land users, and water users must become directly involved with water management for policy to be effective. Users, therefore, must be involved in policy formation and implementation.

Because site-specific contexts within watershed areas will likely become the method used for water policy, the paper suggests that a systems approach is necessary to integrate society and landscape. Although blue water from surface and underground sources has been sometimes over used, there is potential for developing green water or rainfall as a source of clean water with many uses.

Many institutional arrangements regarding water quality are under developed and exclude the people who directly benefit or are affected by water policy. The paper identifies three major challenges for strengthening the institutional framework of water policy. The first

challenge is the proper use of technology including regular monitoring of water quality within watersheds and the public dissemination of the data in easy to understand terms. Also included in the technology category are clear guidelines of land use and ownership responsibilities. The second challenge to water policy is to define objectives and provide dispute resolution mechanisms for water usage within watersheds. The third challenge is to ensure that future generations are involved with water policy so that water policy reflects a fluid process of social interaction and environmental management. This can be achieved by education of youth and their involvement in watershed management.

This paper emphasizes that all human activities take place in the environment and a holistic approach is essential for determining how best to achieve water quality. The multiple roles of water in society and in the watershed have to be analyzed. The relationship between water quality and soil management has to be considered. The traditional institutional separation of water quality and quantity has to cease being a dichotomy and become regarded as interconnected concepts. Although economic valuation studies are recognized as a valuable component of a holistic approach to watershed management, they are only a component and often ignore long-term sustainability and productivity. Social and cultural information should also be considered for effective watershed management.

This paper argues that there is tremendous potential for developing green water supplies from rainwater. Minimizing runoff and erosion to prevent surface runoff, conserving forests because they recycle rainwater in an efficient way, promoting sustainable grazing to allow vegetation recovery, and conserving wetlands will produce green water supplies. This strategy is dependent on effective management of ground and surface water sources, however, and the paper insists: "Throughout history, no society has reached a high standard of living or development on rainwater alone" (p. 49).

The paper argues that resilience is an important term that refers to the "capacity of ecosystems to absorb disturbances without undergoing major change and loss of ecosystem-generated services" (p. 40 *references to Holling 1986*). The management of water quality in watersheds should strive for a resilience of the ecosystem that can effectively purify water that runs through it.

The different uses of water within the same watershed require that different distinctions be made of the various uses of water both upstream and downstream. Upstream activities that are water impacting as well as downstream activities that are water dependent must be identified. The paper emphasizes that 'water problems' have human and social origins and that water solutions will require a human and social understanding of the landscape through which the water flows.

The paper explains that effective management of water and water quality will require more financial resources than are presently applied

to water management in many areas. Regular water quality monitoring and water treatment require a reconsideration of how water is managed at an institutional level. Because of the fundamental human health issue of water quality, the public expects that present tax regimes should cover the provision, monitoring and regulation of water. However, this is not the case in many areas. Even though local taxpayers may believe that they are already paying for this service, water related institutions are beginning to lean toward user pays-polluter pays frameworks for promoting water quality. Another problem at the institutional level is a human resources issue, as new policy makers are required to manage complex water issues in new ways. Technological approaches should be merged with sustainable social and ecological solutions.

Lundqvist on page 52 describes his 1998 concept of 'hydrocide', which refers to the potential terminal social implications of not managing water in watersheds. He identifies water quality and water and land stewardship as essential for future human development. He identifies the ramifications of hydrocide as follows:

> (1) Water pollution will affect morbidity and mortality;
> (2) Loss of productivity in ecosystems, including food- and biomass production; and
> (3) Repercussions on the economy, with general economic strains as a result of increasing costs and difficulties in assuring a supply of fresh water (through the necessity of long distance water transfer solutions and treatment facilities), and also as a result of trade barriers ("green labelling" in already industrialized countries). (p. 52)

The so-called Dublin Principles of 1992 are an attempt to conceptualize the important policy implications of water management. They are as follows:

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
3. Women play a central role in the provision, management and safeguarding of water.
4. Water has an economic value in all its competing uses and should be recognized as an economic good (P.53).

Water management is depicted as being socially determined. Social realities, can in turn though, be determined by water issues: "A change in the degree of resource utilization of a renewable, finite and vital

natural resource such as water will give rise to corresponding and deep seated social changes" (p. 55).

