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Research Objectives

An interdisciplinary research team, working in collaboration with and under the auspices of the Institute for Science, Technology and Public Policy in the George Bush School of Government and Public Service at Texas A&M University, conducted a two-year research project entitled *Ecological, Economic, and Policy Alternatives for Texas Rice Agriculture*. This project was sponsored by the Texas Water Resources Institute (TWRI). Principal investigators were Dr. Letitia T. Alston, Dr. Thomas E. Lacher, Dr. R. Douglas Slack, Dr. Arnold Vedlitz, and Dr. Richard T. Woodward. They were assisted by Dr. James C. Franklin, post-doctoral research associate, and the following research assistants: Nicole Canzoneri, April Ann Torres Conkey, Deborah F. Cowman, Jeanine Harris, April Henry, Elizabeth Kennedy, Michelle Krohn, Kelly Mizell, Jill Nicholson, Kelly Tierce, and Yong-Suhk Wui.

The objectives of this research were: (1) to develop a reliable first estimate of the environmental consequences of reduction in rice acreage; (2) to analyze economic consequences of changes in rice acreage that may occur due to the changes in the system of price supports; and (3) to critically review existing policy and explore the kinds of institutional arrangements that might be developed to encourage the preservation of the environmental amenities provided by rice farming.

Rice Industry Overview

In Texas, rice is a flood-irrigated crop grown in coastal prairies and marshes, located primarily in the region adjacent to the Gulf of Mexico. In addition to its agricultural value, rice is linked to a surrogate wetland system that provides at least some of the ecological services that have been lost as natural wetlands have given way to residential and commercial development.

Currently the rice industry is facing significant challenges that include the following:

- If government subsidies are not included in the calculations, rice sales along the Texas Gulf Coast have, on average, been unable to cover all the costs of ownership and production for many years.
- The viability of rice farming is being affected by changes to the system of commodity price supports, as a result of the 1996 Farm Bill.
- Urban expansion and increasing competition over water resources are negatively impacting rice production.
- The infrastructure that supports rice drying, milling, and transport is also declining, and the potential for a rapid and abrupt change in rice agriculture because of this decline is a significant risk to the industry.

It is believed that the impact from these market and public policy forces will probably result in further reductions in rice cultivation. This decrease has an associated environmental impact because of the potential loss of ecological services that are a by-product of the farmed wetlands on which rice is grown. Rice fields serve as over-wintering grounds for vast numbers of migratory birds and also provide recreational activities such as hunting and bird watching. Since most of the environmental benefits and costs accrue to society rather than to the rice farmers themselves, policies, regulations, and/or agreements are needed that identify the social value of these positive ecological services and that also create incentives for rice farmers to be involved in their continuation.

Ecological Analysis and Findings

To conduct the ecological analysis, long-term data sets on rice acreage and migratory birds from government and non-government sources were collected and statistically analyzed. Prior to this study, the extent of the role that the rice-cropping system plays in the ecology of migratory birds had not been documented for either the southern U.S. or Texas. It was found that the rice-agronomic system produces a variety of habitats used by a rich diversity of migratory birds during an annual cycle. It was also found that declines in waterfowl and northern bobwhite numbers were correlated with declines in rice acreage.

However, some wetland-dependent birds and some ground foraging birds exhibited stable trends or have increased in numbers during the same period of study. The data available to analyze these trends reflect only large-scale populations and broad geographic patterns. In addition, there are few data available to look at the relationships of specific bird population responses to rice-cropping practices and changes in rice acreage. The resolution of the impact of rice agriculture on biodiversity will require research designed to specifically answer this question.

Rice agriculture is highly dependent on water, and like most agricultural production, high rice yields depend in part on the use of fertilizers and pesticides. The Texas Natural Resource Conservation Commission (TNRCC) has identified 142 impaired water segments in the state that do not meet water quality standards. Of these, 81 fall within Texas rice-belt river basins, although it is not possible at this point to attribute these effects to rice agriculture. To date, Texas has not attempted any statewide evaluation of the impact of rice agriculture on water quality. Return flows from irrigated agriculture are nonpoint sources of pollution and so are not regulated.

Economic Analysis and Findings

The economic implications of the recent changes in the farm program were studied using a retrospective analysis of the sector. The rice production system provides a variety of market and non-market goods and services. Obviously, the primary output of this system is rice. It is valued by consumers, generates profits for the producers, and employment and revenue for a host of related industries. Using averages for Gulf Coast rice producers, it was found that if not for government subsidies, rice farming would have been unprofitable for many years. On average, therefore, the true economic contribution of this activity is small and perhaps negative since the costs exceed the benefits expressed by the market. Of course, the averages hide variability in which some farmers have consistently produced valuable output and made significant profits.

In addition to farming, ricelands are used for recreational hunting and bird watching. Landowners earn some income by leasing their land to hunters and guide operations. While small relative to operating expenses, this bit of revenue can mean the difference between a profitable and unprofitable year for some farmers. The market for bird watching is still new and has yet to generate much income for riceland owners. While some have speculated that this market may be a substantial source of income, recent studies suggest that the market for serious bird watching is quite limited, meaning that markets will not capture most of the non-consumptive benefits of wildlife.

Little is known about the magnitude of the non-market benefits of rice. Using an analysis of valuation studies of natural wetlands, it was found that wildlife habitat, a service that is also provided by ricelands, can be quite valuable socially. This finding demonstrates the need for future studies to determine the extent to which the ecological services provided by ricelands are substitutes for those provided by natural wetlands and the value that society places on these services.

Policy Analysis and Findings

The policy analysis included a review of existing policies and their implications for rice production. In addition, surveys were conducted of small samples of rice producers, representatives of environmental groups, and the general public. Survey results were compared where possible with data from earlier surveys to gain insight into changes in attitudes and preferences since the implementation of the 1996 Farm Bill. Information from California, another rice-producing state whose rice farmers are doing relatively better than those in Texas, was also reviewed.

Rice farmers in Texas face several challenges. One of the most important policy trends reviewed is the one encouraging a market-driven basis for U.S. agriculture, as exemplified by the 1996 Farm Bill. As stated above, we should expect rice farming to decline in Texas within this new policy climate, barring significant changes in markets, production methods, or policy. Indeed, our survey shows that a majority of rice producers expect to farm less rice or get out of farming altogether within the next five years, and 94% of farmers expecting to reduce acreage cite the 1996 Farm Bill as an important reason for this reduction. Furthermore, there are some important aspects of agriculture in general and of rice production in Texas in particular that limit the degree to which rice farmers can respond to market forces by shifting to other crops. Our survey indicates that many rice farmers are leaving farming altogether rather than planting more marketable crops, and survey results also indicate that the land tenure system that exists in rice cultivation is an important factor in these kinds of decisions. Finally, rice producers in Texas face high water costs and increasing competition for existing water supplies.

Despite these challenges, the policy and survey analysis indicates that there are reasons for optimism about the long-term viability of rice production if it can be maintained at some level for the next few decades. One source of hope is the possibility of new rice varieties that help reduce the costs of production. Another is the growing political interest in reopening lucrative markets for Texas long-grain rice.

An additional source of hope for rice producers in Texas is a growing recognition of agriculture as a multiple use activity, providing recreational and environmental benefits as well as food production. This raises the possibility of taking advantage of nonagricultural activities, such as hunting and bird watching. Our survey results show that there is some potential for increasing participation in hunting activities, particularly among smaller farms, as well as for increasing the price of hunting leases. We find many reasons to doubt, however, that bird watching can make a significant contribution to rice farmers' income.

This new view of agriculture allows the framing of rice production as part of a larger environmental issue. Government green payment programs that reward farmers for providing environmental benefits embody this view. Participation in these programs is low, however, and the most commonly cited reason for nonparticipation by our survey respondents is a lack of knowledge about these programs. Participation rates were also lower among producers who lease land than among those who own their land. Nonetheless, there is hope for expanding such programs in the future, since majorities of environmental group representatives and the public surveyed indicated a willingness to spend more to support environmentally-minded farmers. This suggests that farmers have natural allies among environmental groups and the conservation-minded public, and these alliances could provide the means for influencing future policy decisions in mutually beneficial ways. Furthermore, there is evidence that many rice producers are willing to make efforts to develop these alliances, as many of those surveyed asserted that they would be willing to adopt strategies that would educate the public and interest groups on the ecological benefits of rice production.

Recommendations for the Rice Industry and Policy Makers

The recommendations that grew out of our findings specifically address measures that have the potential to reduce the costs of production and broaden the scope of income-generating activities for rice producers. However, these recommendations also have much broader implications for basic changes in the way agriculture relates to other parts of the social structure. Traditionally, agricultural production has been seen as being in competition with other users for resources such as water and acreage. Our research points out the growing realization that there are overlapping interests among the various users of natural resources and the growing necessity of utilizing the same resources for multiple purposes. On the most general level, it is recommended that producers, their representatives, and policy makers become more attuned to the multiple output nature of agriculture and the implications of this for increased income, valuable alliances with powerful interest groups whose goals also include environmental health, and for a workable strategy for sustainable agriculture. Specific recommendations are:

- The rice industry should consider developing consumptive and non-consumptive recreational uses of ricelands.
- Rice producers need to implement new irrigation technology that would allow them to reduce expenses by using water more efficiently. Special attention needs to be paid to incentives for owners as well as tenant producers.

- Better ways to inform producers about the benefits of green payment programs such as the Environmental Quality Incentives Program, the Wildlife Habitat Incentive Program, and the National Waterfowl Habitat Program should be devised. These programs should be re-examined and their incentive structures revamped. Changes in tax laws such as federal tax credits for expenses assumed for improving or creating new habitat for wildlife and additional offsetting of property taxes on lands that provided habitat for wildlife are examples. These incentives should address the needs of owners as well as producers.
- Rice producers should be encouraged to form coalitions with environmental groups, similar to the activities of the Rice Industry Coalition for the Environment (R.I.C.E.), and with regional water planning groups.
- Better ways to inform both the public and environmental groups about the ecological benefits provided by rice production should be developed.
- The rice industry and the U.S. Department of Agriculture should adopt a broader perspective on agricultural production generally. With regard to rice, producers and their representatives need to become more attuned to the multiple output nature of rice production.
- State and federal agencies should expand programs that recognize and reward well-established links between particular agricultural practices and ecological benefits.

Recommendations for Future Research

In order to firmly establish the important role that rice agriculture can play in ecological services, the following studies need to be done:

- Collect ecological information at the farm level to document important changes in abundance of individual species of wetland dependent birds and to identify habitats used by key representatives of the various foraging guilds in the rice-cropping system.
- Conduct a comprehensive assessment of the use of rice agroecosystems by other vertebrates (mammals, reptiles, and amphibians, as well as the possible use of rice fields by fish) and relate these data to trends in abundance and distribution of these species in the coastal prairie region.
- Obtain data on the key invertebrates that are consumed by migratory birds during the annual cycle; the abundance and distribution of invertebrates associated with man-made and natural depressional wetlands are virtually unknown but have important implications for the health and abundance of avifauna in the region.
- Determine if rice agriculture provides water quality services that are present in natural wetland systems and investigate potentially detrimental effects on water quality due to increased salinity from irrigation, nutrient loading from fertilizer applications, and contamination from pesticides.

While research on impacts of rice agriculture on the ecological environment is conducted, parallel studies on the social and economic impacts of various aspects of the rice industry are also recommended. For example, our survey and other investigations have shown that the tenure system has implications for a number of critical decisions affecting rice cultivation and the ecological services associated with it. However, relatively little hard data exist describing the relationship between land tenure and decision making. Similarly, conventional wisdom holds that at some point the rice infrastructure will no longer be able to sustain production, but hard data on this are not available. At a minimum, social science research would include the following:

- Identify the critical point at which the rice industry's infrastructure will no longer support rice cultivation in the region and quantify the economic impact that changes in the industry will have on regional economies.

- Perform a series of analyses to examine the effects of the tenure system on planting and practice decisions, on resource use, and on participation in conservation programs and non-agricultural activities.
- Develop and test policy options that make participation in practices and/or programs that have ecological benefit more attractive to owners who lease their land.
- Analyze the non-consumptive and consumptive recreational uses of agricultural land to ascertain the distribution of costs and profits and to establish the break-even points. Costs would have to include some measure of expenses incurred by farmers resulting from public access to their land.
- Analyze the ecological impact of current non-consumptive and consumptive recreational uses of agricultural land and model the potential impact of their expansion.
- Perform a full economic analysis of rice production in Texas to quantify the value of the market and non-market goods and services. The analysis should also focus on the secondary community-level impacts of the industry in the form of, for example, employment and local tax revenue.
- Fully assess the potential for strategic coalitions and both policy and programmatic means for facilitating them.
- Systematically examine the economic, social, and ecological outcomes of participation in green payment programs.
- Examine the advantages of various policy and program options of green payment and other conservation programs for their ability to increase the participation by various groups. This type of analysis would include an investigation of tax options that could contribute to a decrease in the fragmentation that often results when inheritance taxes require the breakup of land holdings.

It should be noted that most of these studies would be truly interdisciplinary, involving not only economists and policy scientists but ecologists as well because questions of ecological impact and soundness will be an important part of the research in many cases.

Our research has indicated that there are both economic and ecological benefits that can be derived from alliances among rice producers, other environmentally linked commercial interests, and environmental interests. In addition, our survey and others have indicated that the public could be a valuable ally in this kind of effort. This is a relatively new concept, however, and little information exists on either its feasibility or its long-term consequences. We would recommend research to add to our knowledge base on the economic, political, social, and ecological feasibility and potential consequences of such alliances.

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PROBLEM AND PROJECT GOALS

The 1996 Farm Bill, also known as the Federal Agriculture Improvement and Reform (FAIR) Act, introduced a phasing out of the commodity price supports system, and this is believed to have caused important changes in farming in Texas. It is widely anticipated that the loss of price supports will lead to significant reductions in rice cultivation. The resulting conversion of rice acreage to other uses represents an environmental concern because of the possible loss of ecological services that may be a by-product of rice enterprises. Natural wetland areas are important because they provide numerous ecological and economic benefits, such as wildlife habitats, recreation, storm buffering, and improvements in the quality of water outflows.

There has already been significant wetland loss. It is estimated that 116.7 million acres of the original 220 million acres of wetlands have been lost in the lower 48 states (USEPA, 1998) with agricultural and urban growth causing most of the losses, especially during the 1950s-1970s (Johnson, 1992). An estimated 56% of the natural wetlands in Texas have been lost in the last 200 years (Anderson, 1997).

In Texas, the loss of wetland benefits has been mitigated to some extent by the presence of flooded rice acreage that can provide some of the same benefits as natural wetlands (Brouder and Hill, 1995). Rice fields now provide an estimated 30% of Texas' existing wetlands (Barta, 1997). These surrogate wetlands also generate valuable ecological services as a by-product of agricultural production. These services include over-wintering grounds for many migratory birds, as well as habitat for resident bird species. In addition, these rice wetlands provide habitat for many different nonavian species, such as amphibians, reptiles, mammals, and insects. It has been suggested that rice fields may improve water quality through the uptake of excess nutrients (Fouss et al., 1998; Huffman, 1996). This results in a decrease in excess productivity that would reduce potential negative consequences such as down-stream algal blooms. Although they are not perfect substitutes for wetlands, rice fields are more manageable than natural wetlands because farmers flood them even in drought years (Barta, 1997).

PROJECT OBJECTIVES

Over the past two decades, most agricultural commodities, including rice, have faced a cost-price squeeze. Rice crop prices have decreased substantially, in real terms, while production has remained stable. It is also believed that the economic viability of rice farming is being affected by the elimination of federal subsidy programs. Urban expansion and increasing competition over water resources also threaten rice production (American Farmland Trust, n.d.; TWDB, n.d.). It is believed that these market and public policy forces may continue to cause reduction in rice acreage and an associated long-term decrease in the wetland services they provide. However, "the full role and impact of rice production on the environment and ecology of the Gulf Coastal Region and other rice producing regions is not well understood" (Fouss et al., 1998). Valid and useable information that can contribute to understanding the role of rice production in the ecology of the Gulf Coast Region has not previously been assembled.

The objectives of this research have been to (1) develop a reliable first estimate of the environmental consequences of reductions in Texas rice acreage, (2) analyze economic consequences of changes in rice acreage that may occur due to the changes in the system of price supports, and (3) to critically review existing policy and explore the kinds of institutional arrangements that might be developed to encourage the preservation of the environmental amenities provided by rice farming.

Because policy forms the background for much that has taken place in agriculture since 1930, the report will begin by establishing the policy context for the ecological and economic analyses. This will be followed by a quantification of wildlife benefits, particularly for waterfowl and geese, as well as a review of our current state of knowledge about impacts on water quality. Then the economics of rice production along the Texas coast will be presented. Next, the policy implications of the findings will be reviewed. Finally, alternative courses of action will be examined and their probable outcomes explored in light of the economic and ecological analyses and survey results for rice producers, environmental group representatives, and a sample of the general public.

THE POLICY CONTEXT

FARM POLICY AND THE 1996 FARM BILL

Two policy areas are important for affecting the future of rice. Farm policy and environmental policy are both relevant to understanding the legal and political context in which changes in rice production are taking place. Like social programs such as Social Security, contemporary farm support programs were developed in response to stresses produced by the Great Depression of the 1930s. The Agricultural Adjustment Act (AAA) of 1933 introduced price support and acreage reduction programs designed to provide producers with the same purchasing power that existed in the base years of 1909-1914 (Hansen, 1991). Although some portions of this act were declared to be unconstitutional, Congress subsequently enacted a series of bills that established an array of agricultural support programs that, in combination, attempted to maintain farm incomes while exerting control over the supply of farm products (Knutson et al., 1995).

At the time of program implementation, the control efforts were oriented toward stabilizing prices by reducing the supply of agricultural products. World War II changed the focus of governmental intervention from one of supply control to that of supply enhancement. Price supports were increased significantly, and the commodities covered by the parity-based supports increased as well. The Post-war Agricultural Act of 1949 was passed without an expiration date, and all bills passed after this date were passed as amendments to it. By the mid-1950s, there were surplus stocks of price-supported commodities, and the policy shifted once again to supply control (Hansen, 1991). This took the form of acreage reduction programs that extended into the 1960s. By the 1970s, dollar devaluation and increased purchases of U.S. farm products abroad (especially by the Soviet Union) led once again to an emphasis on increasing agricultural production. There was also a demand for greater planting flexibility. The 1973 Farm Bill introduced the target price deficiency payment concept as a means of income support. This program ensured that farmers achieved a predetermined target price for their output. The structure of the program, however, was such that farmers tended to get locked into a particular crop since payments were based on "base acres" of a crop. The government used this program to encourage farmers to participate in the acreage reduction program. This 1973 Bill limited total government payments to $20,000 per person but, because of the agricultural sector's financial problems, this limit was later increased to $50,000 per person (Richardson et al., 1999).

The 1985 Farm Bill represented a major shift in farm policy as it sought to allow the prices of U.S. commodities to fluctuate with prices in world markets. This was accomplished by lower price support levels. For rice and cotton, a marketing loan program was introduced in which the government no longer purchased excess stocks at the loan-rate price, but made "deficiency loan payments" directly to the farmers. Hence, for the first time, the market price of rice actually fell below the loan rate price and the prices for these commodities began to fluctuate much more with world prices. Through programs of target prices and deficiency payments, however, farmers still enjoyed income support. The 1990 Farm Bill expanded the marketing loan program to other commodities to increase the relative attractiveness of U.S. commodities on world markets. In response to the pressure to cut the federal deficit, target prices were decreased in 1990.

The 1996 Farm Bill furthered this policy direction and made substantial changes to previous farm legislation. The first major change was the elimination of the target price deficiency payment program. By eliminating the concept of base acreage, farmers were no longer tied to a single crop but could instead produce those for which they could get the best price. To cushion farmers from the blow to their incomes, the 1996 Bill instituted government contracts with landowners that established fixed, declining payments over seven years, regardless of market conditions. However, farmers were no longer required to plant the crop in order to receive subsidies, nor were they required to make government mandated acreage reductions. These changes in the Farm Bill, therefore, gave farmers much more flexibility in planting decisions. They were also susceptible to risks to which they had not been vulnerable under previous farm bills.

SUPPORT FOR THE 1996 FARM BILL

The strongest legislative proponents of the 1996 Farm Bill were the Senate and House chairs of Agriculture Committees in those two bodies (Lugar, R-Ind and Roberts, R-Kan). Most Republicans supported the Bill. Supporters argued that the Bill would encourage farmers to produce for the market and would encourage them to take the booming overseas market into their planting decisions (Hosansky, 1996a). In spite of the faith in market forces that were the basis for this Bill, it continued to provide protection for peanuts, tobacco, and sugar. Many Democrats had reservations about the Bill, arguing, for example, that it would provide higher than necessary levels of support while commodity prices were high, but would provide low levels of support when prices dropped (Hosansky, 1996a).

Many farmers (primarily corn and soybean growers) generally supported the 1996 Farm Bill because they saw the potential for varying their crop production. In addition, the direct payments promised by the Bill would provide relief for drought-stricken farmers in the mid-West who would not receive subsidies for ruined crops. Most major farm groups also endorsed the Bill. At the time, commodity prices were so high that many farmers were receiving no subsidies at all, and the 1996 Farm Bill promised higher payment in the short term. Consumer groups generally supported the Bill because they expected that it would lower food prices (Hosansky, 1996a). Environmental groups supported the Bill for continuing the old conservation programs and adding new ones (Hosansky, 1996a; 1996b).

The strongest opposition to the 1996 Bill came from Democrats who feared that the farmers in their districts would be hurt (Hosansky, 1996a). Rice and cotton farmers were also skeptical of the Bill as were wheat farmers in the drier wheat producing portions of the country (Hosansky, 1996a). These groups were dependent on subsidies and had few profitable crop alternatives. The Clinton administration also criticized the Bill for its fixed payment system. However, Democrats received concessions on food stamps, conservation programs, and the retention of 1938 and 1949 farm law and so most of them voted for the Bill.

New conservation measures were also created at this time. The Environmental Quality Incentives Program of 1996 was one of a long list of environmentally–oriented programs that started with the Conservation Reserves of the 1930s and the Soil Bank of the 1950s. However, growing concern for the environment has supported a recent proliferation of programs designed to encourage the modification of agricultural practices thought to be damaging to the environment (Ervin, 1994; Ervin et al., 1998). Concern over the budget deficit and pressures from market conditions, trade liberalization, and demographic shifts have also produced a demand for better targeted agro-environmental programs (Stuart and Runge, 1997; Batie, 1998).

Farm bills prior to the 1996 Farm Bill included conservation provisions which used commodity and other farm programs as leverage to induce producers to avoid certain farming practices. For example, eligibility for price supports, crop insurance, disaster payment, and loans were dependent on compliance with conservation practices. These programs were often abandoned by farmers when market prices for program commodities were high and government support was less needed, resulting in loss of reserve acreage and associated conservation benefits (Ervin et al., 1998). Past conservation programs have, therefore, been criticized for not being targeted to achieve environmental outcomes, and as a result, have not provided stable conservation incentives or desired environmental outcomes (Batie, 1998; Heimlich, 1995; Wu and Babcock, 1995; Ervin et al., 1998).

In general, farm bills have sought to (1) maintain farm income at politically acceptable levels, (2) stabilize commodity prices, and (3) exert control over farm production and over at least some of the environmental effects of that production. Specific farm bill provisions over the years have reflected beliefs about the best ways to achieve these goals. It may be, as Knutson et al. (1995) contend, that the failure of any given year's farm policy to achieve its goals over a long period of time has been the result of a poor diagnosis of the problem. However, the formation of farm policy is also influenced by more than the current understanding of the problem. It is also subject to U.S. and foreign agreements as well as world market activity, political climate, the strength of special interest groups, the results of technological changes, and the relative importance of other issues and agendas before the nation and its legislators.

The goals that drive farm policy have, in other words, been "…distinguished by these qualities: they are multiple, conflicting, and vague" (Nienaber and Wildavsky, 1973, p. 10). Knutson et al. (1995) identified a number of farm policy goals that emerged in this decade, goals requiring conflicting policies and programs to carry them out. For example, maintaining a safety net for farmers and reducing farm programs to establish a more open trade environment are goals that can call for quite different policy configurations. Another pair of goals in potential conflict is assuring sufficient food supply for the world and addressing concerns over the environmental effects of some agricultural practices (see Napton, 1994).

The aspects of the 1996 Farm Bill that are of most concern here are the phasing out of deficiency payments that have helped to sustain rice production in the past and the uncoupling of production and contract payment under the current phase-out schedule. As stated above, supporters of the Bill argued that these changes would encourage farmers to plant according to market demands and make U.S. agriculture efficient by forcing it to remain competitive. Eliminating inefficient farmers may be one, overall, result of these changes. However, the constraints faced by rice producers, to be discussed in greater detail later in the report, limit the alternatives available to even the most efficient rice farmers facing unfavorable market conditions.

Rice production decisions have other consequences that were not considered at the time of the passage of the 1996 Farm Bill. Discussions focused exclusively on agricultural producers and ignored the effects of the Bill on other actors. A poor market for Texas rice and various disincentives to rice cultivation inherent in farm policies since the 1980s have been associated with fewer acres being planted in rice. Rice farming, however, is accompanied by a considerable additional infrastructure that is often highly specialized. A definite reduction in the rice infrastructure has been seen as a reduction in acres planted in rice has occurred. For example, between 1996 and 1997, the number of dryers in rice producing counties of Texas declined by 48% (Fouss et al., 1998). These secondary effects (also know as pecuniary externalities) obviously have short-run impacts on local economies, and long-term implications for any future rice production. As the number of acres planted in rice declines, the milling, processing, and drying infrastructure supported by it will decline as well. Infrastructure loss will make it difficult to take advantage of any future improvement in the rice market or any attempt to improve rice's economic returns to the area brought by the creation of value-added industries. It will also decrease the economic viability of even the most efficient rice producers who might be left because it means that Texas rice will have to be shipped outside the state for drying and milling.

Economic analysis of such losses in production and its infrastructure tends to view the impact of such changes as local in nature. Although such losses would introduce difficulties for rice producing counties in Texas, these difficulties would be canceled out by economic gains in other areas or from other activities in the local area. Another set of potential consequences, however, has ramifications that extend beyond the local rice-producing areas. These are the ecological consequences of surrogate wetland loss that are an inevitable part of this process. Another example of the unanticipated consequences of the 1996 farm policy is its apparent impact on the non-human environment. All agricultural activity modifies the environment in some way, and from its earliest years, some aspects of farm policy have focused on ameliorating the environmental aspects of agricultural practices (Napton, 1994). Rice production, however, occupies a unique position in the relationship between the human and non-human environments. The most visible positive contribution rice production makes is to provide forage and habitat for over wintering waterfowl along the coast. A negative impact on these bird populations would logically be a consequence of declining rice acreage, but this has yet to be demonstrated empirically.

WATER POLICY

Policies on water quality and water availability are relevant to any discussion of the future of rice production in Texas. Historically, the conservation programs developed as part of agricultural policy have focused on reducing and preventing soil erosion rather than on issues of water conservation. Ironically, the outcome of farm policy for much of its history has been to discourage crop rotation and other practices that would reduce erosion. In addition, practices indirectly encouraged by farm policies have had negative impacts on water quality (Napton, 1994). The late 1970s brought concern over the deleterious effects of agriculture on the environment, and regulations and programs were implemented to address some of them. Many point sources of pollution were regulated by the 1980s, leaving agriculture as an identifiably major nonpoint source of water pollution (Braden and Lovejoy, 1990). Little of the research or program development at the time did much to change this perception. It has been claimed that rice production has a positive effect on water quality because rice fields may duplicate some of the cleansing functions of natural wetlands. This has yet to be clearly demonstrated although some research has been done on the way different management practices contribute to the levels of pesticides, herbicides, and sediment leaving treated rice fields (e.g. see Fealey et al., 1992).

Water quality standards mandated by the Clean Water Act of 1977 affect the types and amounts of fertilizer, herbicide, and pesticide that can be used on rice crops, but these inputs are also important in determining the quality and quantity of the rice grown. In Texas, greater problems with insects and disease than are experienced in cooler locations have encouraged the use of these inputs, and herbicide and fertilizer account for close to 30% of the variable costs of rice production (Patterson, 1997). The restrictions to their use introduced by water quality standards are being met with research into rice varieties that are resistant to disease and to herbicides.

One of the most important recent water policy documents is the 1997 Texas Senate Bill 1 of the 75th Texas Legislature (SB1). It is the end product of the Water Plan Legislative Summary that addressed water project and policy findings. The 1997 SB1 is a comprehensive omnibus water bill passed by the Texas legislature that is based, in part, on the recommendations by the Texas Water Development Board (TWDB). It addresses a number of different water-related issues. The 1997 SB1 established a system of 16 state water planning groups organized around state planning regions. Each of these groups is responsible for setting up a 50-year water plan for its region. These plans will be incorporated by the TWDB into a statewide water plan by September 1, 2001. The planning groups are to represent 11 interest areas: agriculture, counties, electric utilities, environmental interests, industry, municipalities, the public, small business, river authorities, water districts, and water utilities. Three of the planning regions (East Texas, Houston, and Mid-Coast) include in their areas, the rice producing counties of Texas. Generally speaking, the Mid-Coast region includes those counties referred to as the western rice-producing counties, and the East Texas Region includes the eastern rice-producing counties. The Houston region includes both eastern and western counties. Because of its importance in the water utilization equation, the counties immediately surrounding Houston/Harris county were designated a separate region (TWDB, 1997).