Social changes related to water quality are complex and water quality problems are often difficult to solve because the source of the problem is often an integral part of the means of production in society. An example is water quality affected by the accumulation of commercial fertilizer and pesticides used by farmers to earn their livelihoods. Farmers can be so ensconced in a technology treadmill of agricultural production that they cannot afford to change their environmentally compromising ways.

The virtual water solution (p. 56) refers to water diverted from agriculture to the needs of industry and for urban potable water, and is shown to have some merit for nations facing absolute water scarcity in the future. Virtual water is "the amount of water needed (but not available) to grow food which instead is imported. A ton of food imported roughly corresponds to a thousand tons (cubic meters) of virtual water". This valuation of water in relative terms may become an option for supporting employment in growing cities at the expense of the livelihood of rural farmers in water scarce countries. The paper explains that virtual water has already become a reality: "Resource capture by the more powerful segments of society has led to the ecological marginalization of powerless people" (p. 63).

Forsberg, Blaine. 1991. *Optimal Fertility Management: The Case of the Brown Soil Zone in Saskatchewan*. ERDA 5.2-21a. Saskatchewan Agriculture and Food. Regina, Saskatchewan. Saskatchewan Government Printing Office.

This paper examines soil degradation in Saskatchewan and concludes that soil conservation measures are adopted only when they present immediate economic benefits to the farmer.

Friesen, Ron 1999. "Conservation suffering from farm financial crunch?" *Manitoba Co-operative*. December 9, p. A1

Farmers in Manitoba are destroying treed shelterbelts to increase their acreage and grow more crops and are therefore undoing over thirty years of conservation policy promoting shelterbelts. As farmland taxes are the same for wetlands and woodlots, farmers are destroying natural habitat to maximize their tax expenditure. Friesen explains that there is less of a need for shelterbelts as farmers adopt zero-till practices that also combat soil erosion. New conservation policy involving the heavy use of agriculture chemicals is replacing the use of tree as windbreaks to conserve the soil.

Fulton, Murray, Ken Rosaasen, and Andrew Schmitz. 1989. *Canadian Agricultural Policy and Prairie Agriculture*. Canadian Government Publishing Centre: Ottawa, Canada

This report examines structural causes of upturns and downturns in the prairie agriculture economy and how 'boom and bust cycles' have a very real impact on all agriculture policy. Particularly unsettling for farmers is the purchase of land and equipment in times of 'unsustainable expectations' when the values of land and equipment are high. As the agriculture economy cools, farmers are sometimes unable to make their land or equipment payments. Agriculture policy, including conservation policy, should consider the implications of farm debt and the stabilization of farm asset values. The article notes that agriculture policy, if implemented over time, can indirectly support the value of farmland and equipment. The farm income stabilization programs in the 1980's, however, did not stabilize the reduction in value of farm assets. Unlike European and American government policy which mainly provide income support in advance, Canadian farm income support policy is usually after the fact, and according to many farmers, too little, too late. An advance financial incentive based upon the implementation of conservation policy might be more effective for many farmers as it could provide real relief to their debt obligations.

Gertler, Michael E. 1998. "Biotechnology and Social Issues in Rural Agricultural Communities: identifying the Issues." Pp. 137-145 in Resource Management in Challenged Environments. The National Agricultural Biotechnology Council NABC Report 9. Ithaca, New York.

Gertler argues that rural communities are far more complex than just being places of agricultural production. There are different forms of property regimes, varied types of communities, and different forms of agriculture that are often taken for granted by those who formulate agriculture policy. Biotechnology, with its dependence on agrochemicals, has the potential to adversely affect rural environments as well as human health. Ongoing research has shown that agrochemicals like 24D once regarded as safe are not necessarily safe for humans or for the environment. Gertler explains that farmers are becoming powerless in being able to choose how and what they grow because value added firms dictate market conditions. As a consequence, farmers in the agriculture industry are becoming less able to direct their own destinies. Gertler argues, furthermore, that Biotechnology and the

agrochemical regime that comes with it are contributing to the alienation and oppression of rural people.