All three planning regions that make up the Texas rice belt (East Texas, Houston, Mid-Coast) predict a decline in water going to agriculture starting by 2010 and continuing through 2050 (TWDB, 1997). This estimate is based on assumptions of more efficient water use by agriculture and a decrease in the number of acres in agricultural production. Shifts from agriculture to industry are predicted for the East Texas and Mid-Coast regions, and shifts to both industrial and municipal uses are predicted for the Houston region. The Mid-Coast region, which comprises much of the lower Gulf Coast rice region, is expected to experience significant shortages in water supplied for agriculture by the year 2000 continuing through 2050 if alternative water supplies are not developed (TWDB, 1997). Moreover, the Lower Colorado Regional Water Planning Group lists as a major problem the inadequacy of surface water and ground water supplies to meet long-term irrigation needs in Colorado, Wharton, and Matagorda Counties, all of which lead the state in rice production (LCRA, n.d.). The Lower Colorado River Authority, which provides irrigation water to this leading rice-growing region, defines irrigation water as interruptible (i.e. it does not have to be providing throughout the year). Demands for interruptible water are met only to the extent that water is available after firm demands are satisfied. Under normal conditions, there is currently sufficient water to meet the demands of farmers, but this is not the case during drought years (LCRA, 2000). Increased population growth and economic development will increase the competition for water in Texas, so water availability for rice production is an important issue.

It is hoped that an important outcome of the deliberations of the regional water planning groups will be realistic estimates of future water needs for the various interest groups and decisions on how already scarce water resources will be allocated. Water planning group membership lists suggest that in the rice producing areas of the state, rice interests are generally well-represented among the agricultural interests in rice producing counties, with the exception of the East Texas Region that includes the Beaumont area (TWDB, n.d.).

A number of other provisions of the 1997 SB1 also have implications for the future viability of rice production in Texas. Article 8 repeals the Wagstaff Act which allowed a city needing municipal water to take it from another water right holder without compensation as long as the water right was established after May 7, 1930. This act was the result of concern by West Texas municipalities over plans to harness water down river for hydroelectric power and fear of the impact that future industrial development would have on municipalities (Wimberley, 1996). Article 5 approved funds for the TWDB to provide indirect loans to farmers for water conservation. It also raised (from $5 million to $15 million) the amount in the Linked Deposit Program (Sec. 44.007) to support agricultural production in Texas, two-thirds of which can be used to finance water conservation.

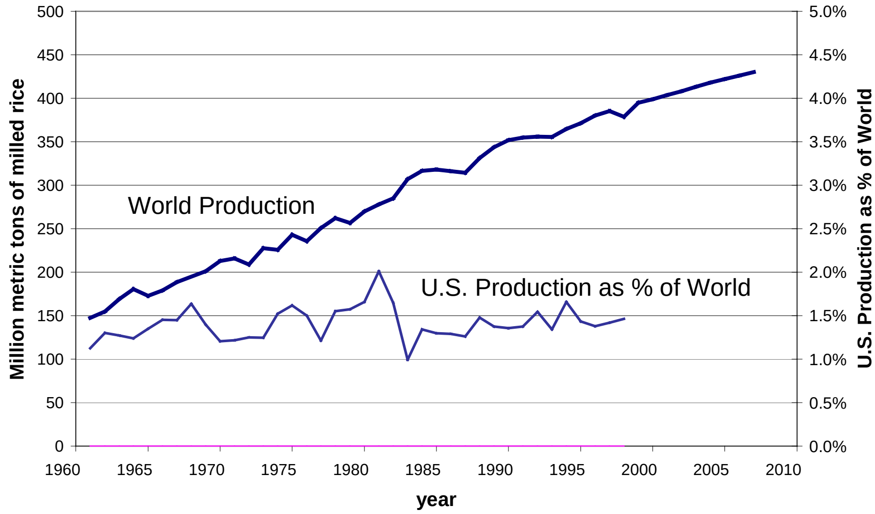
Water quality and availability are linked to the viability of wetland areas as well as to the viability of rice agriculture. Much of the ecological interest in rice agriculture is because of its ability to provide services similar to natural wetlands. Once viewed as wastelands, wetlands are now widely regarded as valuable resources. Wetlands have numerous benefits including providing fish and wildlife habitats, offering recreational and educational opportunities, maintaining ground water supplies and water quality, protecting shorelines from erosion, storing flood waters, and trapping sediments (USEPA, n.d. c). This growing appreciation and subsequent increase in perceived value of wetlands is evident in the proliferation of public policy directed at their protection and conservation.

HISTORICAL BACKGROUND OF RICE AGRICULTURE

Rice is a flood-irrigated crop grown in Texas coastal prairies and marshes, located largely in Southeast Texas, along the coastal plain adjacent to the Gulf of Mexico. The rice-growing region encompasses land from the coastal marshes to from 12 to 93 miles (20 to 150 kilometers) inland (Gould, 1975). In Texas, rice is grown on lands that were historically tallgrass prairies, characterized by nearly level to gently sloping topography, interspersed with small, rain-filled depressions (Lacher et al., 1999). Rice was first introduced to the coastal prairies in the mid-1800s. By 1954, a peak of 254,000 hectares of rice were harvested on the gulf prairies (Hobaugh et al., 1989). Prior to the late 1800s, the prairies of the upper Texas coast were grazed by herds of native bison (*Bison bison*) and non-native wild horses (Robertson and Slack, 1995). As the land was settled, bison and wild horses were replaced with free-ranging cattle and later by agricultural crops (Craigmiles, 1975; Stutzenbaker and Weller, 1989).

In spite of its importance for the state, the role of Texas rice production has always been relatively small with regard to the world market. Total world rice production increased continuously during the 1960-1997 period and is projected to continue to rise until 2007 (USDA, 1999). As can be seen in Figure 2-1, the U.S. remains a relatively small contributor to the world production of rice. The U.S. portion of the total has only once exceeded 2% and has remained at approximately 1.5% in recent years.

Figure 2-1
World Rice Production and the Percentage of World Rice Produced in the U.S., 1960-2007
(Production and percentages are projected for the years 1999-2007)

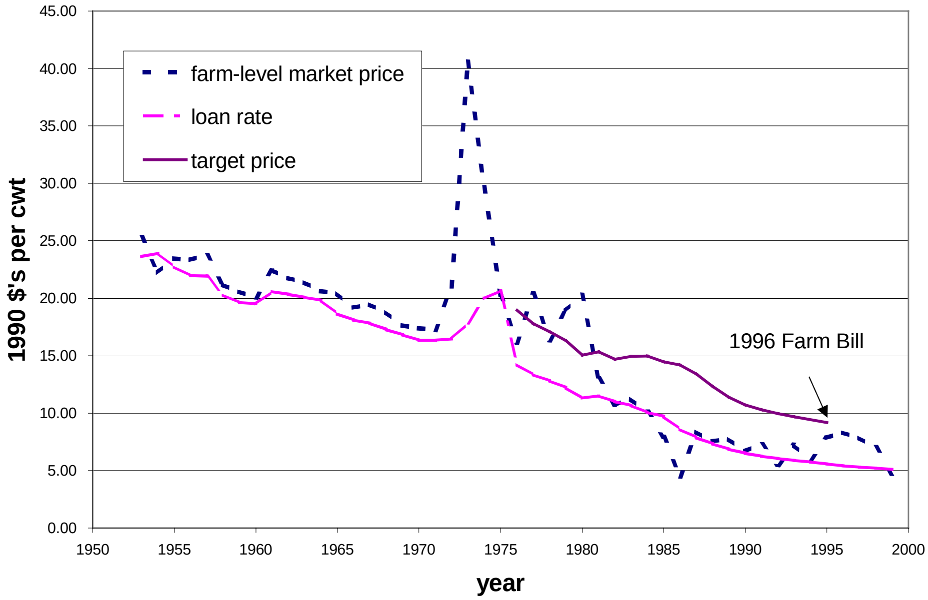


Sources: 1961-1998 USDA 1998, Rice Yearbook. Projections for 1999-2007 from USDA, 1999a. International Agricultural Baseline Projections to 2007.

Recent changes in farm policy have made the U.S. market price of rice fluctuate with prices on the world market. The relatively small role played by the U.S. in this market implies that changes in U.S. production will have little impact on the market price of rice. Hence, the price of rice in the U.S. (and in Texas) will be largely determined by supply and demand at a global scale. The real price of this commodity has declined substantially since the 1950s (Figure 2-2).

In addition to the gradual decline in the real price, starting in the early 1970s, the variability of the price from year to year increased significantly. It was largely in response to the increasing variability of agricultural prices that farm programs were put in place in the mid-1970s to insulate U.S. farmers from the volatile international markets. As can be seen in Figure 2-2, the target price exceeded the farm price in all but three years between 1976 and 1996. Hence, in all years but these three, the government provided a substantial portion of the net income farmers received from the production of their crops. In order to qualify for the target-price program, however, farmers were required to withhold a portion of their total acreage from production. While these programs led to a relatively certain economic environment for rice production, they also reduced the number of acres in production. These acreage reduction requirements explain most of the dramatic decline in acreage in the early 1980s despite the increases in the target price. Rister et al. (1990) have identified three programs that provided important incentives for reductions in cultivation. They were the Acreage Reduction Program (ARP), the Paid Land Diversion Program (PLD), and the Payment in Kind Program (PIK).

Figure 2-2
Market and Government Support Prices Per Hundred Count Weight for Rice — 1953-1998
(1990 U.S. $'s)



Source: 1961-1998 USDA 1998, Rice Yearbook. (http://usda2.mannlib.cornell.edu/data-sets/crops/89001/table17.wk1). Consumer Price Index used to deflate nominal values. 1999 estimate from USDA, 1999. World Agricultural Supply and Demand Estimates. August 12, 1999.

In response to the multinational General Agreement on Tariffs and Trade (GATT), the regulatory changes of the 1996 Farm Bill eliminated the target price, exposing farmers to market risks to a greater extent than any time in recent history (F. O. Boadu, Associate Professor, Department of Agricultural Economics, Texas A&M University, College Station, Texas, personal communication, February 1997).[1] While the Farm Bill called for the gradual elimination of deficiency payments by 2003 (see Table 2-1), there is no longer a requirement that the commodity must be produced in order to obtain the subsidy (Outlaw et al., 1996). Uncoupling the link between production and government payments further reduces the incentive to farm and has provided an extra incentive for landowners to renegotiate or end leases because they can receive the government payments without sharing them with the farmer (F. O. Boadu, personal communication). This is particularly important in rice because a high percentage of land is leased. Approximately 67% of the rice farmers surveyed indicated that they owned less than 40% of the land they farmed (Eaton, 1993).

[1] The loan program continues to set a floor for the price that farmers actually receive for their product. However, as can be seen from Figure 2-2, this loan price is substantially lower than the target price.

Table 2-1
Schedule of Declining Support Payments Under the 1996 Farm Bill

			CROP YEAR						
Commodity	Texas Rank (among U.S.)	Production as % of U.S. Production*	1996	1997	1998	1999	2000	2001	2002
			Dollars Per Acre						
Rice	4	10.7%	116.10	114.42	122.78	119.04	109.01	88.14	85.20
Cotton	1	25.7%	32.18	26.29	27.96	27.00	24.72	20.03	19.43
Corn	**	**	19.98	38.35	30.04	29.16	26.69	21.65	20.85
Wheat	**	**	21.00	14.72	15.68	15.32	13.76	11.09	10.85
Grain Sorghum	2	28.5%	15.54	25.07	21.07	20.06	18.52	15.01	14.53

* Based on 1992-1995 levels.
** Not in top 5 producing states.
Source: Outlaw et al., 1996

In addition to their agricultural value, these ricelands are linked to the wetland system that drains into streams, bays, and estuaries of the Gulf of Mexico. Moulton et al. (1997) have described the Texas Gulf Coast as one of the most ecologically complex and biologically diverse regions of the state. Coastal wetlands perform valuable ecological services including water quality maintenance, groundwater recharge and flow stabilization, energy transfer and ecosystem stabilization, biogeochemical cycling, and maintenance of fish and wildlife habitat (Hefner et al., 1994; TPWD, 1997a). During the period 1955 to 1992, Texas lost approximately 61,000 hectares (150,730 acres) of coastal, freshwater emergent wetlands (Moulton et al., 1997).

The wetland system along the Texas coastal plain is important economically as well as ecologically. It supports a $400 million commercial and sport fishing industry, which employs in excess of 30,000 coastal residents (Moulton et al., 1997). The coastal prairies, marshes, and associated bays of the upper Texas coast alone account for $75-150 million annual income from recreational fishing. From 1990 to 1994, over 30-40,000 hunters pursued an average of 1 million geese and over 1.5 million waterfowl in Texas (Moulton et al., 1997). Further, in 1992 alone over 6,000 bird watchers spent time and money at High Island, Texas and adjacent mainland sites on the upper Texas coast observing neotropical migrants.

An important aspect of the history of Texas rice farmland is the multiple functions that these lands provide. Rice farmland is primarily seen by policy makers and the public as an agricultural enterprise. With its supporting infrastructure, rice production supplies employment to approximately 6,200 Texans in 1992 (Taylor et al., 1993). However, rice farming also contributes to a surrogate wetland system that provides at least some of the ecological services that have been lost as natural wetlands have given way to residential and commercial development (Huffman, 1996). As such, rice farmland may provide ecological services that contribute to the health of the natural environment of Texas and, therefore, contributes indirectly to commercial enterprises, such as sportfishing, that depend on a healthy environment for their continuation. These surrogate wetlands also directly provide non-farming economic benefits in the form of hunting and wildlife viewing opportunities. The presence of these multiple functions has been largely ignored in deliberations on farm policy.

Because of recent changes in the Farm Bill, therefore, the economic environment faced by rice farmers has changed dramatically. While the future of Texas' rice industry cannot be predicted with certainty, there is little doubt that producers are more exposed to market forces today than at any time in recent history. This exposure may lead to changes in rice acreage. As we discuss in the following section, changes in rice acreage may have important ecological consequences.

ECOLOGICAL IMPACTS OF RICE AGRICULTURE

WATER QUALITY AND QUANTITY ISSUES IN RICE AGRICULTURE

BACKGROUND

Water quality standards in place through the Clean Water Act (CWA) regulate discharge to waters of the United States through permits issued under the National Pollutant Discharge Elimination System (NPDES). The CWA requires that point source discharges of pollutants to waters of the United States have an NPDES permit. Currently, return flows from irrigated agriculture or agricultural stormwater run-off are not defined as point source pollution (USEPA, n.d. a), and so are not regulated and rarely tested. However, this status may change, as proposals have been put forth by U.S. EPA to redefine individual farm drainage outlets as point sources, and/or to require sources of nonpoint discharges to follow water pollution reduction management practices (University of California Agricultural Issues Center [UCAIC], 1994).

Rice agriculture is highly dependent on water, and like most agricultural production, high rice yields depend in part on the use of pesticides and fertilizers. Rice cultivation, therefore, faces a variety of water quality issues. Much of the rice grown in the United States today relies on the use of agricultural pesticides for the control of water weevils (Furadan®), tadpole shrimp (*Triops longicaudatus*) (Bluestone®), and invasive broadleaf plants, water grasses, and sedges (Bolero®, Ordram®, Londex®, and MCPA [4-Chloro-2methylphenoaxyacetic acid]). In addition to pesticide discharge regulations, the rice industry may encounter future regulations regarding sediment, nutrients, and other constituents of rice field drainage. As of September 14, 1998, U.S. EPA no longer administers the NPDES permitting process in Texas. The Texas Natural Resource Conservation Commission (TNRCC) is responsible for the replacement program entitled the Texas Pollutant Discharge Elimination System (USEPA, n.d. a). U.S. EPA is now requiring states to comply with the Total Maximum Daily Load (TMDL) provisions of section 303(d) of the CWA. A TMDL study estimates the maximum amount of pollution a water body can receive and still be in compliance with water quality standards. In the TMDL program, studies are conducted to determine the maximum level of individual pollutants (often nutrients, pesticides, or fecal bacteria) which will be allowed within a given stream segment. The goal is to protect water quality to such an extent that the stream will be able to meet it's designated use (recreation or a source of drinking water, for example). Once a TMDL has been established, programs then focus on identifying which activities within the watershed are major contributors of pollution. Later, efforts are then undertaken to reduce both point and non-point pollution sources. TMDL implementation plans for the state of Texas have already been approved by U.S. EPA (USEPA, n.d. a).

TNRCC monitors Texas water quality and has water quality data available by watershed/river basins or reservoir/stream/river segments for the state. In 1998, TNRCC began to perform water quality assessments annually within two of five basin planning groups. The two groups (B and C) monitored in 1998 consist of the Trinity River Basin, Neches-Trinity Coastal Basin, Trinity-San Jacinto Coastal Basin, San Jacinto River Basin, and the San Jacinto-Brazos Coastal Basin, and associated estuaries. In 1999, the two groups (D and E), to be monitored included the following river basins, bays, and estuaries: Brazos River; Brazos-Colorado Coastal; Lavaca River; Colorado River, Bays, and Estuaries; Colorado-Lavaca Coastal; Lavaca-Guadalupe Coastal; Guadalupe River; San Antonio River; San Antonio-Nueces Coastal; Nueces River; Nueces-Rio Grande Coastal; Rio Grande, Bays and Estuaries; and the Gulf of Mexico (TNRCC, 1999a). Data has been aggregated at river basin level and is also available at reservoir, stream, or river segment level. The following parameters are included: 1) fecal coliform; 2) dissolved oxygen; 3) metals; 4) organics; and 5) dissolved solids.

TNRCC identified 142 impaired water segments in the state that do not meet water quality standards in the 1996 State of Texas Water Quality Inventory. Of these, 81 fall within Texas rice-belt river basins. These basins are: Sabine, Neches, Neches-Trinity, Trinity, Trinity-San Jacinto, San Jacinto, San Jacinto-Brazos, Brazos, Brazos-Colorado, Colorado, Colorado-Lavaca, Lavaca, and Lavaca-Guadeloupe (TNRCC, 1999b).

It is difficult, if not impossible, to attribute any of these effects to rice agriculture due to the presence of other industrial and municipal sources on those segments. Because agricultural drain water from rice fields is not categorized as point source pollution, and water in these rivers flows from many point and nonpoint sources upstream, it is largely unregulated, and therefore is not monitored by TNRCC or the Lower Colorado River Authority (LCRA) and other river authorities. To date, Texas has not attempted any statewide evaluation of the impact of rice agriculture on water quality. Also, rice agriculture occurs on the lower reaches of these rivers where accumulated effects from the entire drainage would be most manifested. Very little has been published in the scientific literature on water quality in Texas rice agriculture, and data measuring agricultural run-off from rice fields does not appear to exist.

We do know, however, that the percentage of rice farms in Texas that use pesticides is much higher than in California (Salassi, 1992). Insecticide use by rice farmers in California is 70.4% compared to 73.1% in the Upper Texas Gulf Coast (UTGC) and 62.3% in the Lower Texas Gulf Coast (LTGC). No farms used fungicides in California compared to 41.5% in UTGC and 40.1% in LTGC. Herbicide use was 96.6%; 96.5%; and 97.3% in California, UTGC, and LTGC, respectively. Blackbird control was 19.8%; 45.2%; and 19.8% in California, UTGC, and LTGC, respectively. As of February 1999, an estimated 2.5 million blackbirds were killed in the Texas rice belt through the use of the avicide DRC-1339 (Way et al., 1999).

Problems with drinking water for urban areas that are attributable to management practices have not implicated rice agriculture. However, problems similar to those encountered in California (e.g. bad taste in city drinking water; see California example below) may develop if rice agricultural areas expand and urbanization continues. In an unpublished white paper prepared by a team of scientists from Texas A&M University, Louisiana State University, and USDA-ARS (Fouss et al., 1998), several priorities were presented for water quality research. These included monitoring and quantifying the transport and fate of agrochemicals, fertilizer nutrients, and sediments carried by overland flows onto, through, and off of rice production lands in the Rice Belt Region of the Upper Texas Gulf Coast, and evaluating and quantifying the impacts on water quality environmental parameters in the coastal zone water resources (streams, bays, marshes, and estuaries). These recommendations have not been implemented to date. Studies have not been conducted examining whether the water quality services that are present in natural wetland systems are also provided in rice agriculture. Natural wetland systems do not receive direct pesticide and fertilizer applications, nor do they have increased salinity due to irrigation.

Andreu and Gimeno-Garcia (1999) examined the evolution of heavy metals in marsh areas under rice farming in Albufera Natural Park (Valencia, Spain). Some marsh areas are fragile ecosystems and various pollutants (heavy metals, nitrates, phosphates, pesticides, etc.) influence the equilibrium of soil functions, resulting in decreased soil productivity and its filter and buffer capacity (Batjes and Bridges, 1993). Andreu and Gimeno-Garcia (1999) found a tendency for cadmium, a potentially toxic heavy metal, to increase in the soils under study. Various factors may contribute to this increase and more long-term studies need to be conducted. It is unknown if this occurs in Texas rice fields.

CALIFORNIA RICE INDUSTRY AS AN EXAMPLE IN WATER QUALITY CONTROL

The state of California has enacted legislation, conducted research, and monitors ecological impacts associated with rice production. It has established a program in an attempt to mitigate the effects of rice agriculture on water quality. This program is reviewed below as an example of an effective state plan.

Human population growth, subsequent urbanization, and agricultural growth in the Central Valley forced the California rice industry to address water quality issues. Currently, the nine upper Sacramento River Valley counties support 90% of the rice grown in California, approximately 400,000 acres (Finalyson et al., 1993). Rice cultivation in California doubled in the 1970s due to the introduction of a short stem cultivar that increased profit (Cornacchia et al., 1984). This increase in acreage was accompanied by a concomitant increase in the application of the herbicides: molinate and thiobencarb and the insecticides: methyl parathion, malathion, and carbofuran (Cornacchia et al., 1984). Movement of these pesticides in the agricultural drainage, the Colusa Basin Drain, reached toxic levels for selected fisheries and wildlife in the Sacramento River and caused a bad taste in the drinking water in the city of Sacramento (Cornacchia et al., 1984; Finalyson and Faggella, 1986; Finalyson et al., 1993; Bailey et al., 1994). Problems with molinate and thiobencarb were corrected by increasing the holding time for the release of water from rice fields following pesticide application from 4 to 28-29 days (Brian Finlayson California Department of Fish and Game personal communication, August 1998; Christopher Foe EPA California Regional Water Quality Control Board, personal communication, August 1998). The holding time allowed the chemical compounds to dissipate through the use of innovative irrigation systems, the reuse of tailwater, and by ponding on designated areas (UCAIC, 1992). In contrast, the longest holding time suggested after application of insecticides is 7 days (Winn, 1998) and current recommendations for Texas rice growers suggest that fields be flushed 24 hours after herbicide application.

Recirculating irrigation systems may actually speed up pesticide dissipation. A University of California Cooperative Extension study showed that molinate and bensulfuron-methyl residues were substantially reduced (90% and 83% lower, respectively) in a recirculating system as opposed to a conventional flow-through system (UCAIC, 1992). Thiobencarb treated water is now kept within recirculation systems and away from waterways. In 1991, it was below detection limits in the Sacramento River, compared to 5,099 lb. (2,312 kg) in 1985. No fish kills or taste problems have recurred since 1984. In 1991, molinate concentrations were down to 7,027 lb. (3,187 kg) from 40,667 lb. (18,446 kg) in 1982 (UCAIC, 1992). In 1989, use of the herbicide bentazon was suspended on rice after a well survey detected it in ground water underlying rice-growing areas (UCAIC, 1992).

Insecticide use by rice growers also resulted in some water quality problems. Carbofuran (Furadan) has been implicated in numerous cases of wildlife mortality (Eisler, 1985; Mineau, 1993). Two papers by Flickenger et al. (1980, 1986) report finding carbofuran granules in birds found dead in rice fields in Texas. Littrell (1988) reported waterfowl and raptor mortality in Sacramento rice fields due to carbofuran. Waterfowl and consequent raptor mortality (through secondary poisonings) resulting from carbofuran applications on rice in California seem to have been reduced by cultural methods involving incorporation of carbofuran granules into the soil prior to flooding (Littrell, 1988; Finlayson, personal communication, August 1998). However, the World Wildlife Fund has called for an overall ban on this insecticide due to its severe effects on wildlife and Mineau concurs with this assessment (World Wildlife Fund, 1994; Mineau, 1998). In 1993, the California Regional Water Quality Control Board adopted water quality objectives for carbofuran, malathion, and methyl parathion as well as molinate and thiobencarb. Methyl parathion was specifically identified as being present in the Colusa Basin Drain in lethal amounts to shrimp (*Neomysis mercedis*) (Finlayson et al., 1993). Yet approximately one sixth of the rivers and streams (988 miles) in the Central Valley Basin Region are still considered impaired, and of these more than 50% are the result of agriculture and mining activities.

Rice-agricultural drain water comprises approximately one-third of the Sacramento River flow during peak irrigation in early summer (SWRCB, n.d.). Domagalski (1996) found molinate and carbofuran in surface drainage systems and rivers in rice producing areas in the Sacramento River Basin. Because the impacts of pesticides on aquatic species in agricultural canals and the Sacramento River is still a concern, bioassay tests are being used to screen stream waters carrying irrigation drain waters for toxic effects (SWRCB, n.d.). These reveal that a number of streams in agricultural areas are frequently toxic to aquatic life (including the Sacramento and San Joaquin River Basins). Although pesticide contamination may not result in immediate mortality of aquatic species, levels are high enough to inhibit reproduction and reduce food supplies (SWRCB, n.d.). The California Water Control Board recommends cooperation between chemical manufacturers, the rice-growers, the Department of Pesticide Regulation, and County Agricultural Commissioners for accurate information on times, amounts, and sites of each pesticide application. An integrated pest management approach, including careful chemical selection, timing, application method, and water release may be critical (SWRCB, n.d.). Feagley et al. (1992) demonstrated the effects of selected management practices in reducing nutrients and pesticides from rice discharge water in Louisiana. Choice of practice would depend on the priority of stream problems involved.

WILDLIFE AND RICE AGRICULTURE

Rice agronomic practices produce a series of habitats that are particularly well-suited for migratory birds. Rice fields are prepared for planting in late winter, with actual planting occurring in March or April. Fields are flooded shortly thereafter and remain flooded until immediately prior to harvest in August when the fields are drained. These flooded fields provide large expanses of wetlands available for use by resident birds (Lacher et al., 1999). In western portions of the Texas rice belt, a second crop (ratoon crop) results from re-sprouting from the initial planting, and is harvested in October. Harvested fields contain waste grain and are left to stand fallow for up to 2 years. During the subsequent seasons, cattle graze the fallow fields. Therefore, a typical 3-year rice-pasture rotation system involves three fields; during early winter, rice is harvested in one field, another field is plowed in preparation for planting rice the next spring, and the third field is grazed (Hobaugh et al., 1989). In the eastern portion of the Texas rice belt, a two-year rotation system is used.

Historically, the tallgrass prairie of the upper Texas coast was a relatively homogeneous matrix of tall prairie grasses interspersed with small, natural depressions. At local sites within the matrix, the landscape was heterogeneous, consisting of grasses, forbs, and scattered natural wetlands and associated aquatic vegetation (Lacher et al., 1999). As a result of the intensive rice-cropping system, the resulting landscape is a reverse image of the native tallgrass prairie environment, a heterogeneous mosaic at the landscape scale, with homogenous, field-sized stands of rice vegetation, prepared fields, or pastures (Lacher et al., 1999).

The important changes resulting from the transformation of the tallgrass prairies to a rice-wetland system were influenced by the development of large expanses of shallow water in flat fields, the presence of waste rice grains in fields after harvest, and the mosaic of habitats available for migratory bird use. Historically, geese were rarely observed in the coastal prairies before the introduction of rice agriculture; the mature tallgrasses native to the prairies were greater than one meter in height; and geese preferred shorter vegetation (Robertson and Slack, 1995).

Waterfowl and other wetland dependent birds were abundant in the natural depressional wetlands in the tallgrass prairies of the upper Texas coast (Hobaugh et al., 1989). Prior to the 1920s, lesser snow geese wintered almost exclusively in coastal marshes, feeding on the roots, tubers, and rhizomes of native plant species such as saltgrass and Olney's bulrush (Glazener, 1946; Robertson and Slack, 1995). Although Canada geese and greater white-fronted geese occasionally were found on prairies (Hobaugh et al., 1989), snow geese only moved to the inland prairies adjacent to coastal marshes during winters when heavy rains followed substantial summer burns (Robertson and Slack, 1995). Snow geese did not use agricultural fields further inland until after the mechanization of the rice industry in the 1940s. By the 1960s, a large portion of the coastal tallgrass prairies of Texas had been converted to intensive agriculture, with rice as the principle crop on the upper Texas coast.