Goss, M.J. 1994. "Biophysical Criteria for the Evaluation of Intensive Cropping and Livestock Management Systems". Pp. 189-201 in *Sustainable Land Management for the 21st Century* edited by R.C. Wood and J. Dumanski. Proceedings of the International Workshop on Sustainable Land Management for the 21st Century. June 20-26. University of Lethbridge, Lethbridge, Alberta.

Goss explains that the evaluation of agriculture practices on the environment should include considerations of the (1) protection of organic matter in the soil, (2) reductions of agricultural inputs so that run off of externalities is reduced or eliminated, (3) protection of the atmosphere by the reduction and containment of gaseous emissions from intensive livestock operations, and (4) The production of safe food in an economically viable way.

Groetschel, Andreas, Ingrid Muller-Neuhof, Ines Rathman, Herman Rupp, Ximena Santillana, Anja Soger, and Jutta Werner. 2000. "Indo-German Watershed Development Programme Gujarat." Land-Water Linkages in Rural Watersheds Electronic Workshop 18 September –27 October 2000. Food and Agriculture Organization of the United Nations. Rome, Italy. Retrieved October 24 2000. (http: www.fao.org/ag/agl/watershed/casest.htm)

This case study in a highly populated rural watershed in India focuses on how the social effects of a dwindling natural resource base has affected the ability of local farmers to make a living off the land. The causes are listed as follows: Lack of -

> soil or water conservation measures, population pressure on the land, inappropriate land use and insufficient social coherence within their village communities to undertake a coherent effort to change their situation. The consequences are low productivity, poverty, and seasonal migration with all its negative social consequences and a generally low standard of living.

This case study illustrates the need for community involvement in local resource management and illustrates the serious social consequences of unsustainable agriculture practices not addressed at a local community level. This case study also indicates that policy should empower local community members to collectively solve local problems.

Kanwar, Rameshwar S. 1997. "Nonpoint sources of water contamination and their impacts on sustainability." Pp. 187- 192 in *Freshwater Contamination* (Proceedings of Rabat Symposium S4, April-May 1997).

This Iowa State University study of the effects of farming practices on water quality found that chemical and tillage management systems using multiple nitrogen injections and the banding of pesticides at appropriate times dramatically reduced the potential for ground and surface water contamination over conventional agrochemical application. The author maintains that economic development and environmental protection need not be mutually exclusive terms and should instead be understood and managed as interacting concepts.

Kowalski, Joanne Cora. 1997. "The Influence of Extension on the Adoption of Soil conservation Practices in the Brown Soil Zone of Saskatchewan." Masters Thesis. Agriculture Extension and the Department of Crop Science and Plant Ecology, University of Saskatchewan, Saskatoon, Canada.

Kowaski explains that most farmers prefer non-intrusive government policy that offers them the power to choose their farming methods. Education of conservation farming methods, then, should be activated using mass media that targets farmers and educates them about soil erosion and water quality degradation. Kowalski suggests that land assessment and crop insurance could be changed to promote conservation farming methods and farmers adopting Best Management Practices could be rewarded with lower taxes or insurance premiums.

Leiss, William. 1999. " Presentation by Dr. Bill Leiss, Queens University (invited speaker)." Canadian Environmental Assessment Agency. (http: www.ceaa.gc.ca/panels/nuclear/transcripts/earav5/s6.htm) Retrieved 09/08/2000.

Leiss explains that the process of risk communication in Canada is largely qualitative and based upon expert opinion. He argues that the effective communication of risk to the public should be on a comparative basis and enable the public to compare new risks with known risks. In addition, the process of determining and communicating risk should be done by an agency that is transparently independent of industry and government influence.

Leiss argues that water quality policy would benefit from an effective process of determining and communicating risk. The process must recognize that governments supporting intensive livestock operations and regulating their environmental effects will lack credibility with certain groups in the population. Leiss recommends that water quality policy be communicated to farmers in linguistic and conceptual terms that are easily understood by farmers and others who use water in the community. Water quality risks should be framed in terms of comparison to known risks that farmers deal with. An example would be to equate water quality risks with production risks associated to changes in the weather.

McGregor, D.F.M., D.A Thompson and D. Simon. 2000. "Water quality and management in peri-urban Kumasi, Ghana." Land-Water Linkages in Rural Watersheds Electronic Workshop 18 September –27 October 2000. Food and Agriculture Organization of the United Nations. Rome, Italy. Retrieved October 24 2000. (http: www.fao.org/ag/agl/watershed/casest.htm)

This case study outlines strategies used in Ghana for increasing awareness and communication of water management strategies and suggests that these strategies may have merit in developed countries. The study stresses that the important point for water or environmental policy is that children are not only the inheritors of our environmental legacy but that they can become powerful proactive stewards of the natural environment if they are involved in meaningful ways.

In Ghana, water monitoring kits were distributed to local schools where children aged 11 to 14 years old monitored local water quality as part of their science course. Regular water test results were collected, recorded and submitted to the local Environment Protection Agency (EPA) and the Ghana Water Company (GWC) that coordinated the testing and the distribution of the kits. Staff from the EPA and GWC followed up water quality problems identified by the students, and students were then informed of solutions taken to improve water quality. The same water monitoring kits were distributed to local farm organizations that expressed an interest in participating with the students in the water quality monitoring: "The driving hypothesis saw school children and teachers as key potential adopters and disseminators of awareness and 'good practice' in relation to daily behaviour affecting the local environment in general, and water quality in particular". The upgraded kit "provides quantitative measures of the following parameters: pH; turbidity, water temperature; and a qualitative assessment of: coliform bacteria; dissolved oxygen; electrical conductivity; nitrate; nitrite; orthophosphate". The study finds that 10 months after the beginning of the project, students are enthusiastic about

monitoring the quality of water in their own environment. The awareness of water quality issues grew in the community as students took water quality issues home with them and into the community. One school even produced a short play on the hazards of water quality and what can be done to promote clean water locally.

Miller, J.J., B.D. Hill, N. Foroud, C. Chang and C.W. Lindwall. 1992. *Impact of Agricultural Management Practices on Water Quality*. Agriculture Canada –Land Evaluation and Reclamation Branch, Alberta Agriculture, Agriculture Center, Lethbridge, Alberta.

This 1991 study found traces of pesticides in samples of soil, surface and groundwater in Alberta in 1991. Several pesticide levels were higher than government recommendations but most were within recommended guidelines. Testing near intensive livestock operations found higher than recommended levels of nitrates in the soil.

Several findings are highlighted by the study. PVC pipe seems to absorb and retain high levels of certain pesticides in concentrated form making PVC pipes a potentially health threatening choice for plumbing of rural drinking water. Several herbicides such as those based on glyphosates seem to dissipate to undetectable levels in soils and in rural water whereas other pesticides remain in the soil for a number of years and possibly could leach into ground water aquifers over time. Commercial agricultural inputs, therefore, that may have no immediate harmful effects to the environment, may have the potential for long-term adverse affects. The timing of the application of fertilizers and pesticides impacts on the levels of water contamination due to precipitation or irrigation. Regular and extensive monitoring of soil, surface water and ground water near intensive livestock operations, therefore, is essential to early detection of contaminated rural water. The study points out that Best Management Practices can only be relevant and effective if they are based upon and apply to local conditions. Also emphasized is the need for studies into the levels of pesticide leaching under BMPs.

PFRA. Project Coordinators: Smith, Dean G. and Terrie A. Hoppe. 2000. *Prairie Agricultural Landscapes: A Land Resource Review*. Regina, Canada: Prairie Farm Rehabilitation Administration.

This comprehensive review of agricultural practices on prairie landscape is designed as a reference manual for policy at the PFRA. An increase in agricultural production on the prairies is forecast but is outlined as possible only if agricultural practices intensify on the existing land base. The review emphasizes the need for site-specific,

multidisciplinary analysis that takes into production consideration the environment and the people living in it.

Rosaasen, K.A. and J.S. Lokken. 1994. "Canadian Agricultural policies and Other Initiatives and Their Impacts on Prairie Agriculture" Pp. 343- 368 in *Sustainable Land Management For the 21st Century* edited by R.C. Wood and J. Dumanski. Proceedings of the International Workshop on Sustainable Land Management for the 21st Century. June 20-26. University of Lethbridge, Lethbridge, Alberta.