The farmed wetlands on which rice is grown have been shown to create habitat for many migratory birds (Terry, 1996). The rice-cropping system produces a landscape of wetland types during the annual cycle including natural depressions, roost ponds, flooded rice fields, and irrigation canals. These sites are used extensively by waterfowl and migratory shorebirds during the fall and winter (Terry, 1996). In addition, the cropping system provides a series of upland pastures and plowed fields that serve as habitats for many other migratory birds.

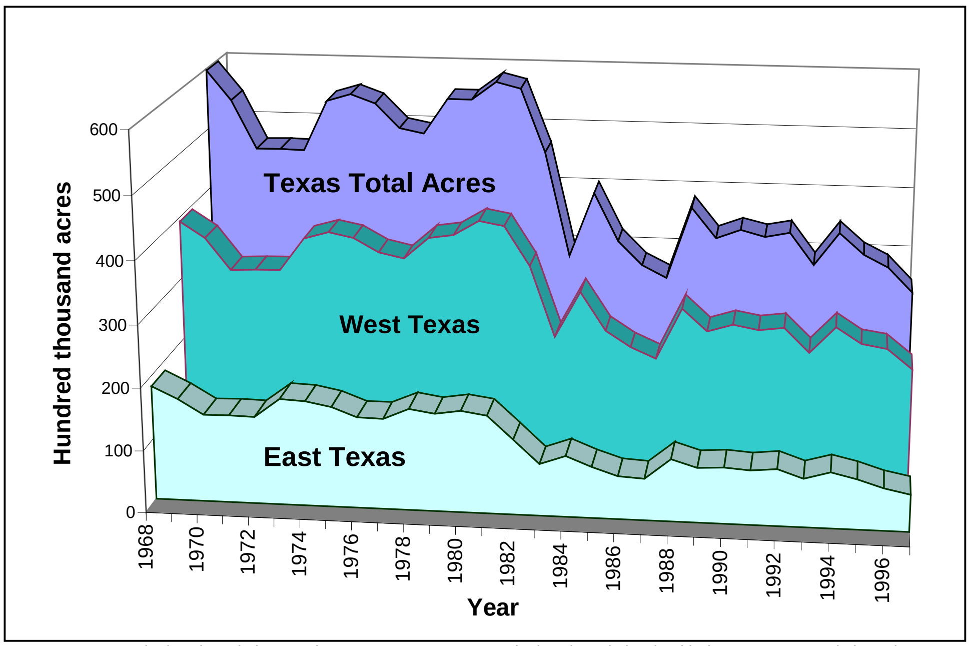
Because of intensive industrial and municipal development of the upper Texas coast, the rice-cropping system plays a significant role in providing habitat for millions of migratory and wintering birds. For example, well over 2 million waterfowl and geese winter on the upper Texas coast. Green-winged teal, mottled ducks, northern pintail, northern shoveler, white-fronted geese, and snow geese account for more than 50% of the total Texas winter counts. Further, green-winged teal, mottled duck, northern pintail, northern shoveler, and snow geese account for more than 50% of the total winter population in the Central Flyway (central U.S. states and Canadian provinces) (USFWS, 1998). The rice-growing region of the upper Texas coast lies adjacent to a heavily industrialized region that contains 30% of the U.S. petroleum industry and more than 50% of the U.S. chemical production (Robertson and Slack, 1995). Economic pressures associated with industrial and municipal development of the upper Texas coast have resulted in habitat losses exceeding 35% (210,000 acres) of the wetlands on the Texas coast since the 1950s (Moulton et al., 1997). The majority of these losses have occurred on the upper Texas coast (TPWD, 1997a).

The rice-agronomic system of Texas provides important habitats for migratory birds that have replaced, in function, many of the wetlands that have been lost to development. The extent of the role that the rice-cropping system plays in the ecology of migratory birds has not been documented for the southern U.S., nor Texas, in particular. Changes in agricultural subsidies, water availability and costs, and urbanization cause concern for the long-term availability of habitats produced by the rice-cropping system (Slack, 1999). Intensive industrial and municipal development of the upper Texas coast, continued degradation and losses of natural wetlands, and the potential threats to the viability of rice agriculture in Texas, prompted us to evaluate the use of rice by migratory wildlife.

RESEARCH DESIGN AND DESCRIPTION OF DATA SETS

We sought long-term data sets on rice acreage and migratory birds from government and non-government sources. Rice acreage by county was obtained from Texas A&M University Agricultural Research and Extension Center at Beaumont, Texas. The 16 rice-producing counties along the Texas Coast were divided into East and West Zones, based on geographic relationships to Galveston Bay and Houston, Texas. The historical acreage of these two regions is presented in Figure 3-1. For additional information, see Appendix A for maps indicating (1) the counties in the East and West Zones and (2) their 1997 rice acreage.

Figure 3-1
Rice Acres in Texas by Geographical Region, 1968-1997



Source: Texas Agricultural Statistics Service. 1980-1998. Texas Agricultural Statistics (entitled Texas Crop statistics prior to 1996). East Texas: Chambers, Jefferson, and Liberty counties. West Texas: Galveston, Brazoria, Matagorda, Waller, Colorado, La Vaca, Calhoun, Harris, Fort Bend Wharton, Austin, Jackson, and Victoria counties

We anticipated that changes in rice acreage would be correlated with changes in migratory bird populations' use of the rice-growing region of the upper Texas coast. Specifically, we predicted that declines in rice acreage in Texas rice-growing counties will be significantly correlated to declines in bird species assemblages found in habitats associated with rice agriculture.

DATA SETS

Migratory bird data were reported for the years 1980 - 1996. Migratory bird data sets included:

Texas Colonial Waterbird Census (1973 - 1996). U.S. Fish and Wildlife Service (Clear Lake, Texas). Volunteers coordinated by the U.S. Fish and Wildlife Service (and formerly Texas Parks and Wildlife) compiled results of colonial waterbird surveys of the Texas coast since 1973. Surveys were conducted annually, during a two-week period, beginning the last week of May, corresponding to the incubation period of most colonial-nesting waterbirds in coastal Texas. Compiled data from 1980 - 1996 were obtained from the Clear Lake, Texas Office of the U.S. Fish and Wildlife Service.

Analyses of Selected Mid-winter Waterfowl Survey Data (1955 - 1998). U.S. Fish and Wildlife Service (Region 2, Albuquerque, New Mexico). Waterfowl and game bird surveys were conducted by Texas Parks and Wildlife and the U.S. Fish and Wildlife Service. All waterfowl surveys were conducted by personnel from the air, along pre-defined transects. Regional waterfowl surveys were conducted in December and January each year. Transect data from Texas Parks and Wildlife were used to supplement regional waterfowl surveys.

Mid-Winter Waterfowl Survey (1980 – 1996). Texas Parks and Wildlife. Waterfowl data were obtained from Texas Parks and Wildlife, Austin, Texas. The survey consisted of systematic aerial sampling along transects through the rice growing region, and a less-systematic “cruise” aerial count of specific roosts and open water areas of the upper Texas coast. These data were used to supplement the regional data from the U.S. Fish and Wildlife Service.

Christmas Bird Count (1980 - 1996). National Audubon Society. Christmas Bird Counts are sponsored by the National Audubon Society and are tallies of bird abundance seen during one day, within a selected 24-km diameter area (Sauer et al., 1996). Christmas Bird Counts are conducted from mid-December through the first week of January for each year. The number of count participants and temporal coverage were recorded for each count area and varied both among years and counts. In addition, three Christmas Bird Counts were used for the East rice region and the West rice region. The East rice region included: Old River (Chambers County), Bolivar Peninsula (Chambers County), and Houston (Harris County). The West rice region included: Attwater Prairie Chicken National Wildlife Refuge (Colorado County), Freeport (Brazoria County), and Victoria (Victoria County).

We measured avian abundance at the guild level in order to avoid potentially dramatic effects of yearly fluctuations within a single species. Guilds are defined as species with similar ecological requirements, especially with regard to food resources and habitat. Avian species, related ecologically to the rice-prairie-wetland system, were assigned to guilds using designations by Terry (1996) (Table 3-1).

In order to control for unequal effort among Christmas Bird Count sites, we divided the number of individuals of each species seen at each site by total effort (measured in party hours) from each site. The relationship between species abundance and changes in rice acreage from 1980 to 1996 for both East and West zones was evaluated using a Pearson parametric correlation analysis (MINITAB, 1996). Data sets included combined waterfowl abundance, geese, game (geese + waterfowl), colonial waterbirds, and selected species (after Terry, 1996) from National Audubon Society Christmas Bird Counts. Pearson correlations (MINITAB, 1996) were run on average ranks based on abundance for all species (N = 31), arrayed by guild (Terry, 1996), against rice acreage and year independently. We chose a 90% confidence level (alpha = 0.10, the probability of a Type I error in order to detect any possible significant trends, given the high variability of census data). In order to evaluate the potential ecological values of rice agriculture, we sought (1) to quantify the use of rice-wetland habitats by wildlife in Texas, and (2) to identify relationships between changes in rice-land acreage and changes in bird species abundance throughout the rice-growing region of Texas.

Table 3-1
Avian Guild Classifications for Rice-Prairie-Wetland System Analysis*

GUILD	SPECIES
Waders	Great Blue Heron, Great Egret
Dabblers	American Coot, Northern Pintail, Mottled Duck
Divers	Belted Kingfisher, Lesser Scaup, Pied-billed Grebe, Ruddy Duck
Shorebirds	Common Moorhen, Greater Yellowlegs, White-faced Ibis
Raptors	American Kestrel, Loggerhead Shrike, Northern Harrier, Red-shouldered Hawk, Red-tailed Hawk
Insectivores	Common Yellowthroat, Eastern Phoebe, Golden-crowned Kinglet, Marsh Wren
Ground Foragers	Brown-headed Cowbird, Cattle Egret, Great-tailed Grackle, Meadowlark Spp., Mourning Dove, Northern Bobwhite, Northern Cardinal, Red-winged Blackbird, Sandhill Crane

*Terry, 1996.

WILDLIFE BENEFITS OF RICE AGRICULTURE IN TEXAS

McFarlane (1994) and Terry (1996) have documented the use of the rice system by more than 70 species of birds during an annual cycle. Christmas Bird Count data (1980-1996) show that over 317 species have been counted on Bird Counts west of Houston, and 286 species have been reported from counts east of Houston.

Analyses of relationships between waterfowl and goose numbers and number of acres in rice agriculture included all species of waterfowl (n = 10 species) and geese (n = 3 species) counted in the coastal rice growing region. Waterfowl numbers exhibited declines in relation to rice acreage in both the East and West regions of the Texas coastal rice belt (Table 3-2).

Table 3-2
Pearson's Correlations for Waterfowl, Geese, and Colonial Waterbirds for the Period 1980 – 1996 for East and West Rice Growing Regions

	Regions			
	East		West	
Waterfowl	0.607	0.010	0.468	0.058
Geese	0.400	0.111	0.290	0.259
Game (Waterfowl + Geese)	0.075	0.775	0.442	0.076
Colonial Waterbirds	-0.280	0.277	0.405	0.107

* Data from mid-winter waterfowl and game surveys and Texas Colonial Waterbird Census (Clear Lake, Texas).

The relationship between waterfowl numbers and decline in rice acreage was especially apparent in the East region. There is a strong correlation between waterfowl populations and rice acreage in both regions. In the East and West regions, respectively, 36.8% and 21.9% of the variation in waterfowl numbers is explained by variation in rice acreage, based upon calculation of the coefficient of determination, or the correlation coefficient squared. With greater than 90% confidence, we can conclude that waterfowl abundance and rice acreage are correlated. The statistical relationship between other populations and rice, however, is not as strong. Although total game numbers (waterfowl + geese) were significantly correlated to declines in rice acreage in the West region, this is not attributable to geese, but rather reflected changes in waterfowl numbers. Goose numbers did not show significant relations to changes in rice acreage for the period 1980 – 1996 (Table 3-2).

Because of the close proximity of the rice prairies to coastal salt marshes, it was not possible to differentiate counts of waterfowl between agricultural and coastal marsh habitats in surveys. In any case, over 2 million waterfowl and geese winter on the upper Texas coast. Based on data from the 1997-98 mid-winter waterfowl surveys, the importance of the upper Texas coast is without question (Slack, 1999). For example, green-winged teal, mottled duck, northern pintail, northern shoveler, white-fronted geese, and snow geese account for more than 50% of the total Texas counts for the mid-winter waterfowl surveys (Slack, 1999).

The importance of rice prairies to snow geese has been identified as a major factor in the continued growth of snow goose populations (Abraham and Jefferies, 1997). Hobaugh (1985) and Gawlik (1994) have documented the importance of the rice-cropping system to white-fronted geese, snow geese, and to Canada geese. Geese that have been successful in over-wintering foraging are more likely to return safely to breeding grounds and reproduce. High population densities of snow geese on the breeding grounds have resulted in significant disturbance and destruction of Arctic coastal marsh plant communities (Abraham and Jefferies, 1997). Our data do not support the hypothesis that wintering snow goose numbers have been affected by recent declines in rice acreage. These data may support Hobaugh’s (1985) contention that geese wintering on the rice prairies were able to meet their metabolic needs.

No significant relationships were found between colonial waterbird counts and changes in rice acreage for both rice growing regions (Table 3-2). This lack of a relationship is not surprising as colonial waterbirds were counted during the nesting season (May – June) and were more likely tied to the numerous streams, open water canals, and lakes in the region. Terry (1996) documented the importance of flooded rice fields and irrigation canals for colonial waterbirds. Given the flat topography, the numerous irrigation ditches that hold water regardless of rice acreage, and the numerous streams and lakes in the region, colonial waterbird numbers appear to be independent of winter rice availability.

Terry (1996) and McFarlane (1994) have documented more than 70 species of birds using various rice-related habitats during the annual cycle. Sheridan et al. (1989) documented 22 species of colonial-nesting waterbirds in colonies on the upper Texas coast, including rice growing areas. In addition, Terry (1996) identified 16 species of shorebirds using rice-wetland habitats. Migratory shorebirds take advantage of the wetland habitat associated with rice agriculture, as well as moist, open fields prepared for the following year’s rice crop (Lacher et al., 1999).

Relationships between ranks of rice acreage and average ranks of abundance of species arrayed by guild (modified from Terry, 1996) were evaluated using Spearman’s Rank correlation analysis (Table 3-3) (MINITAB, 1996).

Only the Wader guild showed a significant, but negative, correlation in the East region, while Waders, Dabblers, Raptors, and Ground Foragers showed significant correlations, some positive and others negative, in the West region. A negative correlation indicates an increase in relative abundance as rice acreage declines; a positive correlation indicates a decline in relative abundance as rice acreage declines. The negative correlation for the Wader guild in the East may reflect changes in water availability or other land use factors impacting riparian zones throughout the East region independent of rice acreage, as all of the Christmas Bird Counts available for the 1980 - 1996 time period were associated with the coast (Bolivar Peninsula), riverine environments (Old River), or the city of Houston (Houston count). Waders and Raptors guilds all showed relative positive relationships in the West between changes in ranks of rice acreage and guilds, indicating declining relative abundance as rice acreage declined. Changes in water availability in the West region, or land use changes associated with declines in rice agriculture in Texas, may account for the relationship between relative abundance of guild members and rice acreage. Dabblers and Ground Forager guilds, however, showed strong negative relationship with changes in rice acreage, indicating an increase in relative abundance as rice acreage declined. The members of the Ground Foraging guild are often associated with pasture and/or grassland habitats. Land not in active rice cultivation will normally be in grazed pastures or, in parts of the West region, in grain crops such as sorghum and corn. These land uses (grazing, sorghum, or corn) are conducive to use by the members of the Ground Forager guild. The increase in the relative rank of the Dabbler guild may reflect use by waterfowl of increased numbers of roost ponds used to hold waterfowl for hunting lease operations, and an increasing use of moist-soil management impoundments specifically designed for waterfowl (Ritter 1999).

Table 3-3
Spearman's Rank Correlations for Guilds* vs. Rice Acreage, 1980 – 1996

	Regions			
	East		West	
Guild	r	P	r	P
Waders	-0.463	0.061	0.659	0.004
Dabblers	0.260	0.314	-0.503	0.040
Divers	0.056	0.832	-0.105	0.688
Shorebirds	0.101	0.699	0.272	0.291
Raptors	0.529	0.029	0.574	0.016
Insectivores	-0.039	0.881	0.139	0.596
Ground Foragers	-0.154	0.555	-0.492	0.076

*= data from Christmas Bird counts

In order to determine if observed relationships between rice acreage and changes in ranks of guild members mirrored changes of individual species within the guilds, we evaluated changes in abundance of individual species by year and by rice acreage, within the rice producing region, and compared observed relationships with the Christmas Bird Count Trends for Texas and the Continental U.S. (Sauer et al., 1996) (Table 3-4).

In Table 3-4, the first two columns present correlations from the rank abundance of guilds versus rice acreage. The most common guild was ranked the highest, and the least common guild was ranked the lowest. Thus, these comparisons are relative. By inspection of Table 3-4, Waders, Divers, Shorebirds, and Insectivores have exhibited declines in rank abundance as rice acreage declined, as evidenced by the significant positive correlations, especially in the West rice zone. These declines have come primarily as a result of increases in relative abundance of Ground Foragers, which show strong negative correlations, especially in the West region.

However, in these same guilds, absolute abundance for individual species has shown no change (or occasionally a slight increase - see columns 4 through 6) versus year or rice acreage in the rice producing regions. In several of these instances these same species have shown significant, strong increases in Texas and Continental U.S. (e.g. great blue heron, great egret, ruddy duck, belted kingfisher, marsh wren and golden-crowned kinglet) as presented in columns 7 and 8. This implies that, even in situations where some species have shown stable trends in the rice producing region as a function of year or rice acreage, they are still doing poorly compared to larger scale trends in Texas or in the continental U.S. This analysis has also identified declines in abundance of northern bobwhite in both East and West zones by year and by rice acreage. The rice prairies are apparently important habitats for northern bobwhites, an important game bird in Texas. These trends, mirrored by both Texas and Continental U.S. populations, confirm findings of Brennan (1991). In addition, although northern pintails exhibit strong declines nationally and in Texas, we found no similar trends in abundance by year and rice acreage in the rice producing region, nor by changes in relative ranks of guild members. In general, the Ground Forager guild species members have responded favorably to declines in rice abundance, due to expanding pasturelands.

The general trend found in the data is that many, though not all, populations of wetland-dependent bird species have remained stable or have declined slightly with the loss of rice acreage. Examined alone the results do not cause concern, but comparisons of these flat trends with increasing abundance of some of the same species in either Texas as a whole or in the continental U.S. might be more cause for concern. The data available to analyze these trends, however, reflect only broad patterns and there are few data to specifically look at dependence strictly on rice agriculture. The effect of the loss of rice agriculture on bird abundance is still equivocal, and a resolution of the impact of rice agriculture on biodiversity will require research designed to specifically answer this question.

Terry (1996) and McFarlane (1994) have documented the importance of the rice-cropping system and associated mosaics, to migratory birds. The conversion of the remaining rice acreage to pasture would negatively impact all migratory birds that rely on the habitat mosaic produced by this cropping system. Those species that originally used coastal salt marshes during winters (e.g. snow geese) would be forced “back” to original wintering areas in even greater numbers than today’s use. Miller et al. (1996) have shown the relationship between increased snow goose numbers and the generation of persistent, unvegetated areas (mudflats) in tidal marshes. Anthropogenic factors that cause increased use of coastal marshes by snow geese will jeopardize salt marsh plant communities. Dramatic alterations in salt marshes will result in changes in plant productivity, diminished diversity, and alteration of hydrology.

Table 3-4
Significance Levels of Pearson Correlations for Rice-Prairie Bird Species According to Christmas Bird Counts (1980 – 1996) for East and West Zones*

GUILD	SPECIES	CORRELATIONS							
		RANKS		ABUNDANCE					
		Guild[1] East	Guild[1] West	Year[2] East	Year[2] West	Acreage[3] East	Acreage[3] West	Texas[4]	Continental[4] U.S.
Waders	Great Blue Heron	--	+++	0	0	0	0	+	+++
	Great Egret	--	+++	0	0	0	0	0	++
Dabblers	Mottled Duck	0	0	0	--	0	+	++	+
	Northern Pintail	0	0	0	0	0	0	--	---
	American Coot	0	0	0	--	0	0	0	0
Divers	Pied-billed Grebe	0	+	0	0	0	+	NA	NA
	Lesser Scaup	0	+	0	0	0	0	0	--
	Ruddy Duck	0	+	0	0	0	0	+++	0
	Belted Kingfisher	0	+	0	0	0	0	++	++
Shorebirds	White-faced Ibis	0	++	0	--	0	+	+++	0
	Greater Yellowlegs	0	++	0	0	0	0	0	0
	Common Moorhen	NA	NA	NA	NA	NA	NA	NA	NA
Raptors	Black Vulture	0	0	+++	+++	-	+	0	0
	Turkey Vulture	0	0	++	0	0	0	0	+++
	Northern Harrier	0	0	0	--	0	++	0	0
	Red-shouldered Hawk	0	0	0	0	0	0	+	+
	Red-tailed Hawk	0	0	++	0	0	0	++	+++
	American Kestrel	0	0	0	--	0	+	++	+
	Loggerhead Shrike	0	0	0	--	0	0	--	---
Insectivores	Eastern Phoebe	0	+	+++	0	0	0	+	0
	Marsh Wren	0	+	+	0	0	0	0	+++
	Golden-crowned Kinglet	0	+	0	-	0	0	0	+++
	Common Yellowthroat	0	+	0	0	--	0	-	0
Ground Foragers	Cattle Egret	0	---	0	0	0	0	+++	+++
	Northern Bobwhite	0	---	---	--	++	0	0	---
	Sandhill Crane	0	---	0	0	++	0	0	0
	Mourning Dove	0	---	+	0	0	+	0	+++
	Northern Cardinal	0	---	0	0	0	+	--	0
	Red-winged Blackbird	0	---	0	++	0	0	---	0
	Meadowlark Spp.	0	---	0	--	+++	+	0	---
	Great-tailed Grackle	0	---	0	+	0	0	NA	NA
	Brown-headed Cowbird	0	---	0	+	0	0	-	NA

+ P<0.10 ++ P<0.05 +++ P<0.01

***Correlations for year vs. rice and acreage vs. rice are based on species abundance. Trends analyses by species for Texas and Continental U.S. are based on species abundance for period 1959 – 1988 (Sauer et al., 1996)

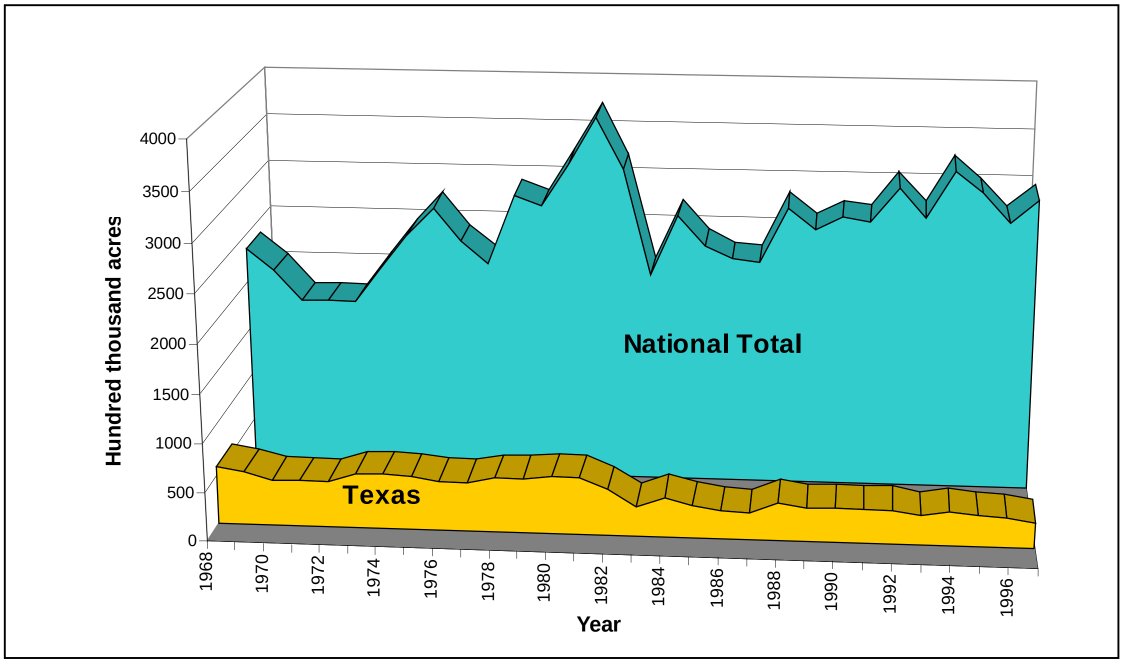
(1) Ranked species by guild vs. rice acreage; (2) Species abundance vs. year; (3) Species abundance vs. rice acreage; (4) Trends analyses of species abundance 1959 – 1988.

ECONOMICS OF RICE AGRICULTURE

Rice acreage in both Texas and the nation grew gradually between 1970 and 1980, peaking at nearly 600,000 harvested acres in Texas and 3.8 million acres nationally (see Figure 4-1). Both national and Texas acreage declined dramatically between 1980 and 1983. By 1983, the state's total acreage had fallen to only 332,000 acres and the national total had fallen 25% in only three years. Much of the reduction in acreage in the early 1980s can be explained by the acreage reduction requirements introduced at this time (Rister et al., 1990). While the national total has grown gradually since the 1983 low, rice acreage in Texas never recovered from the collapse in the early 1980s. The total acreage in the state has averaged only 327,000 acres from 1983 to 1997, with 259,000 acres in 1997 being the lowest in the entire 1968-1997 period.

While some optimistically predict increases to over 400,000 acres early in the next decade (J. W. Stansel, Memorandum to Rice Faculty of the Texas Agricultural Experiment Station, regarding planning for Texas Rice Water Needs, April 19, 1999), a sustained recovery in rice acreage will only take place if rice farmers are able to operate profitably in the new regulatory environment.

Figure 4-1
Rice Acres, Texas and National Total — 1968-1996



Source: Texas Agricultural Statistics Service, 1980-1998; USDA, National Agricultural Statistics Service, 1997; USDA, ERS, 1997.

CONCEPTUAL MODEL

The basic economic question to be addressed in this report is whether the trends in rice acreage should be of concern to policy makers. Our analysis fits into the standard economic framework in which policies are evaluated based on the principles of equity and efficiency. Because these criteria are central to our analysis, we begin by discussing the technical interpretation of these terms that will be used in our discussion.

THE NORMATIVE PRINCIPLES OF EQUITY AND EFFICIENCY

Change is inevitable and when there is change there are inevitably both "winners" and "losers." Equity concerns are associated with the distribution of the benefits and costs of such a change. While common-sense notions of equity can inform policy analysis, formal economic analysis can provide little guidance as to whether one distribution of benefits and costs is unequivocally better than another. For example, should policies that benefit rural areas at the expense of urban areas be preferred? Should race be a relevant consideration in policy evaluation? Because these questions have no clear answers, the preferred economic approach is to attempt to spell out who is winning and who is losing as a result of economic changes, and then leave the evaluation as to whether such changes are desirable to the political process. Hence, although we believe that equity considerations are important, and we seek to provide some data that might be useful to inform discussions of the rice industry on equity grounds, our economic analysis focuses on issues of economic efficiency where there is a clearer sense of what is and is not desirable.

The normative guideline that is most used in the economic analysis is that of *efficiency*. As defined by economists, the use of resources is *efficient* if there is no alternative use that could provide greater economic benefits to all participants. In many market transactions buyers and sellers are the only affected parties and typically both the buyer and the seller are made better off as a result of a transaction. Hence, a market is said to be *perfect* if it leads to an efficient outcome and, conversely, when inefficiency results we say that there is a *market failure*. If an inefficiency is identified, then there is a good argument for some kind of remedial action. If a resource is being used efficiently, then arguments for changes must be made based on some other grounds such as equity or politics.

EXTERNALITIES AS A SOURCE OF INEFFICIENCY

There are numerous reasons that efficient markets do not evolve naturally. Sometimes social or political barriers keep markets from developing. Other times informational constraints make it impossible for economic agents to make the transactions that would lead to mutually agreeable outcomes. In considering the issue of rice farming in Texas, an important consideration is the possibility that *externalities* might exist.

"An *externality* exists whenever the welfare of some agent, either a firm or a household, depends directly on his or her activities and on the activities under the control of some other agent as well" (Tietenberg, 1996). Using a rice example, suppose that a farmer decides to convert his or her rice farm land to pasture, and that the rice fields are critical habitat for birds. As a result of this land-use change, birdwatchers might be adversely affected. The extent of this externality might be so substantial that despite the farmer's gain, the birdwatchers would be *willing to pay* the landowner to stop the conversion. If this is true, then we would say that the conversion of the land is socially inefficient since both the farmer and the birdwatchers could be made better off with an alternative arrangement.

It is important to note that it is the birdwatchers' *willingness* to pay that makes the transaction inefficient; actual payment need not take place. Of course, if there is no such payment then the conversion would probably occur anyway, it would simply be inefficient. There are numerous reasons why actual payments might not be made. First, the birdwatchers may be unorganized and obtaining payment from a large, disperse and unorganized group can be virtually impossible. Second, there is a *free-rider* problem in that if enough funds are raised to prevent the transaction, then all the members of the birdwatchers group obtain the benefits whether they personally contribute or not. Because the provision of the good may not require any individual's participation, there is a disincentive to actually contribute. Third, the possibility of payments to avoid conversion could induce many landowners to threaten to sell their land or divert it to alternative uses simply to obtain the payment from the birdwatchers.