Prairie agriculture is presented as a mining process in which rich natural resources from the prairie ecosystem are permanently degraded for short-term profits. The article recognizes that scientists must be responsible for working together across disciplines to provide alternative rationalizations beyond the economic evaluations of current agriculture policy. The needs of the environment and the needs of humans are shown as converging as population and economic pressure now threaten the ability of the environment to sustain us given our present technology. The article insists that without a fully developed definition and without public acceptance of sustainable agriculture, conservation policy designed to preserve water quality will ultimately fail. It is the responsibility of policy makers to inform the public about the health of their ecosystems and to give projections of long-term health risks associated with the continuation of present agriculture practices.

Ross, Carolyn. 1999. "Inventory of Wetland Associated Wildlife and Examination of Landowner Perspectives in Southwestern Saskatchewan. " Master of Science thesis. Department of Biology, University of Saskatchewan.

Ross explains that the health of an ecosystem can be measured by the range of diversity of plants and animals living within it. Agriculture practices that disturb wetlands reduce the number of species living in the ecosystem. Declines of bird species are correlated with declines in wetland and grassland habitat. Small wetlands including potholes in fields provide refuges for birds, animals, and plant life. Ross's thesis research found that 43% of farmers surveyed declared that wetlands are a nuisance, 71% drained them to increase cultivated acres and 70% cultivated to the pond's edge. Only 14% of farmers surveyed said they would conserve wetlands if it was promoted as a government policy. Natural resources such as wetlands and the organisms that live in them are not valued in economic terms and this makes them unpopular with farmers. Ross recommends financial incentives to farmers to adopt

conservation based farming practices such as maintaining wetlands and adopting buffer zones around them to minimize the damage from agrochemicals.

Schaller, Neill. 1994 "Impacts of U.S. Farm Bills on Sustainable Agriculture". Pp. 327- 341 in *Sustainable Land Management for the 21st Century* edited by R.C. Wood and J. Dumanski. Proceedings of the International Workshop on Sustainable Land Management for the 21st Century. June 20-26. University of Lethbridge, Lethbridge, Alberta.

The lack of widespread success of conservation agriculture policy in the US is blamed on "resistance from the conventional agriculture community, lack of agreement on the meaning of sustainable agriculture, lack of information about it, and prevailing beliefs and values of our society "(p. 337). Truly sustainable agriculture is possible but only if people change their faith in conventional agriculture to continue to provide food and livelihoods for rural populations.

Stirling, Robert. 1998. *Farm Knowledge: Machines versus Biotechnology*. Pp. 147-154 in Resource Management in Challenged Environments. The National Agricultural Biotechnology Council NABC Report 9. Ithaca, New York.

Technological advances that reduce the need for human labour in farming are eroding local knowledge of prairie ecosystems and farming practices. As older farmers retire and young people who leave their rural communities take their local knowledge with them, site-specific applications of technology are replaced with technology with wide applications that may be harmful to local environments. Research efforts should be directed to universities to develop sustainable local technologies suited to production and protecting local environments.

Sutherland, Jim. 1987. "A Way of Life in Question". *Sask Report News Magazine*. Saskatoon, Saskatchewan. August Pp. 20-24.

The establishment of agriculture on the prairies after the Industrial Revolution meant that community development was built around the export of farm produce to distant markets rather than regional self-sufficiency. An export economy is not always conducive to environmentally friendly farming practices as the driving economic force of production does not live with degraded soil and water and is not inclined to introduce measures to curb these by products of production.

Local farmers dependent upon the market for their economic and social survival often unquestionably follow the agro-industrial model of production and discount policy and people proclaiming the dangers of soil and water quality degradation.

Weisensel, W.P., A. Schmitz, and W.H. Furtan. 1990. *The Saskatchewan All Risk Crop Insurance Program: An Evaluation of Land Use, Technology Adoption and Participation*. Department of Agricultural Economics, University of Saskatchewan. Saskatoon Saskatchewan: Saskatchewan Agriculture and Food.

Although this study found that farmers who have crop insurance manage their farms differently than those who do not, the study concludes, "crop insurance does not influence land use significantly" (p. ii). Regional differences in climate conditions seem to be the best indicator for of crop insurance use. Several farmers interviewed suggested that crop insurance should be replaced by income insurance and others suggested that it should be changed to reflect regional differences in terrain and climate (a site-specific approach). This study was done over one year, and the evaluation suggests that for these findings to be significant, they should be observed over time. An implication for water quality policy is that site specific initiatives are more likely to be acceptable to farmers than broad policy instruments. For example, water policy with programs that support farm incomes are more likely to be accepted than those that do not.