As we have seen in the econatural logical analysis in Chapter 3, for some species, particularly waterfowl, there is evidence of linkage between rice agriculture and bird populations. This relationship suggests that there may be substantial impacts of rice agriculture that are not captured in markets. The problem of externalities is, therefore, a critical feature in the rice ecosystem, and begs a closer evaluation of the land-use trends in this region.

PECUNIARY EXTERNALITIES OR SECONDARY IMPACTS

Another form of external impact of market transactions is the affect on other markets. For example, our hypothetical conversion of riceland to pasture might lead to localized increase in the demand for veterinary services or decreases in demand for fertilizer. Such impacts are referred to as pecuniary externalities or secondary impacts. Unlike standard externalities which typically lead to inefficiencies, the presence of pecuniary impacts does not necessarily imply that the market will lead to an inefficient outcome. Hence, while the impact of our rice transaction on avian habitat immediately raises questions about efficiency, only under special conditions should the secondary impacts of such a transaction be taken into account.

When a market change affects the demand or supply of other products this will alter their prices. In our rice example, the market might lead to a decrease in the relative price of fertilizer. Such a change will make some people better off and others worse off. Under perfect-market conditions, it can be shown that the magnitude of these secondary benefits exactly equals the magnitude of the costs (Sugden and Williams, 1978). Because these two effects exactly counterbalance, these secondary impacts are typically ignored in an evaluation of economic efficiency.[1]

One reason why secondary impacts might be relevant to policy relates to the distribution of those impacts. While it may hold that the impacts on the "winners" exactly counterbalances that on the "losers," policy makers may care more about the losers than the winners. This is particularly true when winners and losers live in different regions. For example, those that gain from a market change may live outside the state or region of concern. When this is true, policy makers may be justifiably concerned with these secondary impacts. This explains why local governments regularly offer incentives for businesses to relocate in their area — they are keenly aware that there will be winners and losers as a result of such relocations and they want the winners to be in their district.

In considering the secondary impacts of changes in rice agriculture, therefore, we should be careful to specify where these impacts fall. Some of the secondary benefits of a program to protect rice agriculture would fall at the local level with countervailing costs falling outside the rice belt. In this case, an analysis at the local level would want to consider these impacts while a state-level analysis may want to ignore them or at least treat them differently. In general, secondary impacts are distributed unequally across regions, states and even nations.

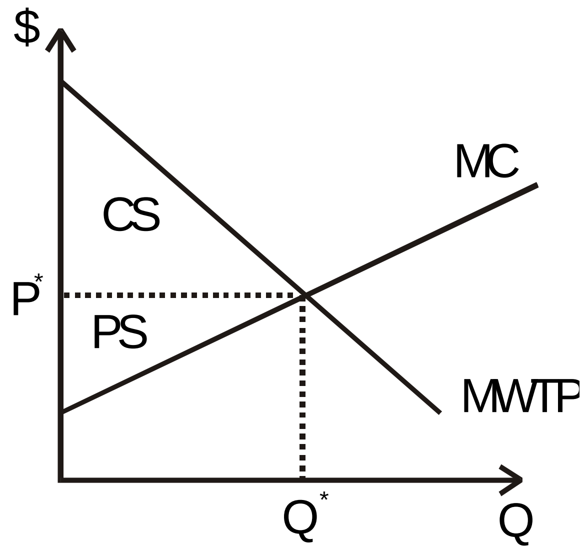
AN ECONOMIC MEANING OF VALUE

Any attempt to quantify the market or non-market value of a good or service requires a specific notion of what is meant by "value." In the standard neoclassical model, *value is equivalent to net surplus*. That is, the economic value of a particular good is the difference between the total amount individuals would be willing to pay (WTP) to obtain the good or service, and the cost of providing that good (including both out of pocket expenses and the value of opportunities forgone).

It is important to account for both the producer and consumer surplus when determining value. The simplest model for the calculation of these quantities is presented in Figure 4-2.

[1] Numerous theoretical reasons why pecuniary externalities might be important have been discussed (e.g., Loong and Seckhauser, 1982; Scotchmer, 1986). Nonetheless, in most situations economists concur that the price effects in other markets can typically be ignored in conducting welfare analysis (Just et al., 1982).

Figure 4-2
Consumer and Producer Surplus



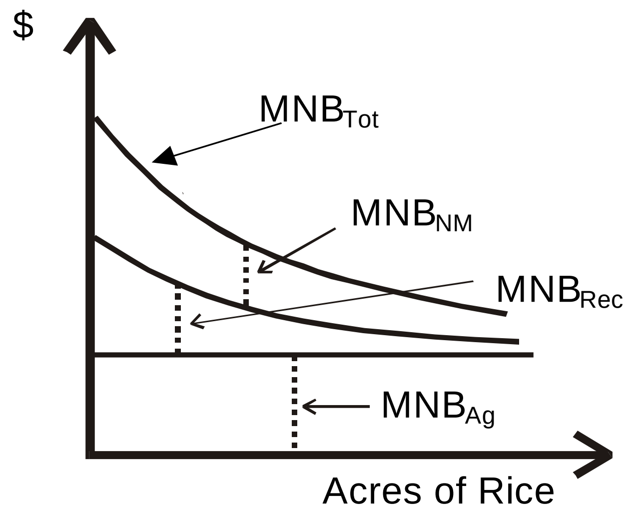
KEY	CS = Consumer surplus.	MWTP = Marginal willing to pay.
	PS = Producer surplus.	P = Price.
	MC = Marginal cost.	Q = Quantity.

In this figure we assume that the amount that an individual is willing to pay for an additional unit of a good (the Marginal WTP) decreases as the number of units obtained increases. Similarly, the cost of producing additional units (Marginal Cost, MC) increases as the number of units increases. The difference between the MWTP curve and the MC curve is the total surplus generated by the provision of Q^* units of the good. This total triangle can be divided into that portion which accrues to consumers, consumer surplus (CS), and the portion which accrues to producers, producer surplus (PS), given the price, P^*.

Note that economic value is not equal to the market value of the product. In Figure 4-2 the market value of the output is equal to the rectangular area $P^* \times Q^*$. While this area includes PS, it also includes the cost of producing Q^* and excludes any of the surplus that might accrue to consumers. If the MC of producing the good were equal to zero, then the producer surplus and the total revenue would be equal. Only then is revenue a theoretically correct measure of economic value and in this case would equal PS.

The benefits of rice acres can be divided into three main categories, benefits generated by agricultural production, benefits related to the provision of recreational services, and non-market benefits. To calculate the benefits of rice agriculture that are captured in markets, the basic supply and demand framework of Figure 4-2 is satisfactory. Globally, the cultivation of rice generates surplus to consumers who demand that product, and surplus to producers who make profits from the economic enterprise. However, because consumers rarely have specific preferences for Texas rice over rice from other regions, we can assume that the MWTP curve for Texas rice is perfectly elastic, i.e., horizontal. If this holds, then there is no consumer surplus associated with rice production and the surplus generated by rice is only that which accrues to producers. In our analysis of the agricultural benefits generated by rice, we will focus on the sector's profits.

Figure 4-3
Theoretical Framework for the Economic Analysis of the Benefits of the Rice Production System

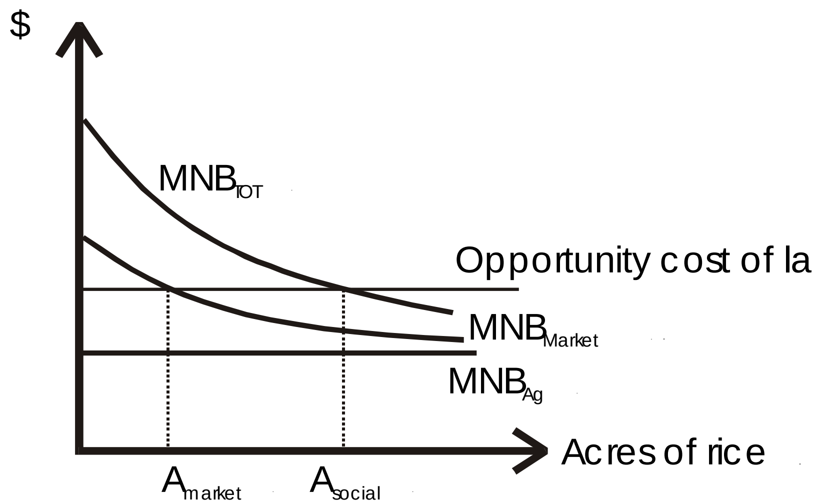


KEY MNB_{Ag} = Marginal net benefit (MNB) of an acre of rice in terms of agricultural production.
MNB_{Rec} = MNB of an acre of rice for provision of recreational opportunities.
MNB_{NM} = MNB of an acre of rice for provision of services not valued by the market.
MNB_{Tot} = Total MNB of an acre of rice = MNB_{Ag}+MNB_{Rec}+$MNB_{NM.}$

As with the production of rice, hunting opportunities generated on ricelands are largely captured in markets since landowners are compensated for leasing their land to hunters. Unlike the rice market, however, it seems likely that there is site-specific demand for these hunting opportunities. Hence, we would anticipate that the MWTP falls as the supply of hunting opportunities increases as shown in Figure 4-3. Because of the downward sloping demand curve, both consumer and producer surplus are likely to be generated in this market.

The non-market benefits of rice agriculture are not reflected in markets and, therefore, cannot be analyzed by the simple supply and demand framework of Figure 4-2. The total benefit of rice agriculture includes the benefits to all those affected by the econatural logical services provided by these areas.

Figure 4-4
Theoretical Framework for the Analysis of the
Market and Socially Efficient Use of Rice Agriculture



KEY MNB_{Ag} = Marginal net benefit (MNB) of an acre of rice in terms of agricultural production.
MNB_{Market} = MNB of market activities.
MNB_{Tot} = Total MNB of an acre of rice.
A_{market} = Equilibrium rice acreage that would be reached in the market.
A_{social} = Socially efficient level of rice acreage.

In Figure 4-4 we demonstrate the principles of market and socially efficient rice acreage. In this figure we assume that the next best use of the land has a constant marginal net benefit across all acres and that this alternative use generates neither non-market costs nor benefits. Without government intervention, an acre will remain in rice only if its market value in that activity is greater than the market value in all alternative uses. The equilibrium rice acreage that would be reached in the market is indicated A_{market}. However, because the market does not take into account the non-market benefits of these acres, the market equilibrium is less than the socially efficient level, indicated A_{social}. Because we have assumed substantial non-market benefits in this figure, the socially efficient level of rice acreage exceeds by a large margin, that which would be provided by markets.[2]

The theoretical models of Figures 4-3 and 4-4 lead to an empirical question: How great are the marginal benefits of rice acreage? If the marginal net benefits of rice production are greater than the benefits from any other use, then we would expect this practice to predominate. Even if the market value of rice production is exceeded by alternative uses such as pasture, rice might continue to be planted because of the synergies with the provision of valuable recreational opportunities. It might be, however, that even taking into account the recreational market, rice production is still uneconomic and further declines are likely to occur. In this case the policy question is whether the lost public benefits are sufficiently large to justify public intervention to achieve a higher level of rice acreage.

[2] There are, of course, numerous simplifications in the models that are presented in these figures. For example, the marginal value of an acre of rice land does not follow a smooth monotonic path as we have presented it here, and land that has a relatively low marginal value for agricultural production may have a relatively high value for hunting and/or the provision of non-market goods. While the graphical models are ill-suited to relaxing these restrictions, such generalizations could be introduced in a mathematical optimization model. The basic message regarding economic efficiency, however, would be unaltered by such generalizations.

LIMITATIONS OF THE ECONOMIC MODEL

The framework that we utilize for the analysis of the rice economy has some limitations that we should present at the outset. First, we give scant treatment to issues of economic equity. While we attempt to specify the distribution of the benefits of rice production or public policy to support this agricultural process, the complete distributional impacts of this economic system are not developed. Secondly, the analysis is partial equilibrium. That is, we do not account for the fact that the rice sector is integrated into the economy and that changes in the sector will necessarily change prices in other sectors. A complete general equilibrium sector analysis is beyond the scope of this project but could yield valuable insights in the future. Finally, the framework is essentially static, providing a lens through which a snapshot of the economy might be analyzed. A fully dynamic model would take into account the fact that systems that appear to be inefficient at one point in time might be on an efficient trajectory or vice-versa.

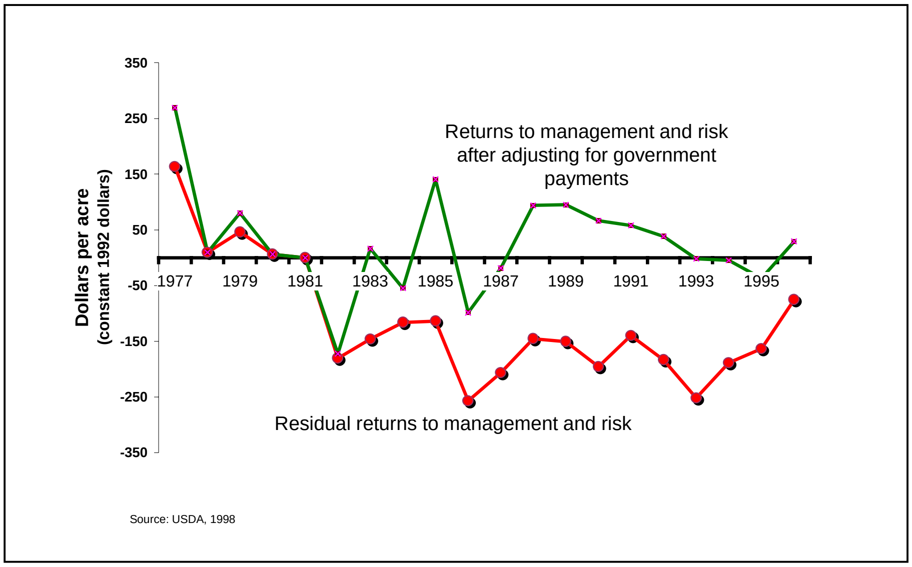
It should also be pointed out that the practical implementation of the theoretical model often leaves out important values that are difficult to quantify. For example, individuals may not be aware of importance of econatural logical interactions that make our environment more pleasant. If individuals are unaware of such interactions, then they are unlikely to be willing to pay to protect them. Hence, there are many who question the usefulness of "willingness to pay" as the appropriate metric for economic analysis of the value of ecosystems. In principle, these limitations might be overcome, but in practice the concerns are valid and should be taken into account when interpreting the results of such analysis.

ECONOMIC FINDINGS:
THE MARKET AND NON-MARKET BENEFITS OF RICE PRODUCTION

ECONOMICS OF RICE PRODUCTION

Our first step in evaluating the social value of rice acreage is to look at the economics of rice production. As noted above, given the elasticity of the demand for Texas rice, the total economic surplus that is generated by this activity is captured by producers and the associated milling and distribution network. In recent years, profits in the sector have been quite weak. After adjusting for inflation, prices have fallen sharply and productivity gains and cost savings have been unable to keep pace (see Figure 4-5 and Appendix B).

Figure 4-5
Economic Returns to Rice Farming
Gulf Coast — 1977 – 1996

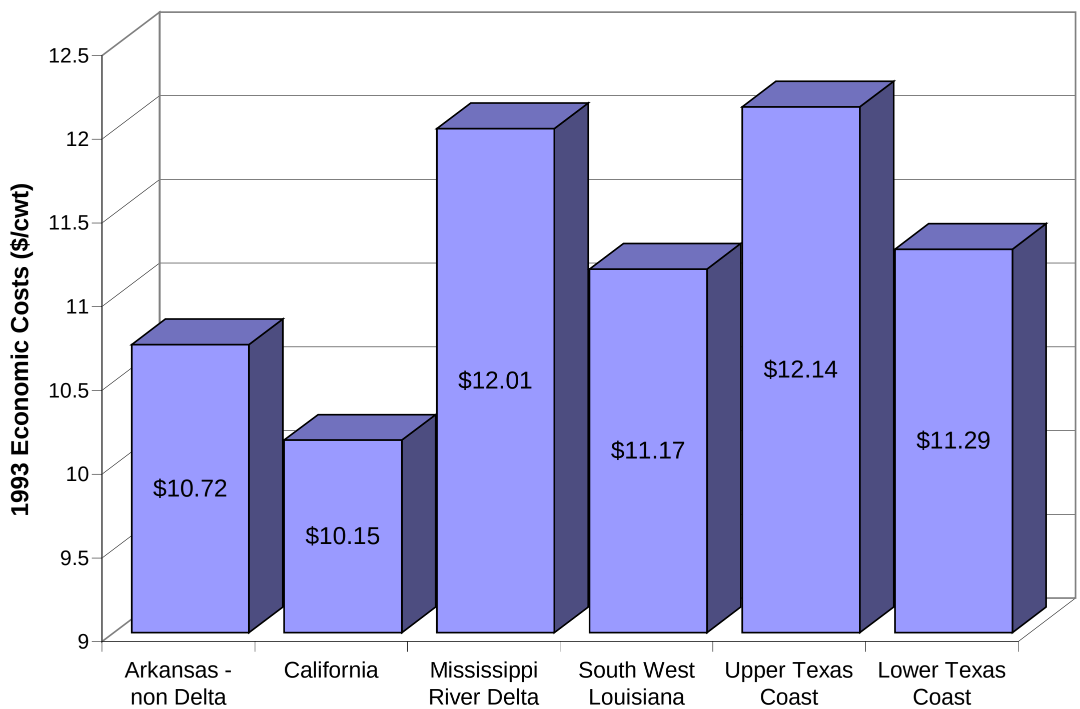


While some components of the cost structure have increased sharply, farmers have been able to compensate by reducing other costs such as farm overhead. Adding up all economic costs, the real cost per acre has actually declined 8% over the period while yields have increased 39% so that the cost per hundred weight has actually declined by 34%.

Despite cost savings and yield improvements, the fall in price has been so pronounced that if it were not for government subsidies the average rice farmer along the Gulf Coast would have lost money in every year since 1981 (the bottom line in Figure 4-5). After including the various subsidies available to the industry, however, the same average farm would have been profitable most years during this period (the top line in Figure 4-5). The evident importance of government subsidies to rice production profitability suggests that subsidy reduction, as a consequence of the 1996 Farm Bill, which eliminated deficiency payments which made up the larger portion of the government payments, may result in substantial transition for rice producers.

The cost and returns data presented in Figure 4-5 and Appendix B provide some indication as to why rice acreage along the Gulf Coast has fallen off over the last twenty years. However, these data do not explain why the fall in Texas has not been mirrored in the rest of the nation. As seen in Figure 4-1, acreage in the rest of the country has grown steadily since 1983. This difference between the situation in Texas and that in the rest of the nation can be explained in part by the fact that costs in the Gulf Coast region are higher relative to the rest of the nation. Data from 1993 (Figure 4-6) identify the costs per hundred weight of rice for producers along the upper Texas coast as the highest in the nation at $12.14. Even the comparatively cost efficient producers along the lower Texas coast had costs of $11.29, higher than all other rice producing regions except those along the Mississippi River Delta.

Figure 4-6
1993 Rice Production Costs Per Hundred Weight ($/cwt) for the Regions of Arkansas, California, Mississippi River Delta, Southwest Louisiana, Upper Texas Coast, and the Lower Texas Coast



Source: Salassi, Michael, USDA-ERS Economist, Washington, D.C.: Personal Communication, May 27, 1993, cited in Texas Rice Task Force, "Future of the Texas Rice Industry." Department of Agricultural Economics, Texas A&M University, 1993.

The reasons for Texas' comparative disadvantage are summarized by the Texas Rice Task Force (1993):

> Costs of production for Texas rice tend to be higher than average costs in other U.S. rice-producing states, due primarily to the following four factors: (a) lack of a feasible production alternative to include in a crop rotation / crop mix, thereby reducing opportunities to spread fixed overhead expenses and capital machinery and equipment costs across enterprises; (b) abbreviated time periods suitable for critical field operations due to weather variability and unique soil conditions, necessitating above-average per unit of production (cwt) investments in capital machinery and equipment; (c) above-average pest management problems, including weeds, insects, and diseases, resulting in higher costs than occur in other states; and (d) higher-than-average water pumping and distribution costs, as well as increasing municipal, industrial, and recreational competition for scarce water resources. (pp. 19-20)

Based on the data presented above, one might wonder why rice agriculture persists at all in Texas. There are answers to this question from numerous perspectives, but there are two main economic reasons. First, alternatives to rice production are limited. The Texas Rice Task Force (1993) discussed eighteen alternatives to rice that could be used in the Texas rice belt. All of these faced substantial challenges. Recently rice farmers have considered developing the infrastructure for the production of sugar cane in the region (Barta, 1998). However, preliminary analysis of the financial viability of such operations has found that such a sugar cane industry cannot be financially viable in the region (Rister et al., 1999).

The second reason that rice agriculture remains is that the averages presented above belie the true situation in which substantial variability in the profitability of farms exists. The data only show that average farms are barely making a profit from growing rice. In fact, many farms are making profits and many others are not covering their costs. Unfortunately, there has been little empirical research into the cost structure of the rice industry in the U.S. Very little seems to be known about questions such as: what is the correct specification of the production function for rice, possible scale economies in the production of rice, input and capital elasticities, and how the costs and productivity of the rice production process interact with practices in off-years and the use of land for waterfowl habitat. Without answers to these questions, a full understanding of the nature of the rice industry and the possibilities for its survival will be difficult to obtain. The theoretical and methodonatural logical groundwork for such analysis has been largely provided by studies of the rice industry in other nations (Pandey and Sarup, 1989; Shanmugam, 1994; Fan et al., 1997). The application of these methods to the U.S. and Texas rice sectors would be extremely useful.

What is known is that the unit costs of rice farms varies substantially. Salassi (1992) reports the average 1988 costs of production per hundred weight was $5.42. However, 25% of rice producers had costs 14% or more below the average while the least cost-efficient producers had costs 21% above the mean. Not surprisingly, they found a close correlation between producers' relative costs and their financial solvency. Compared to the industry average, low-cost producers were about twice as likely to find themselves in a favorable economic position while high-cost producers were four-times as likely to be in a vulnerable economic situation (Figure 4-6).

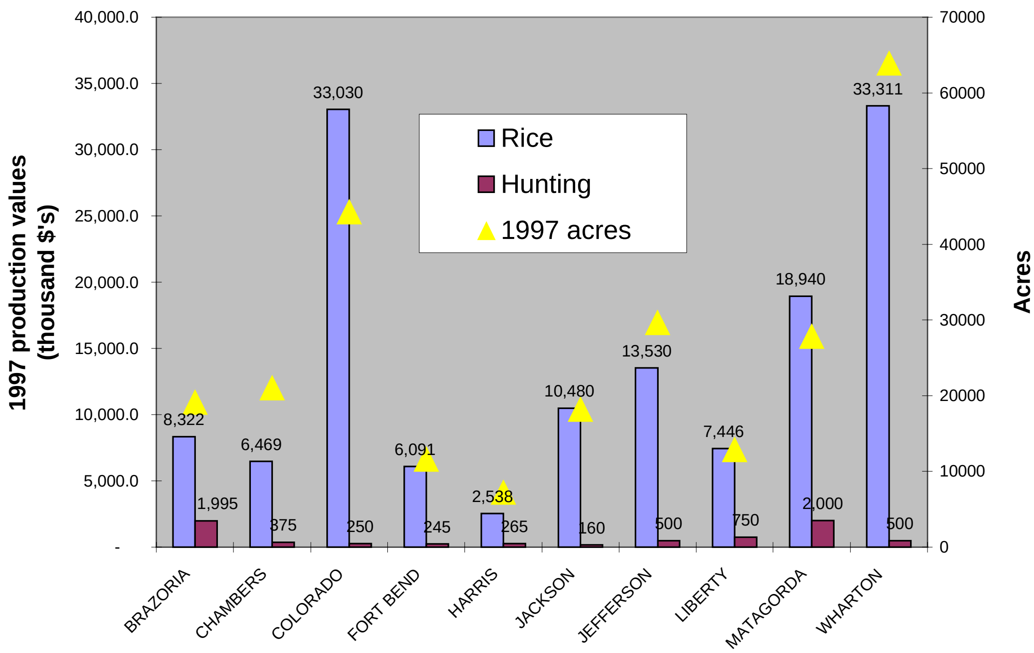
The most complete study of the rice industry in Texas was carried out by Thompson et al. (1994). Using survey data from 413 rice farmers, the authors estimated a complete production function for rice cultivation. The data from these studies give some sense of the variability of productivity in Texas rice. The average yield per acre was 5,790 pounds per acre and the standard deviation of 827. If yields are distributed normally, these data would imply that the lowest 10% of the yields per acre were below 4,730 pounds and the highest 10% were in excess of 6,850. Since costs are also likely to increase with yields, however, it is likely that the most productive farms are not the most profitable.

ECONOMICS OF WILDLIFE MANAGEMENT

In addition to their agricultural production, rice farms regularly generate revenues from recreational activities, typically hunting. The total value of hunting is quite small compared to the agricultural production in the major rice producing counties (Figure 4-7). However, in the previous section we found that profits of the rice production enterprises are, on average, quite small or even negative. Hence, recreational revenues might mean the difference between an unprofitable and a profitable year for a rice producer.

As has been discussed in the econatural logical section of this document, the cultivation of rice can play an important role in providing habitat for wildlife, particularly waterfowl and other birds. The presence of these species is routinely exploited for financial gain. We now discuss the two primary markets that are available to landowners in this regard, the hunting market and the wildlife-viewing market.

Figure 4-7
Texas Rice Acreage and the Production Value of Rice and Hunting in the Ten Leading Rice-Producing Counties, 1997



Source: Rice and Hunting values from Texas Agricultural Extension Service, 1998.
Acerage values from USDA National Agricultural Statistics Service, n.d. These values are rough estimates made by county agents.
Acreage data from USDA, National Agricultural Statistics Service, 1997.

Hunting

Nationally, the U.S. Fish and Wildlife Service estimates that 3.1 million people hunted migratory birds during 1996 (USDI et al., 1997). Using the data set from this survey,[3] we estimate that 333,000 individuals hunted these birds in Texas. Of these hunters, 94% of them were residents of Texas. The average expense per hunter was $155, suggesting total expenditures on migratory-bird hunting in Texas of over $50 million.

Across the country, there is significant variability in how hunting opportunities are provided nationally. While in some states hunting takes place primarily on public lands, in Texas and many other states virtually all hunting takes place on private lands. In a survey of state wildlife departments, Frerich et al. (1989) found that approximately 85% of all hunting took place on private lands. Because access to hunting is provided privately, many of the benefits of habitat are captured in the market. These benefits of hunting accrue to both consumers and producers. The producer's portion of total surplus is equivalent to the financial gain that hunting operations yield, and can therefore be measured using data that is relatively easy to obtain. The consumers' portion, on the other hand, can only be estimated if the demand function can be estimated, requiring substantially more involved analysis and data. For lack of these data, we focus our discussion on the producer's side of the coin.

[3] The estimates regarding migratory bird-hunting in Texas are quite speculative as they are based on very few data points.

The profits generated by hunting operations are frequently divided between two parties, landowners, and hunting outfitters. If the landowner leases his or her land to an outfitter, the total economic benefits of the hunting would equal the lease price, less any expenses incurred by the landowner, plus profits achieved by the outfitter. If the landowner leases the land directly to hunters, the benefits would equal the profits achieved.

Using 1983 data, Chamberlain and Bolen (1987) found prices varying between $2 and $12 per acre for leased parcels between 60 and 21,000 acres, with prices dropping off for leases either above or below this range.[4] Based on a recent survey conducted by Bartoskewitz and Cohen (1999), Cohen (Will Cohen, Department of Wildlife and Fisheries Sciences, Texas A&M University, personal communication, June 1998) stated that one large outfitter reportedly paid an average of $5.71 per acre.

Based on these data, it appears that landowners are able to obtain a price of between $5 and $6 per acre. It is unclear, however, the extent to which the landowner is required to incur expenses for the provision of water, or the maintenance of infrastructure such as roads or shelter. Hobaugh (1987) argues, "If you are able to guarantee a source of water from a well or an irrigation company it will make a $2-$3 per acre difference in your lease price." Hence, to some extent some expenses might be passed on in higher lease rates.

There is relatively little careful analysis of the costs and returns to waterfowl hunting operations from which we could calculate the profits of this sector. Bartoskewitz and Cohen (1999) surveyed 26 landowners and waterfowl outfitters in 1995 and 1996. The interviews covered a total of 144,152 acres in fifteen counties across the Texas Gulf Coast. Gross revenues for these operations was $1,045,339 or $7.25 per acre. The 5,800 hunters serviced by the respondents paid an average of $180 for access to the land and services provided by the landowner or guide service. The income received by outfitters was, on average, $9.28 per acre while landowners who leased directly to hunters received an average of $6.65.

The cost of providing hunting services can be substantial. Bartoskewitz and Cohen (1999) report that 52% of the surveyed hunting operations flood their fields at an average expense of $1,000 per year. Other services provided by some outfitters and landowners include housing, decoys, guides, guns, food, game processing, dogs, taxidermy, transportation and airport service. The authors find that the profitability of these operations varies depending on whether the land is leased on a per day or per season basis. In their sample, the average outfitter who leased by the day obtained $128,000 in revenue and faced $105,000 in variable costs, leading to average gross profit (excluding fixed costs) of $23,000. Respondents who leased by the season, on the other hand, averaged only $7,000 in gross profits on $14,000 in revenue. The authors do not provide data from which it is possible to calculate profitability per acre for alternative marketing strategies, but they report approximate gross profit of $10,000 per enterprise, implying $260,000 in the sample. Based on this we would estimate gross profit of approximately $1.80 per acre.

To correctly calculate the surplus associated with the provision of hunting opportunities, we should take into account not only costs that vary with the number of hunts, but also fixed capital expenses that are required to keep the enterprises running. Because of the joint production process associated with the rice-hunting operation, the correct apportionment of these expenses is difficult. While Bartoskewitz and Cohen (1999) estimate fixed costs, their values are extremely high — an average of over $70,000 per enterprise. At this level, they estimate that most hunting operations are losing money after taking into account all expenses. However, the authors themselves question the validity of these values and the magnitude of their fixed cost estimates (Bartoskewitz, student Department of Wildlife and Fisheries Sciences, Texas A&M University Kingsville, personal communication, February 20, 1999). A full analysis of the returns to waterfowl hunting operations requires future research.

Based on the above data, there is preliminary evidence that hunting is generating positive surplus to the rice enterprise. We estimate landowners are able to lease their property, net of expenses, for $4-6 per acre, and that outfitters are able to make $1-2 profit on each acre obtained. Hence, we estimate that the economic surplus of each acre is probably between $5 and $8 per acre. The fact that there is no accommodation of fixed costs in this estimate is a particularly important weakness.

[4] Hobaugh (1987) however, commented that based on his experience the per-acre price drops off at a substantially lower level, around 700 to 800 acres.

There are two likely trends that would affect waterfowl hunting industry if riceland is diminished. First, as access to hunting declines, it is likely that the price that outfitters would be able to charge their clients and the price that landowners would demand of outfitters would both rise. On the other hand, if the landscape were to become sufficiently fragmented, its ability to attract waterfowl might also fall off substantially. As pointed out by Hobaugh (1987), "The value of your property as a waterfowl lease will be affected by the rice acreage you have and/or that surrounding [sic] you. Naturally, a 200 acre rice field miles from any other rice will be less valuable than a 200-acre rice field surrounded by other rice fields." If all rice fields became islands of habitat in a sea of pasture, the impact could be a substantial and economically important decline in the value of these areas for hunting.

Non-Consumptive Wildlife-Based Recreation

In addition to opportunities for hunting, the habitat created by rice agriculture might also play a role in the development of a market for birdwatchers and others. Nationally, wildlife watching, as defined by the U.S. Fish and Wildlife Service (FWS), is extremely popular. Based on a nationwide survey (USDI et al., 1997) the FWS estimated that nearly sixty-three million U.S. residents participated in wildlife watching nationwide in 1996. Texas ranks second nationally behind California in terms of the number of individuals participating in wildlife watching (USDI et al., 1997:Table 47). As a percentage of the population, only 25% of Texans participate in wildlife observation activities compared with the national average of 31%.

Wildlife watching is also an important economic activity. The FWS estimated that approximately $29 billion is spent nationally on these activities. In Texas, the FWS estimated 1996 expenditures of $1.17 billion (USDI et al., 1997:Table 48), with 42% of the total going directly to trip-related expenses and the remainder to equipment, magazines, membership dues, environmental and wildlife contributions and other expenses directly or indirectly related to wildlife-related recreation.

Some might use these data to conclude that wildlife watching represents an enormous market that might be exploited by rice farmers. However, efforts to capture the birdwatching market have been few and have had limited success. One known case of a rice-wetland based operation that has sought to market to birders is the Karankawa Plains Outfitting Company located near Pierce, Texas. This outfitter offers tours that take advantage of rice cultivation to improve the probability of sighting elusive black and yellow rails (Karankawa Plains, 1999). While the Karankawa Plains Company continues to pursue this line of business, owners have been frustrated by their inability to capture a sufficient market to make the enterprise viable (Laurance Armour, Karankawa Plains Outfitting Company, Pierce, Texas, comments at the Texas Waterfowl Conference, Wharton, Texas, February 20, 1999).

Based on analysis by David Scott, it is not surprising that operators are having difficulty making money from the wildlife-watching market. Using data from Stephen Kellert, Scott found that less than 1% of the population would be categorized as serious birders (David Scott, Department of Recreation, Park and Tourism Sciences, Texas A&M University, College Station, TX. personal communication, March, 1998). The total national market for specialized birding trips geared toward the sighting of particular species, therefore, is only about 1.8 million individuals. While such serious birders do spend substantial amounts on their birdwatching activities — Kim et al. (in press) estimated average annual expenses of $3,357 — small numbers limit the potential of this market to generate substantial revenues in the Texas rice belt.

This is not to say that the market for nature-oriented tourism is completely limited. Using a survey of Texas Conservation Passports (TCP) holders, Scott et al. (1997b) evaluated Texas' relatively casual wildlife observers' behavior and preferences. In their sample, 88% took one or more trips annually that include wildlife observation. While this group reported expenses of over $137 per trip, less than 6% of these expenses were on entrance and admission fees. Hence, birders are accustomed to spending relatively little to gain access to birding opportunities. Park entrance fees are the most significant such fees that birders regularly pay, and payment for access to private land is quite rare. When compared with the typical daily fee of over $100 for a half-day of hunting, it is not surprising that bird watching has not taken off as a primary use of the land.

Scott et al. (1997a and 1999) find that other amenities are also important in a quality birdwatching trip. Among participants in the Great Texas Birding Classic, the authors classified only 14% as serious birders, with most of the rest classified as generalists and water seekers (21%), heritage recreationists and comfort seekers (40%) and outdoor recreationists (25%). As the names of these groups would suggest, marketing to the non-serious birder will require the provision of other amenities and recreation opportunities. Hence, while birdwatching might play a role in successful tourism industry, it is unlikely to be the sole attraction at successful operations.

Based on these findings, we find little evidence for any substantial market benefits related to non-consumptive recreational activities on ricelands. Marketing of such activities may lead to some expansion in this direction, and regional planners should not ignore this market. However, it appears unlikely that this market will play a major role in changes in rice acreage in the near future.

NON-MARKET BENEFITS OF RICE CULTIVATION

If the benefits of rice cultivation were all transacted in markets, concerns about the decline in rice acreage would be substantially reduced. Based on principles of economic efficiency, it would be difficult to argue that a practice that is unable to operate profitably should be maintained. As we have discussed elsewhere in this report, however, rice cultivation can provide some of the econatural logical services that are provided by natural wetlands. Indeed, it is the possibility of such values that is the primary motivation for this study.

In this section we will present the results of an innovative and thorough analysis of existing studies to attempt to estimate the value on these non-market services. While there has been limited analysis of these services as they emanate from rice fields, there has been substantial economic analysis of the value of wetland services from natural wetlands. We draw on this literature to gain insight into the value of the wetland services provided by rice cultivation.

Natural wetlands provide many services, including habitat for species, protection against floods, water purification, amenities and recreational opportunities (Larson et al., 1989) Because these services frequently have no market price, the value of wetlands can only be obtained through non-market valuation techniques. Many valuation studies have been conducted and the range of the estimates is remarkable. A recent review by Heimlich et al. (1998) lists 33 studies over the last 26 years with per acre values ranging from 6¢ to $22,050.

The Value of Wetland Services

Wetlands are generally characterized by a number of features including being moist during an extended period each year and having plants, animals, and soils that are distinct from both their aquatic and terrestrial neighbors. These transition areas are highly diverse, ranging from coastal mangroves that are permanently inundated with water to areas that are moist for only a few months during the year. In part because they share features of both terrestrial and aquatic systems, wetlands are remarkably productive bionatural logically.

In assessing the value of wetlands, it is useful to distinguish econatural logical functions of the systems from the associated services that are directly valued by humans (Costanza et al., 1997). Larson et al. (1989) list seventeen services and functions provided by the world's ecosystems. These econatural logical functions generate a number of goods and services that are directly valued by humans (see Table 4-1). Not all of these functions are provided by rice agriculture. However, in the statistical analysis below, we attempt to identify the incremental benefit of those services provided by ricelands.

In addition to the functions listed in Table 4-1, wetlands are often valued because they create attractive environments in which to live. If this impact is real, then one would expect that property values near wetlands would be higher than those far away. To quantify this value, economists use a technique called *hedonic pricing* in which it is possible to identify the marginal impact of proximity to the wetland. This increment in price can be used to estimate the value of the wetland to the landowner.

Through an extensive literature search we identified 39 studies from which 70 separate wetland values were obtained (summarized in Appendix C). Substantial interpretation of the data was required to make the values consistent across the studies.[5] The values per acre vary dramatically. The diversity of the estimates of

[5] A document detailing the values used from each study and how they were obtained is available on request from the authors.

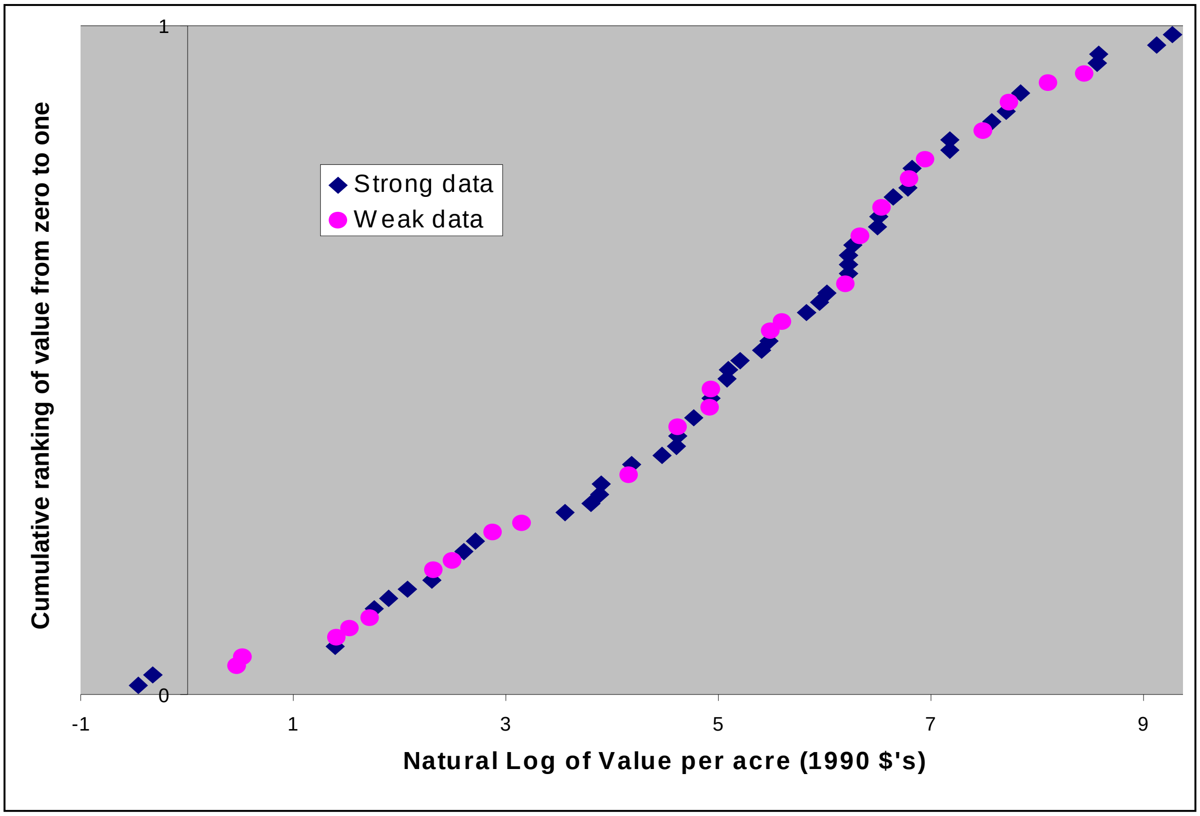
wetland values is revealed in the cumulative distribution of the values presented in Figure 4-8. The natural log of the values per acre lie almost entirely on a straight line from zero to nine. What this suggests is that if we were to simply pick a study at random, it would be as likely to find a study with a value per acre between $2.70 and $3.00 as it would be to find a value between $7,200 and $8,000 per acre.

Table 4-1
Econatural logical Wetland Functions and the Associated Economically Valuable Goods and Services

ECONATURAL LOGICAL WETLAND FUNCTION	ECONOMICALLY VALUABLE GOOD AND/OR SERVICE
• Recharge of ground water	Increased water quantity
• Discharge of ground water	Increased productivity of downstream commercial and recreational fisheries
• Water quality control	Reduced costs of water purification
• Retention, removal, and transformation of nutrients	Reduced costs of water purification
• Habitat for aquatic species	Provision of commercial and recreational fisheries onsite and/or improvements in offsite fisheries
• Habitat for terrestrial species	Opportunities for recreational observation and hunting of wildlife both on and off the wetland
• Flood control	Reduced damage due to flooding
• Stabilization of sediment	Erosion reduction
• Biomass production and export (both plant and animal)	Production of valuable food and fiber for harvest

Source: Adapted from Larson et al. (1989)

Figure 4-8
Cumulative Distribution of Wetland Values Per Acre Estimates



Sources: Data gathered from wetland valuation studies reported in Appendix C.

The studies identified in Figure 4-8 are divided into two groups depending on a subjective ranking of their quality. While some studies were characterized by sound theoretical foundations and state-of-the-art econometric analysis, other studies were crippled by faulty natural logic, poor data or inappropriate econometric analysis. We evaluated the quality of each study along four lines: the apparent quality of the data, the theoretical consistency of the methodonatural logy, econometric techniques, and statistical certainty.[6] If in any of these categories make the results of a study seem highly questionable, it is called "weak" in Figures 4-8, 4-9 and 4-10. As seen in Figure 4-8 there is little immediate evidence that the quality of the studies has systematically biased the estimated values.[7]

It is of course not surprising that values vary significantly. After all, the wetlands that have been studied vary dramatically. The question that we want to answer is whether this diversity can be attributed in part to the functions that are present at each site. Holding all else equal, one would expect that increasing the number of services considered in a valuation exercise would increase the value of the wetland. A preliminary assessment of this relationship is presented in Figure 4-9. As seen in this figure, there is no noticeable correlation between the value of a wetland and the number of services valued.

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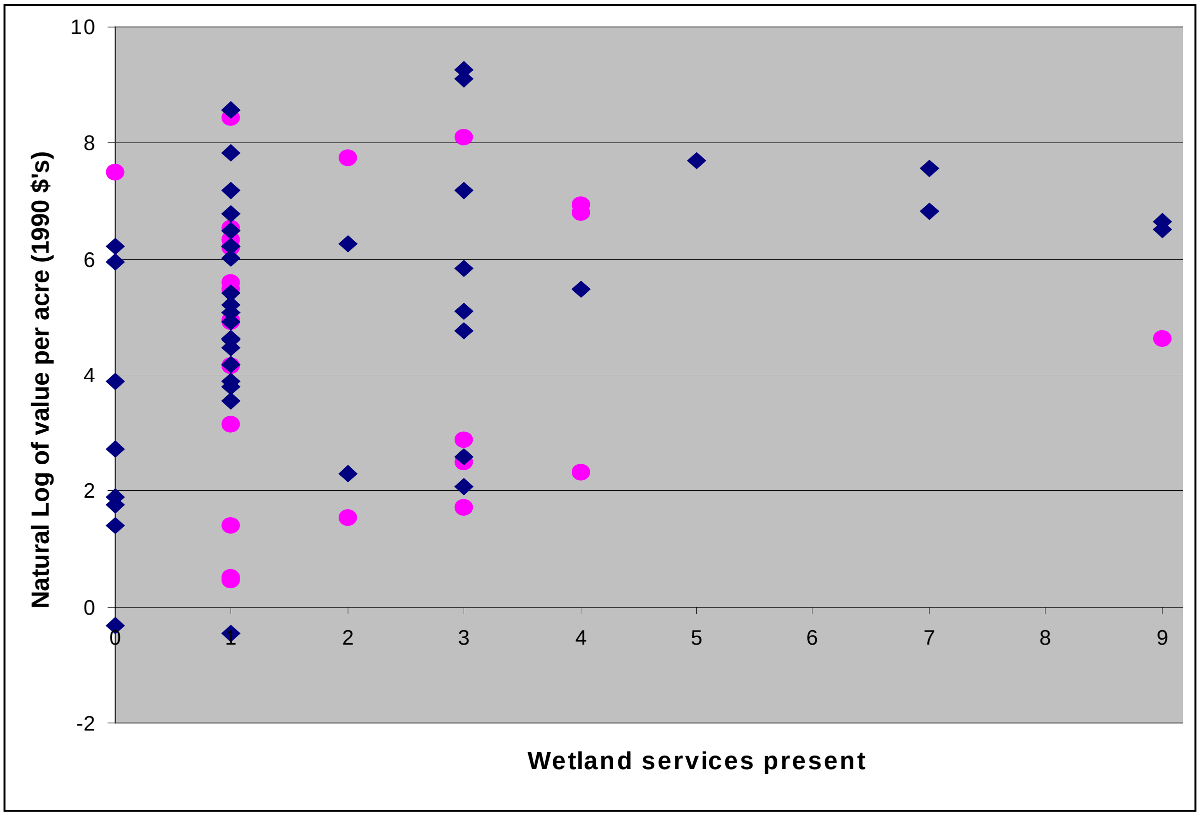
[6] In many cases, what we characterize as "weaknesses" in a study was caused not by the quality of the study, but by the fact that valuation was not its primary objective.

[7] It is interesting to note that the correlation coefficients between the publication variable and the quality variables are quite small in absolute value, -0.46 for data, -0.23 for theory, -0.41 and even the wrong sign for statistical significance, 0.10.

Figure 4-9
Wetland Values and Wetland Services Present

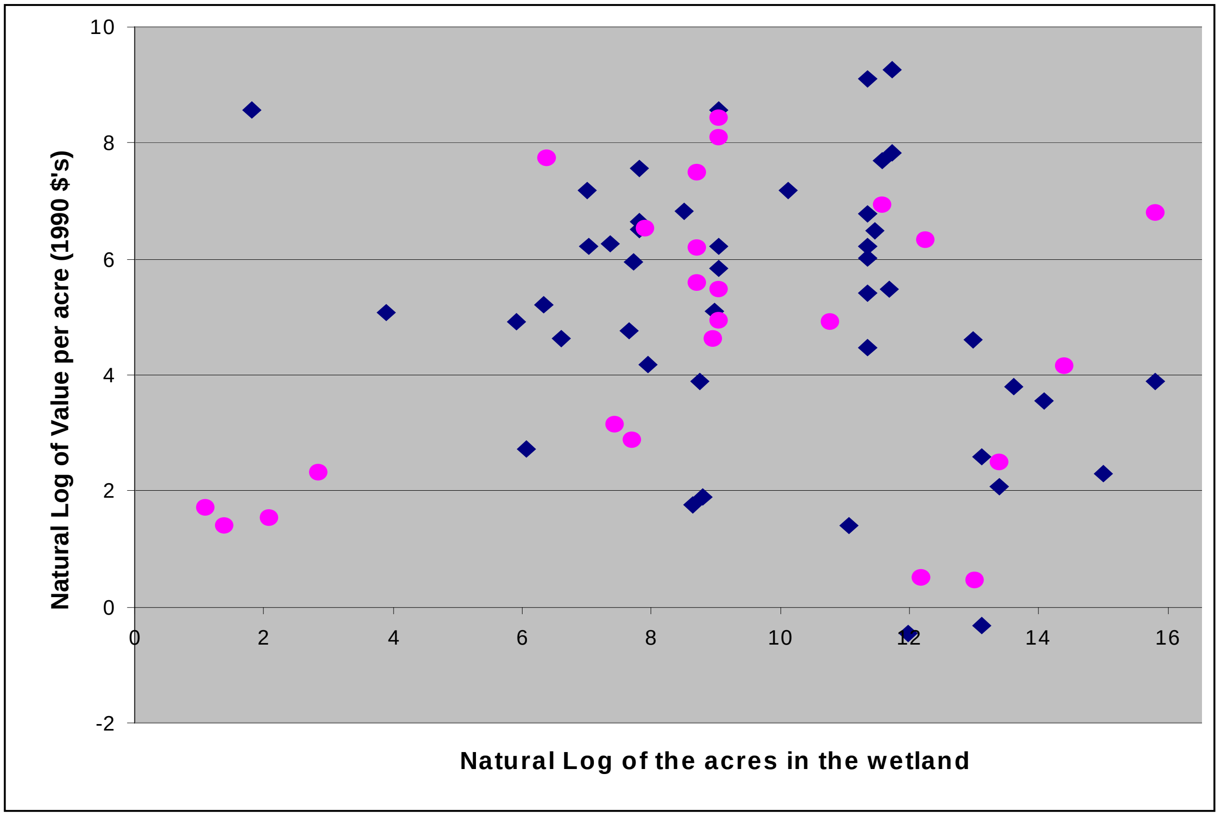


Sources: Data gathered from wetland valuation studies reported in Appendix C.

Figure 4-10 graphs per acre wetland value relative to the acreage of each wetland. In this case there is no clear a priori expectation as to the form the relationship between site and value might take. Economists would hypothesize that the marginal value of each acre would tend to decline as basic needs are met. Econatural logists, on the other hand, would suppose that because of functional interdependence, larger wetlands may provide a much richer set of valuable services. The data, however, reveal no immediate indication of either increasing or decreasing returns to scale.

While we will analyze these relationships more carefully below, Figures 4-9 and 4-10 suggest that the physical characteristics of wetlands are not important determinants of their economic value. The fact that such a value cannot be completely determined by these physical characteristics is not surprising since socio-economic and geographic variables are also likely to be important. Proximity to a city, for example, is likely to be important in determining a wetlands' value. In the next section we use more formal statistical techniques to evaluate the correlation between wetland value and the services provided.

Figure 4-10
Wetland Area and Values



Sources: Data gathered from wetland valuation studies reported in Appendix C.

Meta-Analysis of Wetland Valuation Studies

Meta-Analysis as a Tool in Understanding Non-Market Valuation. Meta-analysis was first proposed by psychonatural logists (Glass, 1976; Schmidt and Hunter, 1977) as a means of synthesizing the results of numerous studies. The method has recently gained attention in economics as a way to appraise numerous studies that have placed economic values on environmental goods and services. Four studies have recently been used to summarize valuation efforts. Boyle et al. (1994) used the data from eight contingent valuation studies to evaluate the value of groundwater. Smith and Huang (1995) analyzed results from twenty-three hedonic property value studies. Loomis and White (1996) looked at twenty-five studies that had attempted to measure the value of endangered species. Finally, Smith and Osborne (1996) used results from five contingent valuation studies to test whether studies of visibility are sensitive to changes in scope.

The basic approach in each of these studies is the same: a set of studies is selected yielding a number of values that become the dependent variable in a linear regression. If a single study reported numerous values, then several data points are obtained. The independent variables are then the characteristics of each study site. Meta-analysis allows the evaluation of the effect of changes in the underlying environmental attributes on value. This is typically not possible in the context of a single study since most such attributes are held constant.

Wetland Valuation Data. The dependent variable in all regressions is the annual value per acre of wetland converted to 1990 dollars. Using binary variables, we identified the services that are represented in each wetland value. For example, if the only services mentioned in a contingent valuation questionnaire refer to the site's role in protecting habitat for birds that can be seen both off-site (Habitat) and on-site (Bird Watch), then we interpret the study as having identified the value of only those two services.[8] Particularly in the context of contingent valuation method (CVM) studies, this is a potential problem since respondents might also be aware that the area provides other (e.g., hydronatural logical) services. In a few instances, authors were contacted to ensure that we had accurately interpreted their results. The variables used in the model are summarized in Table 4-2.

Table 4-2
Descriptions and Observations Variables Used in Meta-Analysis

VARIABLE	DESCRIPTION
Dependent Variable	
LnValue	The natural natural log of the value per acre in 1990 U.S. dollars
Variables Describing the Wetland	
LnAcres	The natural natural log of the number of acres of each wetland
Year	The year of the study
Coastal	A binary variable indicating if the wetland was on the coast
SW	A binary variable indicating if the wetland was located in the Southwest United States
Variables Indicating Econatural logical Services Present (binary variables)	
Flood	Increase in the quantity of water available
Quality	Improve water quality
Quantity	Provide flood control
Recfish	Serve as an input to a recreational fishery
Comfish	Serve as an input to a commercial fishery
Birdhunt	Serve as an input to recreational hunting of waterfowl
Birdwatch	Provide habitat valued for bird watching
Amenity	Provide storm buffering
Habitat	Value based on its amenity value (hedonic pricing studies)
Storm	Provide habitat for wildlife that generates non-use benefits
Single	Indicates that only one species was valued at the site

[8] A detailed discussion of all the valuation methods used has been omitted for brevity. They are discussed in most environmental economics texts such as Tietenberg (1996).

Table 4-2 (continued)

Variables Indicating Study Quality (binary variables)	
Publish	Indicates that the study has been published
Data0	Indicates that the study was deemed "highly questionable" based on the quality of the data used
Theory0	Indicates that the study was deemed "highly questionable" based on the quality of the theoretical framework
Metric0	Indicates that the study was deemed "highly questionable" based on the quality of the econometric analysis
Variables Describing the Methods Used in Each Study (binary variables)	
CS	Indicates that Consumer Surplus was measured
PS	Indicates that Producer Surplus was measured
CVM	The Contingent Valuation Method was used
EA	The Energy Analysis Method was used
HP	The Hedonic Pricing Method was used
MV	The Market Value Method was used
NFI	The Net Factor Income Method was used
RC	The Replacement Cost Method was used
TC	The Travel Cost Method was used

We should recognize that there are certainly important variables that determine a wetland's value that are omitted from our model. Economic factors such as the income levels and population near a wetland are particularly likely to influence the value placed on the area. Because such variables could not be identified in the data we were unable to include them in our model. If the missing variables are uncorrelated with the included set, then the estimated coefficients will be unbiased, but bias in the t-statistics will give an unfavorable impression of the estimated coefficients' statistical significance (Kennedy, 1986).

An important source of bias is sample selection. Certainly a wetland that is valued by society is more likely to be studied than one that is not deemed particularly important. Hence, our analysis reflects relatively valuable wetlands; the extrapolation to other wetlands should be avoided or, at least done while noting the possibility of significant bias.

The Estimated Model and Results. The econometric model used to analyze the wetland valuation data is based on a maintained hypothesis that measured wetland value per acre, y, is a function of services provided, x_s, the methodonatural logy used, x_m, the acres of the wetland, x_a, other variables describing the study including year and location, x_o, and a constant term. Correlation between value and acreage was improved by using the natural logs of both the per-acre value and acres. Hence, the estimated linear model is:

$$\ln(y) = a_0 + a_a \cdot \ln(x_a) + \mathbf{a}_s \cdot \mathbf{x}_s + \mathbf{a}_m \cdot \mathbf{x}_m + \mathbf{a}_o \cdot \mathbf{x}_o + \varepsilon,$$

where ε is an independently and identically distributed error term. The results of several regressions are presented in Table 4-3. Models A and B present results from the 70 observations in the complete data set, excluding only studies for which the data were incomplete. Models C and D are estimated after excluding three observations that were outliers in the data set with per-acre values more than two standard deviations above or below the mean of the data. The only difference in the estimated model is that Model A and C included all classes of valuation methods except CVM, while Models B and D included only the CVM variable. Finally, Model E excludes all studies that were deemed highly questionable in any of the four quality characteristics, resulting in 43 observations. Because of the likelihood of heteroscedasticity in the error structure, the standard errors are estimated using White's (1980) correction.