Whetter, Jay. 1998. "Farming on the Reserve" *The Manitoba Co-operator*, February 12, page 28.

Whetter explains that farming on Indian reserves is hampered because land is held in a federal trust for band members. An individual's ability to access credit for farm purchases would be restricted. Many reservations opt for renting their farmland out to non-aboriginal farmers on a crop share or cash rent basis. When an internal agricultural initiative is proposed on a reserve, it is often withdrawn because of high start up costs or low interest from youth and occassionally by internal band politics.

World Water Council. 2000. *A Water Secure World: Vision for Water, Life and the Environment*. World Commission for Water in the 21stCentury. Then Hague, Netherlands. Retrieved March 2000. (http://www.worldwaterforum.org)

The main premise of this international report is that present water consumption rates and projected requirements for water in the developed and developing world for the next twenty years are unsustainable. In this projected time period, 17% more water for agriculture will be needed to feed increasing populations; and agriculture practices, as a main polluter of water globally, should be changed to conserve the quantity and quality of drinking water. The report emphasizes that active involvement of farmers, legislators, private companies and urban users will be needed.

The report insists that structural adjustments be made to manage water and that water be treated as a precious resource:

> Fresh water is a precious resource. Only 2.5% of the world's water is not salty, and of that two-thirds is locked up in ice caps and glaciers. Of the remaining amount, subject to the continuous hydrological cycle, some 20% is in areas too remote for human access, and of the remaining 80% about three-quarters comes at the wrong time and place-in monsoons and floods-and is not captured for use by people. The remainder is less than 0.08% of the 1% of the total water on the planet. It is precious indeed.
>
> (p. 11)

Several observations and recommendations are made by the report. Polluter pays and user pays principles are described as some of the most valuable water conservation policy measures because both put water conservation into everyone's mind. Water related subsidies, when necessary, should be directly given to individuals in a clear transparent way. It is important to separate the function of government, which is the welfare of the population, and the function of business to provide water services when discussing how to implement water policy. Incentives to corporations to protect and to clean the environment should be implemented to address the coming 'water crisis'. As public providers of water are often inefficient, water delivery systems should be de-regulated everywhere to promote efficiencies of competition, regulation and accountability in the supply of safe water. Local and national governments should seek to empower local groups dedicated to safe water and protection of the environment as well as promote the technological innovations of private companies to develop safer water strategies. The commission has identified full cost pricing of water services and technological innovation as remedies for the looming 'water crisis'. Agricultural point and non-point pollution increase the cost of treating water for consumption and have to be addressed not only as environmentally undesirable but as economically undesirable as well.

The Water Council outlines four difficult goals for future water management. They are (1) a holistic vision of participatory water management at the basin or aquifer level as has happened in Germany and France, (2) development of better water treatment technology such as the desalination of one cubic meter of sea water for less than $1, (3) full

cost pricing with targeted subsidies to those who cannot afford clean water and a separation between public regulation and private providers because 'free water leads to wasted water' and, (4) increases in funding to provide institutional incentives for private delivery of clean, safe water.

The Council explains that, besides promoting local watershed management, governments should provide attractive conditions for the private delivery of safe water in a timely transparent manner. Government should also enforce the polluter pays-user pays principle and target poor groups with transparent subsidies to allow their full participation in the resource. Incentives for technological innovations that allow for the most efficient use of water should be provided. Private companies, given enough regulatory or infrastructure incentive, can usually outperform public water providers, but should attain this goal in a highly monitored environment. Water policies that involve youth are seen as desirable as these are the people who will manage the water resources of tomorrow. The Council admits that there is an almost desperate need for adequate scientific information on water quality on which to base water decisions. Water quality information should be public and easily accessible. Research has shown that as users become more involved with their water management, often because they are paying for it, they demand better data, which stimulates even more regular monitoring of water quality. Successful water management policy should strive to integrate environmental concerns, the hydrological cycle and the socio-economic system of human activities.