Table 4-3
Summary Statistics of Estimated Linear Regression Models of Wetland Value
(natural log of value per acre dependent variable, t-statistics in parentheses)

Variable	Variable mean	------------------------------------ Model ------------------------------------				
		A	**B**	**C**	**D**	**E**
Intercept		11.878 (5.768)	10.176 (5.146)	9.0051 (4.007)	7.6942 (4.446)	7.4095 (5.861)
LnAcres	9.43	-0.33267 (-3.436)	-0.25682 (-2.627)	-0.23001 (-2.195)	-0.1827 (-1.966)	-0.2666 (-3.127)
Year	14.06	-0.061409 (-1.504)	-0.06915 (-1.825)	-0.029121 (-0.670)	-0.035078 (-0.862)	-0.016762 (-0.520)
Coastal	0.47	-0.56846 (-0.832)	-0.01113 (-0.01379)	-0.33194 (-0.514)	-0.17469 (-0.278)	1.3911 (1.317)
SW	0.17	0.036406 (0.042)	-0.77664 (-0.9407)	-0.89216 (-0.937)	-1.2124 (-1.477)	-2.8306 (-2.687)
Flood	0.13	-1.5295 (-1.864)	-1.3235 (-1.464)	-0.74169 (-1.206)	-0.68065 (-1.176)	0.82025 (0.652)
Quality	0.21	2.6915 (2.884)	2.7463 (2.918)	1.9991 (2.086)	1.707 (1.780)	-0.69156 (-0.655)
Quantity	0.09	-0.65399 (-0.401)	-0.39148 (-0.2596)	-0.29985 (-0.194)	-0.19713 (-0.138)	-0.30125 (-0.234)
Recfish	0.36	0.12987 (0.218)	-0.22398 (-0.3264)	0.33657 (0.620)	0.21373 (0.402)	-0.57725 (-1.106)
Comfish	0.30	1.9089 (2.499)	1.8758 (2.171)	0.9495 (1.175)	0.50042 (0.662)	-1.0345 (-1.068)
Birdhunt	0.37	-1.8995 (-4.080)	-1.9828 (-3.998)	-1.8082 (-3.966)	-1.8511 (-3.952)	-0.74793 (-1.658)
Birdwatch	0.24	1.2066 (2.137)	1.4454 (2.606)	1.2462 (2.248)	1.236 (2.240)	0.39203 (0.942)
Amenity	0.19	-4.9157 (-6.085)	-3.5759 (-4.327)	-3.5838 (-3.600)	-2.6473 (-3.066)	0.24435 (0.313)

Table 4-3 (continued)

Variable	Variable mean	A	B	C	D	E
		Model				
Habitat	0.24	1.3165 (2.091)	1.3024 (2.113)	1.3345 (2.180)	1.431 (2.350)	1.5574 (2.808)
Storm	0.03	-0.26861 (-0.249)	-0.82236 (-0.8787)	1.8711 (1.096)	2.1363 (1.762)	
Single	0.14	-1.2736 (-1.379)	-2.1354 (-2.282)	-0.90861 (-0.947)	-1.475 (-1.551)	-4.9289 (-3.728)
Publish	0.74	-0.14129 (-0.185)	0.092101 (0.112)	0.19596 (0.289)	0.13823 (0.207)	0.29075 (0.381)
Data0	0.23	1.788 (1.995)	1.8155 (1.502)	1.026 (1.165)	0.65217 (0.770)	
Theory0	0.27	-2.1688 (-1.310)	-2.2481 (-1.22)	-1.0819 (-0.647)	-0.83415 (-0.501)	
Metric0	0.11	-1.0997 (-1.094)	-1.1648 (-1.147)	-1.3352 (-1.195)	-0.98044 (-0.920)	
CS	0.53	-0.39325 (-0.256)	-0.59732 (-0.3578)	0.16313 (0.118)	0.51404 (0.396)	
PS	0.24	-4.0661 (-2.157)	-4.267 (-1.921)	-1.8503 (-0.856)	-1.157 (-0.567)	2.488 (1.812)
CVM	0.36		0.69952 (1.087)		0.55755 (0.926)	1.7409 (2.644)
EA	0.03	2.796 (1.812)		-0.28741 (-0.236)		
HP	0.03	2.412 (2.388)		2.0418 (2.039)		
MV	0.04	-2.064 (-1.927)		-1.272 (-1.050)		
NFI	0.21	-1.3823 (-1.637)		-1.2185 (-1.591)		
RC	0.23	-1.0782 (-1.330)		-0.67601 (-0.821)		
TC	0.10	-1.8708 (-2.540)		-0.96066 (-1.322)		
R^2		0.6923	0.5981	0.6352	0.6039	0.6847
n		70	70	67	67	43

Does the quality of the study affect the value obtained? We find little evidence in the data that the quality of a study biases the value obtained.[9] In Models A - D only one of the coefficients on the quality variables is statistically different from zero at the 90% confidence level. Furthermore, once outlying data are eliminated, the estimated coefficients fall substantially in absolute value. Researchers should not, however, ignore the quality of their estimates since study weaknesses do decrease the accuracy of the prediction. The sample variance of the predicted value per acre is 30% lower for published studies and is, respectively, two, seven and

[9] The quality variable related to statistical significance could not be included in the analysis due to problems of multicollinearity. Only two values were deemed extremely weak due to problems of statistical significance.

three times greater for studies that were judged to be weak in terms of their data, theory or econometrics. It seems, therefore, that the primary argument for improving quality of a study is not based on bias, but on precision.

Do wetlands values exhibit increasing or decreasing returns to scale? The results indicate significant decreasing returns to scale for small wetlands but limited scale effects for larger wetlands. The coefficient on the acres variable [$\ln(x_a)$] is negative and statistically significant. The marginal effect of an increase in the size is

$$\partial y / \partial x_a = a_a x_a^{(a_a - 1)} e^{(a_a + \mathbf{a}_s \mathbf{x}_s + \mathbf{a}_m \mathbf{x}_m + \mathbf{a}_o \mathbf{x}_o)} .$$

Using the results from Model D evaluated at the means of the variables, a one-acre increase in the size of a wetland of only 10 acres is predicted to decrease the value per acre by about $11. For a wetland of 1,000 acres, however, the same increase in wetland size leads to only a $0.05 decline in value.

Does the valuation method bias wetland value estimates? There is some evidence that the method used in a valuation study has a statistically significant effect on the value obtained. In Model A we see that the energy analysis method has a strong positive effect on estimated value. This effect is eliminated, however, when the outlying value of $602,000 per acre from Amacher et al. (1989) is dropped from the analysis (columns C, D and E). The estimated coefficient on the hedonic price variable suggests substantial upward bias, a seven-fold increase in value per acre, as a result of using this method. It is difficult to evaluate, however, whether the method is truly biased or the results are biased because of missing variables. Only two values were obtained using the HP method, and each of these was carried out for an urban wetland where the value of all land is substantially higher than national averages. The lack of data indicating the socioeconomic environment may, therefore, be the cause of the large HP coefficient.

How do wetland services affect wetland value? We now consider the meaning of the coefficient estimates on the wetland service variables. These parameters indicate the change in natural log of the value per acre that would be expected to follow from adding a wetland service. Using the results from Model D, five of the ten parameter estimates are statistically significantly different from zero at the 95% confidence level. Hence, while we find that the econatural logical services provided by wetlands cannot be used to precisely predict an area's value, there is some systematic correlation between wetland value and the econatural logical services rendered. Some of the results, however, are somewhat counterintuitive. In particular, the fact that the estimated coefficient on some functions is negative implies that the presence of this service actually reduces, on average, a wetland's value. The cause of such negative coefficients can most easily be understood by example. Suppose one wetland provided only habitat protection services that were estimated to be worth $100 per acre. Suppose that a second wetland that provided both habitat and bird hunting services was estimated to be worth $75 per acre. Based on these two data points, it would appear that the effect of adding hunting was actually negative $25. This might be a real effect due to conflicts between the two services – hunting may not be permitted in potentially valuable habitat – but it might also simply be due to the small sample size and intrinsic differences between the study sites. Because of data limitations, however, we may not be able to distinguish between these two causes of the decline in value. In the results presented in Table 4-3 the coefficients on both the Bird Hunt and Amenity variables are found to be significantly less than zero at greater than a 95% confidence level. Hunting, which clearly can be a valuable activity, is associated with lower value wetlands.

In Table 4-4 we present the expected value per acre of wetlands that contain only a single service. Because of the significant variability in the results, the confidence intervals are strikingly large. The 95% confidence interval for a wetland that provides water quantity ranges from $27 to over $9,000. Despite the variability in the results, however, there is some evidence indicating which functions are most valuable. Clearly, the amenity value appears to be the least valuable of all the wetland services. At the other extreme, storm protection, the provision of wildlife habitat and on-site bird watching all yield substantial benefits, with the lower bound on the confidence interval in excess of $700 per acre. The exceedingly high values for storm protection should be viewed with caution as they are based on only two observations so might be capturing specific unobserved features of these wetlands.

Implications of Meta-Analysis for the Value of Rice Acreage. The motivation for analyzing the wetland valuation literature was to find some guidance as to how valuable the ecosystem services provided by ricelands might be. As has been discussed elsewhere in this report, the wetland services that are most clearly associated with rice acreage are the provision of hunting opportunities and avian habitat. Hydronatural logical benefits are somewhat more questionable and require further analysis.

Based on the meta-analysis, we would predict that if rice areas act as a perfect substitute for natural wetlands in their provision of hunting opportunities, their value would lie somewhere between $36 and $253 per acre. This value seems quite reasonable and not out of line with the values based on market data that are reported above. The values estimated here, however, are associated with the consumers' surplus, not producers' surplus. Based on this result, therefore, it appears that in addition to the profits generated for landowners, hunting opportunities provided by rice acreage generate substantial consumers' surplus. Nonetheless, since such hunting values are captured in markets, they do not represent a non-market value that should be added to the market values.

Table 4-4
Predicted Values in Dollars Per Acre of Single-Service Wetlands in 1990[10]

		Predicted Value Per Acre (1990 dollars per acre; 95% confidence interval)		
SERVICE	**E[LN(Y)]**	**LOWER**	**MEAN**	**UPPER**
Flood	5.74	79.7	310.9	1,213.5
Quality	8.13	455.7	3,385.1	25,143.0
Quantity	6.22	27.5	504.2	9,248.2
Recfish	6.63	233.8	760.4	2,473.5
Comfish	6.92	141.7	1,012.9	7,240.5
Birdhunt	4.57	36.7	96.4	253.4
Birdwatch	7.66	705.9	2,113.6	6,329.0
Amenity	3.77	12.6	43.5	150.4
Habitat	7.85	840.3	2,568.6	7,852.0
Storm	8.56	800.2	5,200.3	33,795.4

The habitat value of rice fields, however, is not captured in markets. Based on our statistical analysis, we would estimate that the social value of an area that acts as a perfect substitute for natural wildlife habitat might be somewhere between $800 and $7,800 per acre. We believe, however, that the extrapolation of such values to rice acreage would not be appropriate for two reasons. First, riceland is not a perfect substitute for natural wetlands. While these areas provide avian habitat to some species, the habitats are quite limited both in terms of the diversity of species served and the time during which the habitat is used. Second, we hypothesize that the coefficient on the habitat parameter might be subject to selection bias. That is, valuation studies are carried out for wetlands that the researchers anticipate will be valuable. As rice acres are not pristine natural habitats, it is unlikely that they are representative of the type of areas that were valued for their habitat provision.

[10] The results presented here use estimated coefficients from Model D. The predicted values are obtained at the means of year, acres, coastal and SW variables. The remaining values are chosen so that the predicted value describes a high-quality CVM study that is estimating consumers' surplus.

Secondary Impacts

As discussed in the conceptual section above, it is not immediately clear whether secondary benefits should be relevant to public policy analysis. However, to the extent that policy makers are focused only on the rice-producing region, such secondary benefits should probably be given some consideration.

SECONDARY BENEFITS OF RICE PRODUCTION

The production of rice has substantial secondary benefits in Texas. Taylor et al. (1993) separate the economic impact of rice production into five distinct stages: production, milling, value-added processing, wholesale distribution, and retail distribution. In 1992, production of 20 million metric tons led to farm revenue of $204 million including government deficiency payments. From this base, it is estimated that the sector's total economic impact was approximately $849 million generating over 6,200 jobs.

SECONDARY BENEFITS OF WILDLIFE-BASED RECREATION

Like the production of rice, recreation activities generate substantial secondary benefits. Based on the $1.04 million in total revenues from 26 operators surveyed by Bartoskewitz and Cohen (1999), the authors estimate total regional sales of $2.55 million and total income from all factors of production at $8.23 million. The value added by these factors of production is estimated at $2.81 million associated with 51 jobs in the region. Respess et al. (1999) surveyed five outfitters, three motels, four sporting goods stores, and one restaurant in Colorado, Matagorda, and Wharton counties. The authors found that at least $2.6 million in revenue was generated in this region as a result of the waterfowl-hunting industry.

Wildlife watching can also have substantial secondary impacts. Restaurants, hotels, and other services can earn substantial revenue where tourists seek wildlife. Kim et al. (in press), for example, studied a single birding festival and found estimated total expenses of over $1.1 million and a total economic impact of $2.5 million.

There is, therefore, evidence that recreational activities associated with rice can yield important secondary benefits. If policy makers are specifically concerned with the economic performance of the ricebelt without regard for other regions, then these benefits should be taken into account. In terms of state or national policy, on the other hand, it is less clear that these effects should be considered.

Synthesis of the Economic Analysis

The economic model that we have used to consider the rice industry consists of evaluating the market and non-market benefits of rice agriculture. These benefits are composed of three primary parts: the benefits generated by rice production that accrue to producers, the market benefits of wildlife-based recreation, and the non-market benefits.

In recent years, rice producers' profits have been small and even negative. It is no doubt because of this that Texas rice acreage has fallen so much during this time. As unprofitable farms leave the industry, however, we might find that the remaining producers are able to operate profitably. Hence, the lack of profits historically need not infer that rice farmers will not be profitable in the future. However, an important issue that we have not addressed is the possibility that even relatively profitable farms might be forced out of business because of lack of access to marketing and distribution networks. Because such networks require a large number of producers to be profitable, there is a risk that the exodus of unprofitable farms might lead to the end of the Texas rice sector, or at least localized abandonment of price. This effect is an important area for future research.

We estimate that the market benefits that are captured by operators of hunting operations are, on average, between $5 and $8 per acre. Based on our meta-analysis, there may be substantial surplus generated by the hunting industry as well. This suggests that there might be additional opportunities for operators to obtain more revenue from hunting and this demand for hunting should be studied more. Since such benefits are already captured in markets it does not follow, however, that this hunting surplus should be used as a justification for government intervention to encourage rice cultivation.

We do find some evidence for non-market benefits of rice agriculture. We find that the wetland services of water quality improvements, birdwatching, storm protection and wildlife habitat are particularly valuable. Some of these services are also provided by ricelands. Habitat provision has been a particular focus of this report. Since this service is also provided by ricelands, this land use may provide quite valuable nonmarket benefits to society. However, we hesitate to make strong conclusions in this regard for two reasons. First, even for natural wetlands our confidence in the values predicted using the meta-analysis is very low and we would argue against the extrapolation of any values from one area to another. Second, as noted elsewhere in this report, habitat on rice wetlands is not equivalent to that on natural wetlands. Hence, the extrapolation of the values from natural wetlands to ricelands would be quite speculative. Further research is needed before we could recommend that rice farmers should receive subsidies because of the non-market services their lands provide. An additional qualification is that the meta-analysis reflects average values, while the correct question for policy requires the consideration of marginal values. That is, policy should be based on the non-market benefit of small increments to the state's rice acreage. The econatural logical analysis suggests that the marginal affect of changes in rice acreage is positive for some species and negative for others. Future analysis should focus on the relationship between riceland and wildlife populations as well as society's willingness to pay for improvements in these populations.

Changes in the rice industry will likely have many impacts that have not been fully developed in this report. Of particular importance are the affects that might be felt by rural communities. Rice and its supporting industry are important parts of the economy of southeast Texas. If a substantial portion of the region's riceland is replaced by relatively low value pasture, there could be a cascade of economic impacts as local economies dry up, tax bases fade and populations migrate from the region. While such impacts have not been the focus of this report, they should be looked at closely in future analysis.

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POLICY ALTERNATIVES

This report focuses on changes in rice production in Texas and the economic, ecological and policy implications of these changes. Like almost all public policies, those surrounding agricultural production in the U.S. are the product of negotiations among players with sometimes widely divergent interests, and any future policy changes result from this same kind of process. In spite of the fact that political processes influence policy formation, an evaluation of the benefits and disadvantages that policies have for those affected by them is an important step in the development of rational and effective policy. Policy cannot be discussed apart from the goals it is designed to achieve. Goals represent the "values we seek to promote" (Weimer and Vining, 1989:193). They are normative in the sense that they articulate conditions or states deemed desirable by groups. Policies are the alternative means for promoting goals and have relevance only to the extent that they function in the service of these goals. In the 1996 Farm Bill, the goal of making farming more sensitive to market demands is explicit. Although goals are the starting point of any policy analysis, it is the design of the policy that affects behavior. In this chapter, the impact of policies on rice farmers is assessed and strategies for achieving the goals discussed below reviewed.

Ways to increase the profitability of rice have been the focus of any number of organizations and conferences in recent years (e.g. see Texas Rice Task Force, 1993; Rice Summit Conference, 1977; TAES Beaumont, 1998). This chapter builds on this analysis and evaluates a number of options in terms of their potential for long-term contributions to the incomes of rice producers in the post-1996 Farm Bill environment.

POLICY GOALS

Since the 1930s, farm policies have had a variety of goals, but a dominant one has been to protect farmers from market fluctuations and to insure the continuation of the American farm. Historical and philosophical forces fostered a view of farmers as a group deserving of special environmental and economic consideration (Paarlberg, 1990). Farm policies generally protected farmers from the vagaries of the market place with programs designed to insure their incomes above a politically acceptable level. Rice farmers benefited from this set of strategies as indicated in the economic analysis. In contrast, the 1996 Farm Bill sought to increase the extent to which farm management decisions respond to market forces by eliminating the program of deficiency payments that tended to tie farmers to a single crop. The stated intention of the 1996 Bill was that farmers would seek ways to make farming both more efficient and more profitable.

This recent strategy for encouraging the long-term profitability of agriculture has not worked uniformly well for all commodities or for all parts of the country. The ability of Texas rice producers to respond to market conditions and to make market-driven planting decisions is limited. Such responsiveness presupposes planting alternatives that are not available to most rice producers and an adaptability of the soil to different crops that does not exist in this area. These poorly drained clay soils are, for the most part, well suited to rice and to little else save pasture. Rice production has declined, but pasture has been the favored alternative agricultural activity, particularly in the western portion of the rice producing area of the state. Some of the negative effects on rice of the 1996 Farm Bill described earlier in this report will be summarized later. Other means for increasing profitability will also be evaluated below.

Given the linkages among rice production, water use, and some aspects of the ecology of the rice growing region, it is unrealistic to consider goals for Texas rice production alone; the health of rice production has implications for both water use and ecological services. For example, water availability is a significant problem in Texas. Agriculture is a major user of water, and among agricultural uses, rice is particularly demanding of water. Along the Texas coast, agricultural water use varies from water region to water region. Agriculture accounts for approximately 26% of total use in the Houston Water Region but accounts for 69% in the Mid-Coast Region, the region that is least urbanized and where rice production is heaviest. The number of acre-feet of water used by agriculture in the Mid-Coast Region is also almost twice the number used in the Houston Region (Texas Water Plan, 1997, Sec. 3.2). The potential impact of changes in rice cultivation extends beyond an impact on water availability. It is argued that rice production has the potential to improve the quality of the water that enters rice fields, but little or no systematic information exists to verify this.

The Texas Water Code, which provides for the development of the Water Plan, calls for a plan that addresses “the public interest of the entire state” (Texas Water Code, Sec. 16.051). The Texas Water Plan also explicitly views water availability as a state-wide set of issues that incorporates, but does not favor, regional and local interests. Furthermore, it recognizes the importance of a healthy environment and the necessity of sustaining freshwater flows (TWDB, 1997: 2.4-2.). Given that water-related goals have already been set for the state, policies and the programs that flow from them should be evaluated in terms of the degree to which they contribute to maintaining high quality water supplies adequate for economic well-being (as defined by healthy industrial and agricultural enterprises) and a quality of life, defined as access to good municipal services and a healthy and sustainable natural environment. Again, we recognize that the successful achievement of this goal is a matter of degree, particularly as concepts such as “high quality water,” and “sustainable environment” are not well or consistently defined. Because of the limited scope of this report, the probable impact of policies and programs are evaluated in term of their potential to increase or decrease water quality and availability.

The goals of protecting water quality and availability are linked to more specific ecological concerns addressed in this report. Development along the Texas coast has eliminated significant portions of the state’s natural wetlands (TPWD, 1997a; Stutzenbaker and Weller, 1989), and agriculture and other development on the coastal plain have transformed the landscape from a tall-grass prairie to an intensively cultivated plain (Eubanks, 1994). It is widely acknowledged that the cultivation of rice on the coastal prairie has helped to provide some of the ecological services that natural wetlands once provided (TPWD, 1997a). Rice cultivation has also encouraged the over-wintering of waterfowl and geese in this area to a degree that did not exist in former times (Bellrose, 1980; Gore, 1994; Lobpries, 1994). The presence of these birds provides hunting opportunities and wildlife viewing experiences that help to contribute to state and to local economies.

While it is widely believed that rice cultivation provides important wetland services to birds of many species, the ecological analysis presented in Chapter 3 is the first attempt to document a relationship between rice cultivation and the presence of these services. However, the role that rice production plays in the larger ecology of the Texas coast has yet to be defined and described in any systematic way. The ecological analysis reported in Chapter 3 points to a correlation between reduced rice acreage and reductions in waterfowl abundance. It also suggests the possibility that habitat quality declined for other bird species. Nevertheless, species, such as some species of ground foragers, fared relatively well as rice fields gave way to pasture. Obviously, even those whose primary concern is the ecological health of the region will disagree over the merit of continuing an activity that favors some species over others. This dilemma also points to the fact that the kinds of data on which good ecological policy development should rest are not available. For example, an increase in the numbers of migrating snow geese and the resulting damage to their nesting grounds has occasioned a relaxation of regulations that govern the hunting of this species. With existing data, it is not possible to conclude whether the availability of winter flooding of rice fields and plentiful supplies of food have been the cause of the increase in numbers or just a contributing factor. Without this kind of information, it is not possible to predict with any accuracy the long-term ecological implications of changes in rice acreage.

A number of different policy goals suggest themselves for the ecological considerations of this report. One would be that the existing mix of bird species be maintained. This is likely to result from the continued cultivation of rice along the Texas coast at more or less its current levels. However, an estimate of the amount of flooded acreage that is critical for the maintenance of current numbers has yet to be developed. An alternative goal might be to allow water-dependent species to decline in numbers and to allow those requiring drier habitat to increase. This is already happening to some degree as land is taken out of rice cultivation and is likely to continue as declines in rice production proceed. Neither of these goals can be achieved, however, if industrial and/or municipal development replace open or agricultural land. These are only two of many conceivable goals, but none of them can be used to evaluate policy without more precise information on how changes in bird populations respond to habitat changes. We can, however, evaluate policy and program options in terms of the probability of their having a generally positive impact or a negative impact on goose and waterfowl population numbers. There are other goals that generally play a part in any policy analysis. For example, the development of public policy usually involves considerations of substantive goals like efficiency and equity. A full discussion of these types of goals is, however, beyond the scope of this report.

This chapter includes an examination of the implications for rice cultivation of three key policy areas: the 1996 Farm Bill, Texas water policy as embodied in the 1997 Texas Water Plan entitled *Water for Texas*, and environmental policy as it affects the ecological services provided by ricelands. A brief review of a case study of California provides possible insights into means for dealing with decreases in the profitability of rice in as much as California rice producers are doing relatively well. Finally, various strategies for addressing this decline are reviewed.

Because good policy reflects the needs and concerns of the public and particular stakeholder groups, the team also conducted surveys of three Texas groups. A random sample of 108 Texas rice producers was surveyed about selected practices and expectations for continuation in rice production. Similarly, a random sample of 300 Texans was asked general questions about their participation in outdoor recreational activities, their knowledge about rice and its connection with ecological services, and about their willingness to support various measures to protect the environment. The third survey included representatives of nineteen Texas environmental groups. These individuals were also asked questions to indicate their level of knowledge about the link between rice cultivation and ecological services as well as questions about their group's willingness to financially support measures that would encourage the continuation of these services. Because many of the questions were identical to those asked in past surveys, the data from this survey is used to explore changes in key areas since the passage of the 1996 Farm Bill. These data will allow us to speculate on possible barriers to successfully implementing policy and program suggestions. A description of the survey and its samples can be found in Appendix D.

EXISTING POLICIES: IMPLICATIONS FOR RICE PRODUCTION

FARM POLICY

The economic analysis for this report indicates that the declines in rice production, while exacerbated by the 1996 Farm Bill, are not the direct result of it. Data reviewed in Chapters 2 and 4 of this report suggest that rice acreage reductions in the early 1980s were actually the result of support program requirements but that the reductions in support payments subsequent to the 1996 Farm Bill have also had a negative impact. Over half (61.5%) of the rice producers responding to our survey indicated that they have less acreage planted in rice than they had in 1995. Furthermore, as shown in Figure 5-1, 51.0% of the producers surveyed said that they expected to be farming fewer acres in rice or not farming at all within the next 5 years. (It should be noted, however, that 41.7% indicated that they expected to be maintaining or increasing rice acreage.) The responses varied between rice producers who farm in the eastern rice region, as defined by the Texas Agricultural Experiment Station and those who farm in the western rice region of Texas. Those in the east were more likely to report that they anticipated getting out of farming altogether, but those in the east who reported that they were planning to continue rice farming were less likely to report plans to decrease their rice acreage. Producers who indicated that they did not expect to be farming in 5 years were almost equally divided between those who owned some of the land they farm and those who lease all their land. None of the respondents who own all their land expected to leave farming in the next 5 years.

Approximately three-quarters of those surveyed responded to a question asking them to estimate how many fewer acres they would be farming in rice in 5 years. Responses ranged from 50 to 600 fewer acres with a modal category of 200 acres. When asked about the factors that would be important in decisions to plant less rice, many factors ranked as "important" or "very important." Reductions in price supports, cost of water, costs of equipment, and the market price for rice topped the list (see Figure 5-2). These data support the conclusions of the earlier economic analysis. That is, without support mechanisms, more rice producers

Figure 5-1
Rice Producers' Expectations for Next Five Years (N=108)

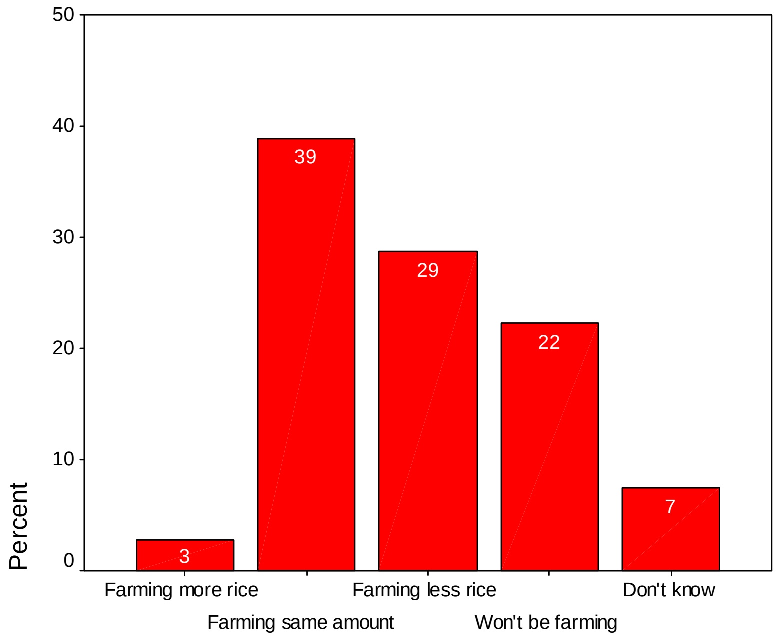


Figure 5-2
Rice Producers' Perception of "Important" and "Very Important" Reasons for Reducing Rice Acreage (N=63)

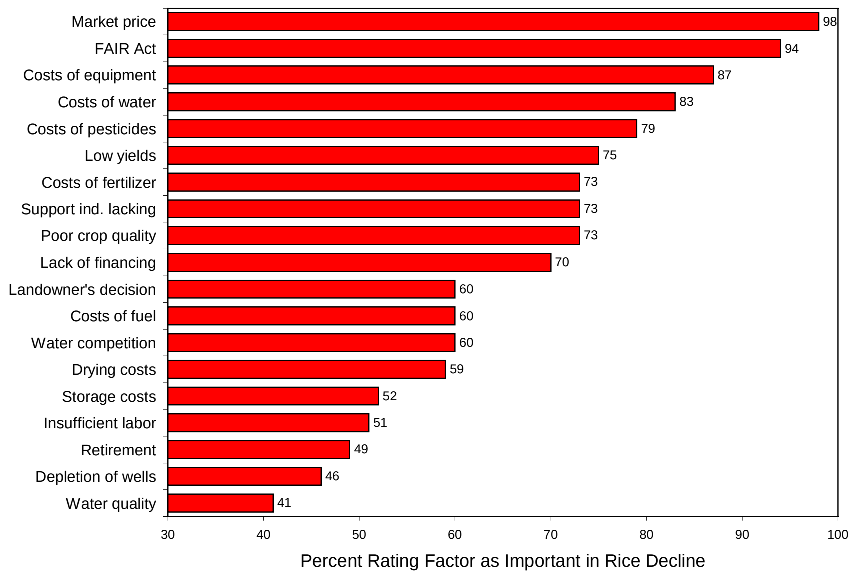
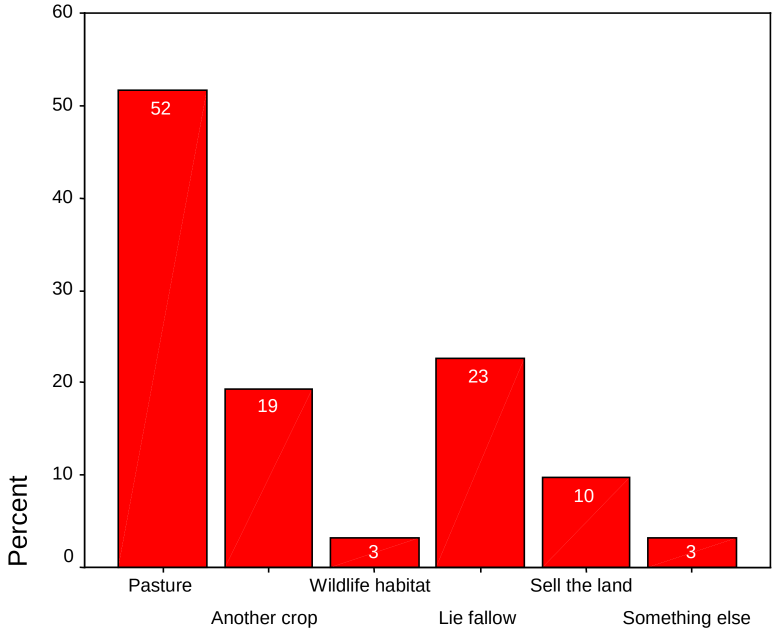


Figure 5-3
What Rice Producers Expect to Do with Acres Taken Out of Rice Production (N=31)



will opt out of production unless 1) the market for rice improves substantially, 2) input costs drop, or 3) additional sources of income are developed. Price supports have played a part in producers' decisions to farm rice, and it is worth reviewing some of the other influences on rice farmers' planting decisions.

A basic assumption of recent farm policy is that agricultural producers can and will respond to market demands when they make their planting decisions and that agriculture will benefit from this "freedom to farm." The ability of rice producers to respond to market conditions and to make market-driven planting decisions is limited, however (Texas Rice Task Force, 1993). Such responsiveness presupposes planting alternatives that are not available to most rice producers. Crops other than rice are produced in the Texas rice belt. Soybeans, corn, and sorghum are the crops most commonly grown where conditions are favorable. Research is being done on the best production methods for these crops as well as for potential crops such as kenaf and sugar cane (TAES Beaumont, 1999). None of these, however, has been recommended as a profitable alternative for rice, particularly in the western portion of the rice belt. Our survey of rice producers shows that only one alternative crop, soybeans, is produced by more than 10% of rice producers. Moreover, as reported in Figure 5-3, only 19.4% of the farmers who expect to be farming fewer acres of rice in the next five years report that they will convert the land to another crop. Instead, the most frequently mentioned alternative agricultural use of land for rice producers in our survey is putting land into pasture. This was the case whether the producer owned or leased the land. Around 61.1% of rice producers currently use some of their land for pasture, and of those expecting a decrease in rice acreage, 51.6% expect to put the land into pasture. However, when the land is allowed to return to pasture for periods in excess of 3 years, it rapidly becomes overgrown with nonnative species such as Chinese tallow, invasive imports from other regions such as mesquite, and with native woody shrubs (Eubanks, 1994). The reclamation of the land for rice is costly. Regional patterns also appeared when looking at alternative uses of rice fields. Farmers in the eastern rice region reported that they were more likely to convert their riceland to pasture or to other crops, while those in the western region reported a greater preferences for fallowing land taken out of rice production.

In addition to the constraints imposed by the soil and climate conditions, there are constraints imposed by investment in equipment. Much farm equipment is specialized for a particular crop, and this is the case with rice farming equipment. As reported in Figure 5-2, just over 87% of our sample of producers indicated that the cost of equipment is "important" or "very important" in determining the profitability of rice. It is not economically feasible to either invest in many different types of specialized equipment or to change equipment inventories as rapidly as markets for different crops change. Rice producers, therefore, face constraints that encourage them to continue to produce a less profitable crop.

This tendency is strengthened by their attitudes toward farming as an activity. A survey of East Texas landowners in 1995 found that the economic aspects of land ownership are less likely than non-economic aspects to be listed as "extremely important." Privacy and land-as-legacy for descendants were among the ownership elements that carried more weight with respondents than the economic aspects of land ownership (Smith and Kellert, 1996). Similar attitudes toward the farm and farming have been widely documented (e.g. Paarlberg, 1964; Larson, 1978; Peterson, 1997). In our survey of rice producers, we found that large majorities of rice producers also mentioned "can be my own boss" (92.6%), "protecting natural state of land" (86.1%), "wildlife conservation" (82.4%) and "enjoying country living" (79.6) as being "important" or "very important" objectives. These percentages are in the same range as those found by Smith and Kellert (1996). On the other hand, 95.4% of our sample indicated that income was also an "important" or "very important" ownership objective. The emphasis on income found in our sample of producers may be understandable for a group that is operating in a declining market and is made up primarily of lessees rather than owners. Although farmers are obviously economic actors as evidenced by their responses to various farm policy incentives, they are also driven to some extent by values that stress independence, stewardship of the land, living a particular lifestyle, and continuity of the culture of farming.

There is also a demographic aspect to the declines in rice production that should not be ignored. The 1997 Agricultural Census (USDA, 1998) indicates that 56.3% of U.S. rice farms of 100 acres or more were worked by operators over the age of 45. Almost one-third of these farms had operators who were 55 and over while just 9.6% of operators were under 35. In our survey of rice producers in Texas, 49.2% of the respondents mentioned anticipated retirement as one of the important considerations in decisions to plant less rice (see Figure 5-2). In spite of farmers' apparent commitment to agriculture in the face of declining economic returns, the tradition of the family farm is in danger. Younger generations are not choosing to carry on the family farming tradition because of the decreasing economic returns of farming and the relative uncertainty associated with agricultural production (Albrecht, 1997). Because the majority of Texas rice producers do not own the land they work, the inheritance to younger generations is largely a cultural one. We speculate that a relatively high percentage of farmers close to retirement age will not be able to pass farming-as-an-occupation on to sons and daughters.

The freedom to farm principle that is explicit in current farm policy appears to assume that producers and owners are one and the same and that planting decisions are made by the one who directly benefits from them. As pointed out earlier, the current Farm Bill allows landowners to receive the entire contract payment, during the phase-out period, without the necessity of producing rice (Hosansky, 1996a). However, the characteristics of land tenure in Texas rice production introduces a unique and important element not addressed by the 1996 Farm Bill. Only 10.2% of the rice producers in our sample own all the land on which they grow rice. Although there is general evidence that owners in lease arrangements may have little interest in participating in production decisions such as selection of pesticides, it is reasonable to assume that owners would be interested in how the land is used to the extent that its use affects the economic return that can be expected from the use (Constance et al., 1996). This is particularly true if – as under some tenure arrangements - the owner assumes a share of the variable costs in proportion to his or her share of the crop. Currently, the return on improved pasture is approximately $15.00 per acre per year (Turner, 1998). As seen in Chapter 4, the returns to rice farming have been very low in recent years. Hence, landowners who earn a share of the profits may have an incentive to change their land to pasture rather than to renew their contracts with rice-farming tenants.

In March of 1998, Congressman Ron Paul introduced a resolution to "amend the Agricultural Transition Act to ensure that rice farms covered by a production flexibility contract continue in rice production during the term of the contract when the principal producer of rice on the farm is a tenant or sharecropper." The intent of this proposed legislation is to "remove the perverse incentive to which the federal government has provided to landowners to exit the rice business and thereby put the entire rice infrastructure at risk" (HR 3339, Congressional record, March 5, 1998). To date, no action has been taken on this resolution (Paul, 1998). Until such a time that changes are made in the land tenure pattern, the owner-tenant relationship that characterizes most rice production will continue to color the decisions that are made about production. As Constance et al. (1996) point out, many conservation programs require that the owner be the one agreeing to the contract that outlines the way the land is to be managed. While it is the owner who is the beneficiary of any cost-share element in the program, owners whose primary interest in the land is economic gain may be less willing to make the effort required to participate in conservation activities as long as they can expect continued return for minimal effort. If it is in the interest of the state to maintain rice production, an incentive structure for owners must be part of any policy development.

Because of the close relationship among rice, water, and migratory waterfowl in this area, the current farm policy has implications for the other two elements in this equation. The potential impact on water is mixed. Projections of agricultural water use by the Texas Water Development Board (TWDB, 1997) include assumptions of continued reductions in agricultural acreage and increases in efficiencies of water use. The continued reduction in rice acreage will contribute to the drop in agricultural water use as long as rice is not replaced by some alternative crop that requires similar amounts of irrigation. This should make more water available for municipal, industrial, and environmental uses. There may, however, be an environmental downside to the reduced use of water as a consequence of continued declines in rice production. Before rice cultivation, the coastal prairie was characterized by an uneven terrain that resulted in natural ponds and wetland areas that provided wildlife habitat, enhanced water quality, and assisted in flood and erosion control (Lobpries, 1994). Ironically, rice farmers' efforts to improve irrigation efficiency by using precision leveling means that, if returned to pasture or to nonagricultural use, the area would lack the ponds and depressions that formerly provided some wetland services (see e.g. TPWD, 1997b), and wetland services in this area would be decreased.

The probable impact on bird populations of reduced rice acreage and reduced water use is mixed. The ecological analysis done for this report indicates that some bird populations have already responded to changes in rice acreage. Water dependent species, such as Waders, Divers, and Shorebirds, show declines in abundance with declines in rice acreage. Migratory waterfowl and goose numbers show strong correlations with changes in rice acreage. The rice fields have also been a hospitable habitat for birds that historically utilized other areas. For example, before the large-scale cultivation of rice, geese preferred wintering in the coastal marshes and occasionally flew into the prairie to take advantage of other food sources (Lobpries, 1994). Without the water and food sources provided by rice, these birds (and their economic potential for the area) would return to habitats in other locations, possibly to the detriment of the habitat given current numbers of geese. On the other hand, there are bird species that will benefit from the loss of rice acreage. These are birds, such as Ground Foragers, that are not highly dependent upon wetland areas for food or habitat. Some of these species have commercial value for hunting (e.g. quail and dove) as well for wildlife viewing. However, quail appear to have declined with the decline of rice acreage.

THE ROLE OF WATER

Water quality standards are relevant to all agricultural enterprises since the passage of the Clean Water Act of 1977. Unlike many types of agriculture, it is often claimed that rice contributes positively to water quality. This hypothesis has yet to be tested in Texas, but rice production has been implicated in the lowering of water quality in California and Louisiana (UC Agricultural Issues Center, 1994; Feagley et al., 1992). Feagley et al. (1992) suggest that the impact of rice production on water quality depends primarily on management practices. California is reported to have had success with gated conveyance facilities; these act as holding ponds for field run-off that retain the water until pesticides dissipate. Flow-through irrigation is not designed for the long holding periods that are required for the dissipation of pesticides.

Ground and surface water contribute equally to the state's water use. Ground water supplies are dwindling, and surface water supplies are variable. One organizing principle of the Texas Water Plan is that surface water will be increasingly be used to replace ground water, and it is estimated that by 2050, surface water can be used to meet 69% of the state's needs (TWDB, 1997:3-14). In 1994, agricultural use of surface water made up 67% of the water used in the state. Sixty-two percent of rice produced in the state is irrigated using surface water although there is considerable variation from county to county (Patterson, 1997).

The availability of water has become a large-scale policy issue in Texas and is critical to continued rice production. As mentioned in Chapter 2, the current water plan calls for a shift of water usage from agricultural uses to municipal and industrial uses. Furthermore, in the leading rice production region in the state, the major supplier of water, the Lower Colorado River Authority, supplies water for irrigation only after its "firm" nonagricultural demands have been met. Thus, the availability and price of water will be of critical importance to rice producers in the future.

The California Rice Industry Association maintains that rice farming is actually a very efficient user of water resources. The general information offered at their web site states that an average serving of rice utilizes 25 gallons of water to grow in contrast to 40 gallons to grow a serving of cantaloupe (CRIA, 1998a). This assertion is based on differences in the degree to which irrigation water is absorbed into the soil for different types of crops, as well as up-take by the plants. A large portion of the water used for rice production does remain on the surface. Nevertheless, substantially more water is used in the cultivation than is used for most other crops. Although no comparable documentation was found for Texas, Hill et al. (1982), for example, indicated that rice irrigation was the single largest user of water in southwest Louisiana. Over a decade ago rice irrigation was estimated to account for as much as 9% of Texas water use (Griffin et al., 1984). Reductions in rice acreage and improvements in irrigation efficiency put the estimated percentage at approximately 5% today (Fouss et al., 1998). While rice may be an efficient user of water, it also requires large amounts of water.

Water for irrigation is a major contributor to the relatively higher costs of rice production in Texas than in other rice producing states. These costs can include expenses for purchase, pumping, and distribution. In 1988, for example, irrigation costs in the eastern rice producing region of Texas stood at $42.21 per acre and at $30.22 per acre in the western rice producing region in contrast to $8.28 per acre for the U.S. as a whole in the same year (Salassi et al., 1990). For the lower Neches Valley Authority, which provides irrigation water for 27,419 acres of rice in the eastern portion of the rice belt, the base rate for irrigation water ranges from $29 to $40 per acre with extra charges for additional flushings (Lower Neches Valley Authority, n.d.). Even for Texas rice farmers who utilize ground water pumped on their property, and, therefore, do not purchase their water, the costs of pumping can contribute as much as 70% of their energy costs (Patterson, 1997). The type of land tenure can also have implications for the costs of water for the individual producer. Over 60% of the acres that produce rice are leased, and the most common arrangement is the one-half sharecrop arrangement. Under this arrangement, the owner typically pays for all the costs of water and seed and 50% of other costs (fertilizer, pesticides, herbicides, etc.) in exchange for half the crop (Griffin et al., 1984). The importance of water costs to rice producers in Texas is supported by our survey. Among the respondents who expected to be farming fewer acres of rice or who expect to get out of farming altogether, 82.5% referred to the "cost of water" as a "very important" or an "important" factor in their decision to plant less rice (see Figure 5-2).

Currently, most rice irrigation systems utilize open canals that contribute to evaporation before irrigation water reaches the fields. Loss estimates run from 25% if the irrigation water is pumped from wells on the property to as much as 40% if surface water is diverted from a reservoir and conducted to fields (McCauley, 1998). More efficient irrigation systems exist, but installation costs are high. In 1984, a sample of rice farmers was asked what their response would be to a reduction in water supplies and an increase in water costs. A number of conservation measures were among the responses, but one of the most common was reduced rice acreage. This response was more common among producers on small than on large farms (Griffin et al., 1984). The same study reported that "a disproportionate share" of water conservation measures were found on land owned by the producer. This was particularly the case for the most expensive of the measures investigated – underground pipe. These researchers also pointed out that in these leaner economic times, conservation measures previously used decreased. For example, reservoirs that were once built to store run-off for use in drier periods, are more expensive to construct than they used to be, and the federal assistance once available for their construction declined (Griffin et al., 1984). Utilization of the measures provided in the

1997 Water Plan could contribute significantly to the ability of rice producers to increase the efficiency with which they use water. However, the apparent reluctance of owners to introduce more efficient measures is another example impact of the riceland tenure system. To maximize the uses of technology, to increase water availability, and to reduce the negative impact on agriculture, regional water plans for this area will have to address the issue with creative incentive structures.

All rice producing areas in the U.S. share the need for large amounts of water. However, most other rice-producing states enjoy higher levels of rainfall and access to more extensive water resources. Water needs of the California rice industry were met with subsidies and access to the unusually ample water supplies of the Sacramento Valley. Even so, water quality and availability are of concern; drought, urban expansion and environmental pressures are all making demands on water supplies. Similarly, a decline in available water is predicted for all three water planning regions making up the Texas rice belt starting in 2010 and extending through 2050 (TWDB, 1997). This situation creates an uncertain atmosphere about state water policy that is reflected in the survey of rice producers. Of the farmers expecting to be farming fewer acres of rice in the next 5 years or expecting to get out of farming altogether, 84.1% referred to “uncertainty over state water policy” as a “very important” or an “important” factor in deciding to plant less rice (see Figure 5-2).

As indicated in Chapter 2, Texas rice interests are in a relatively good position to share in the deliberations of the regional water planning groups. Issues of water rights will be an inevitable part of these discussions. The current structure of water rights is respected by the State Water Plan, which states that the Plan “will not interfere with vested surface rights under existing adjudicated certificates, or water rights permits” (TWDB, 1997:2.3). Further, “In areas of the state outside of ground-water conservation district boundaries, the unrestricted exercise of the legal doctrine of ‘right of capture’ prevails, which essentially allows the private landowner, within his property, the unlimited right or ability to capture as much groundwater as possible for use, so long as it is put to beneficial use” (TWDB, 1997:2.4). The Harris-Galveston Coastal Subsidence District does govern the management of groundwater resources in those counties, and two other groundwater management districts (Ft. Bend and Live Oak) also exist. In spite of a commitment to respect “right of capture,” an important goal of the Water Plan is to reduce the dependence on ground water. Although some rice producers, who use surface water to irrigate their crops, own the surface water rights, most utilize canal systems operated by a public or private entity. The water right belongs to someone else. In contrast to surface water sources, groundwater sources (wells) are often on the farm property and are, therefore, controlled by the landowner/producer. Despite the advantages in controlling the rights to a water source, ground water is more costly to use for irrigation than is surface water because of high pumping and well maintenance costs. Griffin et al. (1984) report that in 1982, ground water costs for first crops were approximately 28% higher than the costs of surface water for first crops.

Continued access to sufficient amounts of this water will hinge primarily on the rice sector’s ability to make a case for its economic and ecological benefits. If allies among environmentalists and commercial interests such as fishing and hunting can also be found, this case can be made more forcefully. Because rice production has changed the terrain, and because its surrogate wetlands are less hospitable to some species, environmental interests and rice interests will not always coincide. However, where those interests do intersect, useful coalitions can be formed. These become more powerful if sport and other commercial interests can be included as well.

ENVIRONMENTAL POLICIES

Explicitly integrating environmental goals into U.S. agricultural production is an emerging agro-environmental policy objective. Environmentally friendly practices in agriculture policy are not a new idea. They date back to the Conservation Reserves of the 1930s, Soil Bank of the 1950s, and the Conservation Reserve Program of 1985. Non-market values associated with water quality, wildlife diversity, and changing rural and urban landscapes have, however, recently become increasingly important concerns as they relate to agricultural practices (Ervin, 1994; Ervin et al., 1998). The multiple forces of federal budget deficits, demographic shifts from rural to suburban areas, growing concerns about the environment, market conditions, and trade liberalization have influenced the demand for better targeted agro-environmental objectives in agriculture policy (Stuart and Runge, 1997; Batie, 1998). These objectives need to focus on accounting for all of the products and services (beyond food and fiber) that agriculture provides in order to meet the demand. Previous tactics to manage agro-environmental objectives included education and technical assistance to encourage voluntary change in practices, compliance schemes, and the regulation of agro-chemical inputs. Past conservation programs within the agricultural sector often receive criticism for not being targeted to achieve environmental outcomes (Batie, 1998; Heimlich, 1995; Wu and Babcock, 1995; Ervin et al., 1998), and because of this, they have not provided stable conservation incentives or uniformly desirable environmental outcomes.

Historical Overview

Farm bills prior to the 1996 Farm Bill included conservation provisions (e.g., Wetlands Reserve Program [WRP], Sodbuster, Swampbuster, and the Conservation Reserve Program [CRP]) designed to use the commodity and other farm programs as leverage to induce producers to avoid certain farming practices. Eligibility for price supports, crop insurance, disaster payments, and loans were dependent upon compliance with conservation practices (e.g., avoiding wetland drainage and not cultivating on croplands prone to erosion). Commodity payment programs tied to acreage reduction systems provided income support in the form of deficiency payments when market prices fell below a pre-determined target price. This financial protection for the farmer coupled to the acreage reduction programs also provided the government a mechanism to control the supply of program crops (Young and Shields, 1996; Childs, 1995). Farmers often abandoned these programs when market prices for program commodities were high (Ervin et al., 1998) resulting in the loss of the reserve acreage and associated conservation benefits these acres provided.

The 1996 Farm Bill, under Title I, the Agricultural Market Transition Act, uncoupled commodity support payments, allowing farmers to make production decisions based on the relative attractiveness of alternative crops. The attractiveness of alternative crops would be based on market prices and government supported loan rates. However, conservation compliance and adherence to wetland provision are still required for farmers to receive transition payments and other cost-sharing and insurance coverage (USDA Natural Resource Conservation Service, n.d.). There are also newly funded conservation programs under Title III of the Act. The new programs include the Environmental Quality Incentives Program (EQIP), Conservation Farm Option (CFO), the Grazing Lands Conservation Initiative, the Wildlife Habitat Incentive Program (WHIP), the Farmland Protection Program, Everglades Ecosystem Restoration, and the National Natural Resources Conservation Foundation (USDA Natural Resource Conservation Service, n.d.). In addition, the Title established the Environmental Conservation Acreage Reserve Program (ECARP) to house the CRP, WRP and EQIP. (A summary of these programs is provided at the Texas Parks and Wildlife Department web site, TPWD, n.d.; see also USDA Natural Resource Conservation Service, n.d.)

Title III also clarified the definitions under the land conservation (Sodbuster) provisions, broadened wetland authority, extended the CRP for seven years, maintained Swampbuster provisions, and continued WRP for seven years. Among the more consequential changes were efforts to better target the CRP, which include capping the maximum allowed CRP area at 36.4 million acres, strengthening the criteria regarding eligible land, and providing an early-out option for land outside of environmentally sensitive areas (Stuart and Runge, 1997). A cap of 975,000 acres for the WRP was also legislated, and in 1997, the area was split into three equal categories of permanent easements, 30-year easements, and restoration cost-share agreements (Stuart and Runge, 1997).

The Wetland Reserve Program (WRP), the Wildlife Habitat Incentive Program (WHIP), and the Environmental Quality Incentives Program (EQIP) warrant a detailed description because of their more specific targeting of wildlife habitat, and their potential impact on rice farmers in Texas. The following information on WRP and WHIP are from the Texas Parks and Wildlife Department and National Natural Resource Conservation Service web sites (TPWD, n.d. and USDA Natural Resource Conservation Service, n.d. respectively).

Wetland Reserve Program

WRP is a voluntary program to restore wetlands and is administered by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) in cooperation with the Farm Service Agency (FSA) and other federal agencies. WRP was authorized by Congress under the Food Security Act of 1985, as amended by the 1990 and 1996 Farm Bills. Funding is provided by the Commodity Credit Corporation. Participating landowners can establish conservation easements of either permanent or 30-year duration, or can enter into restoration cost-share agreements where no easement is involved. In exchange for establishing a permanent easement, the landowner receives payment up to the agricultural value of the land and 100% of the restoration costs for restoring the wetlands. The 30-year easement payment is 75% of what would be provided for a permanent easement on the same site and 75% of the restoration cost. The voluntary agreements are for a minimum 10-year duration and provide for 75% of the cost of restoring the involved wetlands. Easements and restoration cost-share agreements establish wetland protection and restoration as the primary land use for the duration of the easement or agreement. The landowner voluntarily limits future use of the land, yet retains private ownership. Because there is a national acreage cap of 975,000 acres, selection of acres to be awarded easements or cost share agreements is competitive. The landowner and NRCS develop a plan for the restoration and maintenance of the wetland. In all instances, landowners continue to control access to their land, and approved activities may include hunting and fishing. For land to be eligible for WRP, it must have been former wetland and the landowner must prove ownership for at least one year prior to entering into the program.

Wildlife Habitat Incentive Program

WHIP is a voluntary program for landowners who want to develop and improve wildlife habitat primarily on private lands. It provides both technical assistance and cost share payments to help establish and improve fish and wildlife habitat. Participants who own or control land agree to prepare and implement a wildlife habitat development plan. The NRCS provides technical and financial assistance for the establishment of wildlife habitat development practices. In addition, if the landowner agrees, cooperating state wildlife agencies and nonprofit or private organizations may provide expertise or additional funding to help complete a project. Participants work with NRCS to prepare a wildlife habitat development plan in consultation with the local conservation district. This plan may or may not be part of a larger conservation plan that addresses other resource needs such as water quality and soil erosion. Applications are selected based on a state-developed ranking and selection process that achieves state-specific wildlife goals and objectives. WHIP priorities may or may not be tied to geographic areas in a state. Cost-share agreements generally last from 5 to 10 years from the date the agreement is signed. Cost-share payments may be used to establish new practices or replace practices that fail for reasons beyond the participant's control. All lands are eligible for WHIP, except for: federal lands; land currently enrolled in Water Bank; Conservation Reserve Program, Wetlands Reserve Program or other similar programs; and where the expected impacts from on-site or off-site conditions make the success of habitat improvement unlikely. Generally, the total cost-share amount cannot exceed $10,000 per agreement. The NRCS State Conservationist has the authority to exceed this limit on a case-by-case basis.

Environmental Quality Incentive Program

The Environmental Quality Incentive Program (EQIP) is a voluntary conservation program for farmers and ranchers who face serious threats to soil, water, and related natural resources. It is a three-pronged approach providing technical, financial, and educational assistance primarily in designated priority areas. Half the funding is targeted to livestock-related natural resource concerns and the remainder to other significant conservation priorities (watersheds, regions, or areas of special environmental sensitivity, or having significant soil, water or other natural resource concerns). The following description of EQIP is compiled from information on the National NRCS and Texas Parks and Wildlife Department Farm Bill web pages (USDA Natural Resource Conservation Service, n.d. and TPWD, n.d. respectively).

EQIP legislation integrates the Agricultural Conservation Program, Water Quality Incentives Program, Colorado River Basin Salinity Control Program, and Great Plains Conservation Program. This merging of programs is designed to provide coordination for the provision of technical assistance and funding for cost-sharing or financial incentives connected with conservation and environmental practices. The EQIP program is funded through the Federal Commodity Credit Corporation and is provided with $1.3 billion in National funding over a seven-year period. The NRCS, in close cooperation with FSA, manages EQIP. The FSA county committees and conservation districts participate in implementing EQIP at the local level, and State Technical Committees provide guidance for establishing EQIP activities at the state level.

Resource concerns including soil, water, air, plant, animal, and related natural resource concerns are all given equal initial consideration for treatment, but higher priority is given to areas where state or local governments offer financial or technical assistance and to areas where agricultural improvements will help producers to achieve compliance with federal or state environmental laws, such as the Clean Water Act. The majority of EQIP moneys go to priority areas, but additional concerns can be addressed, and producers outside priority areas can still apply. In the fiscal years 1997 and 1998, at the national level 65% of available funds were used in priority areas, while 35% were used for other important natural resource concerns (Molleur and Loser, 1998).

To be eligible, landowners must be engaged in livestock or agricultural production. Land eligibility includes cropland, rangeland, pasture, forestland, and other lands where the program is delivered. Ineligible lands include large confined livestock operations. All EQIP activities must be carried out according to a conservation plan. Producers are encouraged to develop comprehensive resource management plans. Plans should target the primary natural resource concerns of the state. Priority areas are identified by the state through a locally informed conservation process involving working groups. Local work groups, convened by local conservation districts, do a conservation needs assessment, and based on that assessment, develop proposals for priority areas that reflect local natural resource based needs. The composition of local work groups includes representatives from conservation district board members and key staff; NRCS; FSA county committees and key staffs; the Cooperative State Research, Education, and Extension Service; and other federal, state, and local agencies interested in natural resource conservation. Their recommendations go to the NRCS-designated conservationist for the local area and then to the State Conservationist, who sets priorities with the advice of the State Technical Committee. The recommendations are integrated into regional and national strategic plans. These strategic plans provide a basis for funding decisions.

Conservation plans are site specific for each farm or ranch and can be developed by producers with the help of NRCS or other service providers. All plans are subject to NRCS technical standards adapted for local conditions and are approved by the conservation district. The contract period is 5-10 years, and cost sharing may be up to 75% of the cost of the conservation practices. Practice payments may be provided for up to 3 years to encourage producers to carry out management practices they may not otherwise use without the program incentive. The total cost-share and incentive payments are limited to $10,000 per person per year and $50,000 over the length of the contract. The enrollment is continuous with no deadlines.

Common practices that are eligible for cost-sharing under EQIP are grassed waterways -- strips of grass seeded in areas of cropland where water concentrates or flows off a field; filter strips -- stream side planting of trees, shrubs, and grasses; manure management facilities; and capping of abandoned wells. Examples of activities eligible for incentive payments under EQIP include nutrient management; manure management; integrated pest management -- controlling of pest through non-chemical means, or through specific controlled chemical treatment; irrigation water management; and wildlife upland habitat management.

The Performance of WRP, WHIP, and EQIP in Texas

The 1998 Texas fiscal year budget for WRP was $2 million. The total area enrolled in WRP in Texas for 1999 was 3,304 acres. The counties that are receiving funds are Liberty, Haskell, Brazoria, and Panola. The easements in Brazoria and Panola are permanent, while the other two are 30-year easements.

The 1998 fiscal year budget for the state of Texas for WHIP programs was $500,000. The counties funded for 1999 were not in the rice producing counties (they include Robertson, Kimble, Bell, Throckmorton, McMullen, Motley, Dickens, Brewster, Bowie, Kaufman, Refugio, Lubbock, Clay, Jones, Schleicher, Palo Pinto, Somerville, Crane, Bosque, Midland, Gillespie, Milam, Sutton, Shackelford, Hidalgo, Jackson, Montague, Coke, Cochran, Collingsworth, Fannin, Wichita, Crockett, and Stephens).

The priority areas for Texas for EQIP include all of the rice-producing counties. The statewide natural resource concerns are erosion, plant health, water quantity, and water quality. The Texas 1998 fiscal year budget for the EQIP program was slightly more than $13 million. Approximately $10.5 million was allocated to contract awards and $2.5 million was allocated to technical assistance efforts (Sharer 1999: personal communication). Contract awards in the rice producing counties totaled $1,254,240.[1]

Award criteria are based on a calculated offer index which selects applicants who present the most cost-effective plans. In 1997 over 57,000 applications for assistance were received at the national level, requesting more than $552 million (Molleur and Loser, 1998). The nation's state conservationists endorsed over 600 priority areas nationwide in 1997, which after allocation of funds, resulted in 476 funded priority areas, and in 1998, 1,300 areas were presented to state conservationists for approval (Molleur and Loser, 1998).

Designation of the state priority areas appears slightly biased toward areas that historically received commodity price supports. This is partially due to minimal participation by producers, community members, and environmental non-governmental organizations in the local working groups which determine local priority areas and help guide decisions for state priority areas (Doug Sharer, Texas State Conservation Operations Coordinator, Natural Resources Conservation Service, personal communication, May 1999). Although many producers are represented by county Farm Bureaus and other representative agencies, not all geographic areas have the same level of active representation. This results in a process for determining priority areas that is heavily biased towards regions with active representation. These strongly represented areas generally tend to be the same as those previously associated with commodity support, and do not necessarily include the agricultural production in the most ecologically sensitive areas of the state (Amy Hays, Wildlife Extension, Wildlife and Fisheries Sciences Department, Texas A&M University, personal communication, May 1999). Furthermore, the implementing agencies are largely staffed with specialists in agronomy, and do not have the wildlife and natural resource backgrounds to realistically focus on ecological concerns (Hays, personal communication, May 1999; Batie 1998).

Our survey offers some insight into the perceived relevance of these projects for rice producers in Texas. As shown in Table 5-1, WRP was one of the better-known environmental programs referred to by respondents in our survey, with 52.8% of them reporting that they had heard of it. However, only 10.5% of those who had heard of it (5.6% of the total sample) take part in WRP. In addition, 40.7% of the rice producers surveyed had heard of WHIP, but only 4.5% of this group (1.9% of the entire sample) take part in it. Moreover, only 28.7% of the rice producers had heard of EQIP, and only 9.7% of this group (2.8% of the total sample) actually take part in this program. The level of awareness of programs found among our respondents is consistent with those found by Cready and Thomas (1995) in their survey of rice producers in 1991 and with data derived from a survey of East Texas landowners in 1995 (Smith and Kellert, 1996). Cready and Thomas found that among the rice producers they surveyed, only 7% were enrolled in the Swampbuster Program, and 5.4% were enrolled in the Sodbuster Program. Smith and Kellert (1996) found that interest in information about wildlife was generally low among their respondents. Topics of the most interest to these landowners were Property Rights and Wildlife (34.8%), Deer Herd Management (25.3%), and Laws about Wildlife Management on Private Lands (20.8%). Clearly, rice producers are not well informed about WRP, WHIP, and EQIP.

The low level of participation in WHIP is particularly interesting. Unlike most wetland conservation programs that require retirement of land from agricultural production, WHIP has the potential to assist producers in making changes in farming practices that will also improve wetland services provided through the agricultural activity itself. In its 1997 comments on the then proposed rule to implement WHIP, the USA Rice Federation underscored the importance of having WHIP "focus on habitat enhancement activities that complement agricultural production" (USA Rice, n.d.).

[1] Information obtained from Texas State Natural Resource Conservation Service, 101 South Main, Temple, Texas, 76501-7682. Data available upon request.

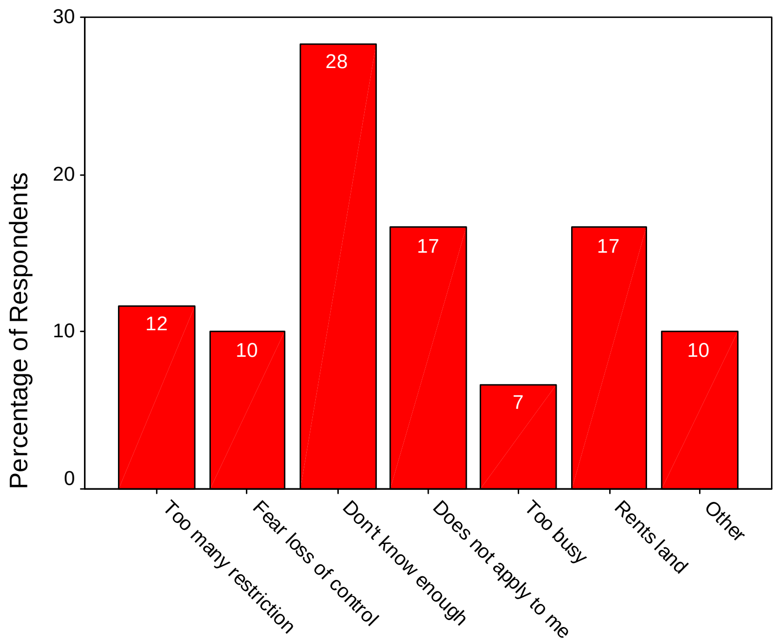
Table 5-1
Rice Producers' Familiarity and Participation in Environmental Programs (N=108)

Program	Heard of Program	Participating in Program
Ducks Unlimited (Texas Prairie Wetlands Project)	88.0%	25.0%
Conservation Reserve Program with TDPW	54.6%	5.6%
Wetland Reserve Program (WRP)	52.8%	5.6%
Wetlands Project Site Registry	41.7%	4.6%
Wildlife Habitat Incentives Program (WHIP)	40.7%	1.9%
Nature Conservancy's Wetland Management Program	36.1%	4.6%
National Waterfowl Habitat Program	35.2%	2.8%
Private Lands Enhancement Program	29.6%	.9%
Environmental Quality Incentives Program (EQIP)	28.7%	2.8%
Any land protection/land trust program like the Katy Prairie Conservancy or Legacy Trust Fund	28.7%	3.7%
Wetland Habitat Alliance of Texas	27.8%	1.9%
Conservation easement arrangement	21.3%	.9%
Any registry programs such as the Land Stewards' Society	15.7%	.9%
Partners for Fish and Wildlife	13.9%	.9%
Private Lands Initiative	9.3%	.9%

Relatively more of our respondents had heard of private lands programs such as Ducks Unlimited (88.0%), the National Waterfowl Habitat Program (35.2%), the Wetlands Project Site Registry (41.7%), and the Wetland Habitat Alliance of Texas (27.8%). Some of these programs (e.g., the National Waterfowl Habitat Program) are specifically designed to integrate rice cultivation with responsible wildlife management. This program (NWHP) is a private lands program aimed at forming a strong relationship among producers, conservation groups, and the public. Although the NWHP was created by the USA Rice Federation, it is supported by grants from the National Fish and Wildlife Foundation, the U.S. Fish and Wildlife Service, and private donations. The Federation's web page states that 400,000 rice acres across the nation are being managed for wildlife habitat during non-production months. The short-term goal is to increase this to one million acres. The NWHP focuses on keeping land in agricultural production while enhancing it for wildlife management by encouraging participation in programs such as WHIP and EQIP (USA Rice, 1995). In spite of this, participation rates are low in the NWHP and in most of the other private lands programs. Ducks Unlimited is the only program in which more than 10% of the respondents claimed participation. This low participation level is consistent with expressed interest in managing wildlife, which was also fairly low. The sample was close to evenly split among expressions of "Great Interest" (34.3%), "Moderate Interest" (36.1%), and "Slight Interest" or "No Interest" (28.7%). Furthermore, participation in activities often associated with wildlife management, such as planting food plots, was low with the exception of winter flooding for waterfowl (65.7%) and brush control (60.2%). Almost a third (31.5%) reported planting food plots within the last 5 years.

Our survey of rice producers asked them to list reasons for not participating in these programs, and the results are shown in Figure 5-4. The most frequently given response was that they did not know about the program. The second most frequently mentioned reason was that the program does not apply to the respondent. In as much as most of these programs are geared toward wetland restoration and require that land be taken out of production, respondents have a point. We would also like to draw attention to the fact that tenure issues and loss of control over land were also mentioned with some frequency. Participation in programs was lowest for producers who leased all their land and in the 5-15% range for those who owned some of the land they worked. Participation rates by owner-producers are difficult to gauge because of small numbers responding to this question.

Figure 5-4
Reasons Rice Producers Do Not Participate in Environmental Programs (N=75)



Additional Programs

Two additional mechanisms for addressing some of the economic needs of rice farmers and continuing to provide some of the ecological services of Texas rice production are wildlife tax exemptions and conservation easements. This section briefly presents these two possibilities.

Historically, the state promoted agricultural production by providing a property tax exemption for farm and ranch land but not for land being managed for wildlife. Such land was not considered productive. The passage of Proposition 11 on November 7, 1995, expanded this exemption to promote land conservation by including land designated as wildlife habitat. This legislation specifies “active wildlife management” and landowners must satisfy at least three of seven approved management practices to qualify (Montgomery Central Appraisal District, n.d.). Eligible practices include (a) habitat control, (b) erosion control, (c) predator control, (d) provision of supplemental water, (e) provision of supplemental food, (f) provision of supplemental shelter, and (g) conduct census counts. The wildlife management use must meet all the requirements to qualify for agricultural use as defined in Chapter 23 of the *Texas Property Tax Code*, and the law requires the primary use of the land to be agricultural. The qualified wildlife management use must include winter propagation of a sustained breeding, migrating, or wintering population of indigenous wild animals (Montgomery Central Appraisal District, n.d.). The law further specifies that wildlife populations be managed for human use (including food, medicine, or recreation). Proposition 11 is a revenue neutral use of land. This means that the landowner pays the property taxes that would be paid for the agricultural use category of the land. For example, if the land was used and valued as grazing land before the wildlife management, the land is placed in the wildlife management category, but is appraised at the grazing land value. Efforts to develop a wildlife management plan and implement such activities that will constitute wildlife management use may be suitable for WHIP and EQIP cost-share funds.

Additional tax credit possibilities include federal tax credits for expenses assumed for improving or creating new habitat for wildlife, income tax deductions for revenue from lands managed to support wildlife, and offsetting of property taxes paid with federal tax credits on lands that provide habitat for wildlife. There are obvious difficulties in implementing wildlife tax credits, and include the politicization of passing such laws at the state or federal level. Such laws often require an overall decrease in tax revenues or an increase in taxes for a different group to make up the loss. This is a transfer of wealth from taxpayers as a group to the individuals who are providing the wildlife benefits. Other revenue neutral tax incentives may be easier to pass through the legislature in the future.

The second option – conservation easement – generally involves a long-term or permanent loss of land use for some purposes. The concept of fee simple title is central to private property ownership in the U.S. Simply put, it grants the landowner with all the necessary rights to treat land as a fully marketable commodity which allows the landowner to legally divide these rights (e.g., water, mineral, timber, specific development rights) and sell to transfer these rights in the marketplace (White, 1993). Any of these rights can be transferred to another party.

A conservation easement is a legal agreement a landowner makes that determines the type and amount of development that may take place on his or her property. The property rights of a landowner are understood as a bundle of rights. In the case of a conservation easement, particular aspects of the fee simple bundle of rights, such as the residential development rights, are voluntarily donated or sold by a landowner to a government agency or an IRS-recognized, nonprofit conservation organization for the purpose of protecting significant ecological resources (Brenneman, 1967). In the case where the perpetual land rights are a donation, the conservation easement is considered a tax-deductible charitable transfer under federal law and the IRS codes (Small, 1989; Tax Treatment Extension Act of 1980). The economic incentive the landowner receives as compensation for the donation is the tax benefit or tax shelter associated with the particular set of rights granted in the easement. A landowner who provides a conservation easement is free to sell the property on the open market, but all easements on the land continue to apply to the property and the new owner must comply with the defined restrictions. The receiver of a conservation easement (a government agency or an IRS-recognized, nonprofit conservation organization) controls the identified land use rights and must monitor the property to guarantee the agreement is upheld.

There are three distinct economic benefits associated with conservation easements: (1) reduction in property tax, (2) reduction in estate taxes, and (3) reduction in federal income tax. With regard to income tax reduction, a donor can deduct the value of the conservation easement up to 30% of the donor's income for the year of the gift. Any amount of the gift remaining after the first year can be carried forward and deducted against income (up to 30%) for the following 5 years (Small, 1992). The full value of the land set in a conservation easement may not be completely utilized as a deduction for income tax purposes because of the 30% limitation, but the entire reduction in the value of the landowner's property results in decreased property taxes and estate or inheritance taxes. For example, if a gift of land valued at $1,000,000 is put into a conservation easement, and the donor's income is $200,000 per year, the first year's deduction will equal $60,000. The unused remaining interest in land ($940,000) can be carried forward and used as a deduction against the landowner's income for the next 5 years. In this example, the total deduction the donor would receive for the gift of land as a conservation easement would equal $360,000 (or 6x$60,000). Under property tax law, land that is subject to a conservation easement can also usually qualify for a reduction in assessed valuation that will reduce the annual property tax for the land parcel. With respect to estate taxes, a conservation easement reduces the market value of a property by reducing its development potential, and as a result, inheritance taxes are also reduced.

The most obvious disadvantage to using conservation easements as an economic incentive mechanism to assist in maintaining rice cultivation services is that it is not an attractive option if landowners have no need for tax shelters, or if the easement agreement required a reduction in acreage in rice production. Furthermore, easements are susceptible to changes in tax laws. For example, if a landowner is granted an easement on the property's use as residential development, and tax laws change for residential land, the landowner is then vulnerable to this change and compensation for the easement is changed accordingly.

CASE STUDY

In preparing this analysis, the group also looked at information from California, a state that also grows rice and whose rice farmers are doing relatively better than those in Texas. California was chosen primarily because it shares the problems of water scarcity and urban encroachment with Texas.

California is ranked second in rice production in the U.S., and Texas is ranked fourth (National Agricultural Statistics Service, n.d.). While the two states share certain concerns, such as the availability of scarce water resources for agriculture, there are also significant differences between the states. One of the most important differences being that rice production in Texas has declined since the 1980s, while it remained generally stable in California over the last ten years (Patterson, 1997; CRIA, 1998a). California took a different approach to water availability and is more proactive in its approach to urban encroachment and to informing the public and policy makers about the ecological benefits of rice production. This section offers a comparison of these important aspects of rice production in California and Texas.

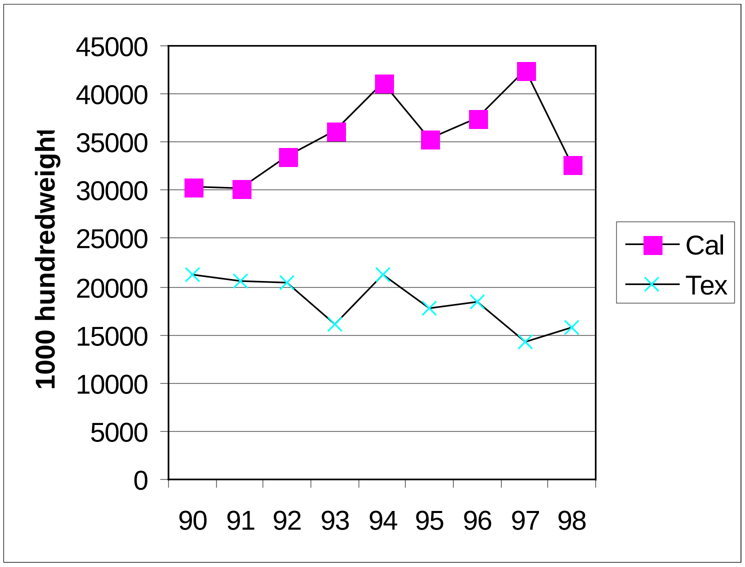
GENERAL OVERVIEW

Rice production in California is centered in the central valley region, north of Sacramento. The climate of these rice-growing regions varies, with the California rice belt being less humid and a much higher latitude than its Texas counterpart. This climatic difference gives California rice growers the advantages of having more sun, less frequent thunderstorms, and less disease pressure than rice growers in Texas (CRIA, 1998a; Patterson, 1997). For the most part, different types of rice are grown in the two regions. California produces mostly medium-grain rice favored by the Asian market, whereas Texas produces mostly long-grain rice (National Agricultural Statistics Service, n.d.; CRIA, 1998a).

PRODUCTION

Figure 5-5 shows rice production in both states from 1990 to 1998. Clearly, production in California is higher and, with the exception of 1998, generally increasing. The substantial drop in production in 1998 for California is attributed to relatively weak farm prices for medium-grain rice and an extremely wet spring that hindered planting (USDA Economic Research Service, 1998). Rice production in Texas, however, has generally been decreasing at least since 1990 (USDA Economic Research Service, 1998). It should be noted that California producers plant their acreage each year rather than on the rotational basis used in Texas. This practice may increase production levels. However, work by Mandel et al. (1975) indicate that rotation is more effective for water conservation than yearly planting in rice and has the benefits noted in Chapter 4 (i.e., controls on salinity and the improvement in ability to mesh planting and weather conditions).

Figure 5-5
Rice Production in California and Texas



PRODUCTION COSTS

Rice farmers in both Texas and California face high average production costs. Salassi et al. (1990) estimated the average cost of rice production in California at $463.78 per acre. Average costs in the upper and lower Gulf Coast regions of Texas were $424.04 and $436.21 per acre, respectively. These costs were significantly higher than the average costs of other major rice producing regions of the United States. Each region has a unique profile of input costs, but one expense was much higher than the national average for all three of these regions – irrigation water.

The high production costs in California and the lower Gulf Coast region of Texas were offset to some extent by the high rice yield in those regions. Salassi et al. (1990) estimated that the yield in California for 1988 was 69.39 cwt per planted acre, while the yield in the lower gulf coast region of Texas was 65.57 cwt per planted acre. Thus, as shown in Figure 4-6, the costs of rice production per hundred weight yield is actually lower in California than in any other region of the country. Compared with costs across the nation, the costs per hundred weight in the Upper Texas Coast are at a median level. In contrast, the yield in the upper Gulf Coast of Texas was just 51.51 cwt per planted acre, and as shown in Figure 4-6, this region had the highest cost relative to production in the country.

Another major offsetting factor in the high cost of rice production in these regions was deficiency payments from governmental programs. Salassi et al. (1990) estimated that, without government programs, rice farmers in all three regions would be losing money, with the upper Gulf Coast of Texas being especially hard hit. With the phasing out of deficiency payments associated with the 1996 Farm Bill, this is an important consideration. Richardson et al. (1994) forecast that, without government supports, the probability of survival of rice farms in California is 11% to 66% for moderate-sized farms and 0% to 1% for large farms. They forecast that, without government support, Texas rice farms would go out of business in 2-3 years. Sumner and Lee (1998) have a more optimistic assessment of the situation as it affects California rice producers, predicting that the 1996 Farm Bill will lead to higher prices for rice, which should offset losses from lower government payments. Still, the phasing out of deficiency payments clearly puts additional pressure on rice producers.

WATER POLICY AND ISSUES

Water costs in both California and Texas will increase as urban and industrial demand for water increases and environmental regulations regarding water become more stringent. Therefore, the water situation in California and Texas should have a significant impact on the future of rice production in those states.

Texas farmers cannot be sure that their future water needs will be met. The 1997 Water Plan for Texas predicts that the share of water going to agriculture will drop from 67% in 1994 to 46% by the year 2050. There are four reasons offered for the decline: improved irrigation management practices, implementation of more efficient irrigation systems, increased acreage being set aside for compliance with federal programs, and a decline in the number of farms. All three planning regions comprising the Texas rice belt (East Texas, Houston, and Mid-Coast) predict a decline in water going to agriculture starting by 2010 and continuing through 2050. The supply of water for rice farmers in California, however, appears to be more reliable than in Texas. A recent study predicts that California agricultural water use will drop from 55% of total water use in 1995 to 53% in 2020 for the Sacramento River Region, which encompasses the California rice belt (California Department of Water Resources, 1998). Thus, a much more modest drop in the share of water going to agriculture is predicted for California. Agricultural acreage in California is expected to increase slightly over the same period. This decline in water use is assumed to come from an expected increase in water efficiency. In contrast, declines in agricultural water use projected by the Texas Water Plan are based on assumptions of continued decreases in agricultural acreage as well as more efficient use of water.

The water needs of many rice farmers in California were taken care of decades ago by major developments such as the Central Valley Project (CVP). The CVP is a federally-funded program to provide water to dry areas of California's central valley. Most of the water currently delivered by CVP facilities in the Sacramento River Region is for agricultural use (California Department of Water Resources, 1998). Thus, there appears to be a steady supply of water in the California rice belt that is reserved mostly for agriculture. Furthermore, the cost of water within this project has been highly subsidized by two provisions. First, capital repayment for irrigation is spread out over a 40 to 50 year period, interest-free. Second, repayments may be further adjusted downward according to a user's ability to pay (Wahl, 1989). Wahl estimates that the Glenn-Colusa irrigation district, which serves a rice growing area, had a $101 per acre subsidy. Water policies favoring agriculture provide a more reliable supply of water and a cheaper one for producers. Thanks to the subsidized costs, rice farmers in California have a distinct advantage over their Texas counterparts.

INTERNATIONAL MARKET

Since California and Texas produce different varieties of rice, there is a significant difference in the international market accessible to rice producers in the two states. As mentioned above, California produces mostly medium-grain rice, which is in demand in East Asia. Texas, for the most part, produces long-grain rice, which is more in demand in Latin America and some Middle Eastern countries such as Iraq. U.S. rice exports to Latin America, the Caribbean, and the Middle East made up over 71.9% of total U.S. rice exports in 1998 (USDA Economic Research Service, 1999). Thus, the market for long-grain rice is large, and during the 1997-98 market year, long-grain rice has enjoyed higher prices than medium grain (USDA Economic Research Service, 1998). However, political events have shifted the balance over the 1990s. Sumner and Lee (1998) assert that the Uruguay Round Agreement (URA) of the General Agreement on Tariffs and Trade has had a substantial effect on the market for California rice since its implementation in 1995. The governments of Japan and South Korea had imposed stiff quotas on rice imports in the past, but the URA required minimum import access that forced Japan and South Korea to increase the amount of rice they import. As a result, rice imports in the countries have increased dramatically. The value of U.S. rice exports to South Korea increased from $215,174 in 1989 to $6,728,626 in 1998. U.S. rice exports to Japan increased even more rapidly, growing from $499,726 in 1989 to $115,929,893 in 1998 (USDA Economic Research Service, 1999). This has been an important market for California, as Japan imported about 17% of California's rice crop in 1995-96 (Sumner and Lee, 1998), and with increases in Japan's rice imports since those years, they presumably make up an even greater share of the California rice crop now.

On the other hand, political events have hurt the market for U.S. long-grain rice. The U.S. has not exported rice to Iraq since the United Nations Security Council placed economic sanctions upon the country in 1990 following the invasion of Kuwait (Political Handbook of the World, 1998). This is significant because rice exports to Iraq in 1989 were valued at $132,880,064, or 10.1% of total U.S. rice exports for that year (USDA Economic Research Service, 1999). Cuba is another country facing U.S. economic sanctions and, considering the large amounts of U.S. rice purchased by other Caribbean nations, Cuba could potentially be another major market for Texas rice farmers.

URBAN ENCROACHMENT

The expansion of cities near rice-growing areas not only increases competition for water but can also result in the conversion of agricultural land to urban uses. The American Farmland Trust (AFT) is an organization that identifies what it considers to be threatened agricultural areas. AFT defines these threatened agricultural areas as those in which high quality farmland coincides with land development that exceeds the state average. High quality farmland is measured according to market value of agricultural production from the land and the percentage of land that is prime or unique farmland. Development pressure is measured according to the acreage of prime or unique farmland that was converted to urban uses between 1982 and 1992. The agricultural area they consider to be most threatened by urban encroachment is the Sacramento and San Joaquin Valleys of California, which encompasses California's rice belt. The Texas rice belt did not make the group's list of the top 20 threatened areas, but parts of Brazoria, Fort Bend, Galveston, Harris, Lavaca, Liberty, Matagorda, Victoria, and Waller counties were defined as threatened. In addition, some of these rice growing counties of Texas have experienced significant population growth in the 1990s. (See Appendix A for a detailed population change map.) The AFT calls for reauthorization of the Farmland Protection Program as part of its legislative agenda for protecting farmland from urban encroachment (American Farmland Trust, n.d.). The data published by AFT often weather criticism for being too vague to provide a clear assessment of urban encroachment for a particular area (Greene and Harlin, 1995). Greene and Harlin (1995) argue that more accurate information can be gained from high-resolution satellite imagery. Unfortunately, such data have only been gathered for small, regional analyses and are not widely available.

The California alliance with AFT has been beneficial (American Farmland Trust, n.d. a). Through it, active steps are being taken to protect valuable California agricultural acreage from urban encroachment. Texas rice-growing areas do not qualify as yet under AFT criteria as endangered areas, but they do face encroachment threats that need to be addressed now if California can be taken as a model. In spite of the fact that the Texas Blackland Prairie and the lower Rio Grande Plain have been identified as the fourth and eighth most threatened agricultural areas in the U.S. (American Farmland Trust, n.d. b), farmland protection activities in the state are limited to differential assessment and right-to-farm ordinances (American Farmland Trust, n.d.c).

WILDLIFE IMPACTS OF RICE FARMING

As in Texas, California rice production is increasingly being seen as more than just an agricultural or economic enterprise. Flooded rice fields can provide many of the same environmental benefits as natural wetlands. The California rice belt also provides important winter habitat for waterfowl on the Pacific Flyway. Roughly 60% of all waterfowl on the Pacific Flyway winter in the Central Valley, and flooded rice fields make up around 45% of all wetlands in the Central Valley (Resource Management International, 1997). It has been estimated that three to five million ducks and geese utilize rice fields on their annual migration along the Pacific Flyway (California Rice Promotion Board, n.d.). At least 30 special status species listed by the state of California or the federal government are known to utilize flooded rice fields, fallow rice fields, or recently drained or harvested rice fields during their annual cycle. Overall, 141 species of birds, 28 species of mammals, and 24 species of amphibians and reptiles are known to utilize rice fields as habitats in California (Resource Management International, 1997). Finally, Brouder and Hill (1995) assert that 177 animal species spend all or most of their life cycles in rice fields. Similarly, rice fields have been estimated to provide 30% of Texas' wetlands. Texas rice wetlands support more than 2 million wintering waterfowl each year, and 70 species of birds have been found in flooded rice fields in Texas (Terry, 1996; McFarlane, 1994).

Because of the environmental benefits of rice production in California, programs have been set up to encourage further benefits to wildlife. Ducks Unlimited began working with the California Rice Industry Association to form VALLEY CARE: RICE, which advocates winter flooding (Brouder and Hill, 1995). Winter flooding benefits the rice industry by degrading excess rice straw naturally in addition to providing a wetlands habitat for more of the year. In addition, the U.S. Fish and Wildlife Service is administering the Agricultural Waterfowl Habitat Incentive program, which encourages farmers to flood fields in the winter (CRIA, 1998b). The Nature Conservancy of California, Ducks Unlimited, California Rice Industry Association, and the California Waterfowl Association funded a program to assist in the flooding of winter fields. Finally, the USA Rice Federation sponsors the National Waterfowl Habitat Program to encourage winter flooding of ricelands. Private sources, U.S. Fish and Wildlife Service, and the National Fish and Wildlife Foundation fund this program.

SUMMARY

Both Texas and California share an interest in the future of rice production. Rice is economically important to both states, and the rice fields, as surrogate wetlands, serve important environmental functions.

Despite these similarities, rice production generally been on the rise in California, while it declines in Texas. Climate contributes to California's better position. California rice growers are advantaged by facing fewer thunderstorms and less disease pressure than the more humid climate faced by Texas rice growers. Furthermore, the different climate facilitates yearly planting in California, whereas rice growers in Texas plant on a rotational basis. In addition, California and Texas rice growers, for the most part, specialize in growing different types of rice which appeal to different markets. Thus, market conditions are different for these two populations. For example, the Uruguay Round GATT agreement has opened some Asian markets to California's medium-grain rice and has the potential to open more.

Water is a major component in the relatively high production costs faced by the two states. California met the challenges of scarce water with a policy that favors agriculture, a mainstay of the California economy, and provides water subsidies for producers. In Texas, producers in the western portion of the rice belt can somewhat offset the higher water costs with higher yields. Those in the eastern portion cannot. California rice growers took a more proactive position with regard to the environmental benefits provided by rice agriculture. Their alliances with environmental interests gave producers powerful bargaining partners and enhanced rice's image with the public.

STRATEGIC ALTERNATIVES

As stated earlier, the future of rice in Texas is problematic. All things being equal, the farm policy changes embodied in the 1996 Farm Bill had a serious impact on rice farmer's income. While the 1996 Bill is not the cause of the relatively poor economic position of Texas rice, absence of the traditional supports will eventually force many Texas rice farmers out of production. Rice cultivation also provides ecological services as one of its by-products. These services may have important economic value. For example, hunting along the coast, and in the rice growing region, provides supplemental income for some, and wildlife tourism is growing. These services may also have non-market value that lies in their contribution to biodiversity and the ecological health of the area. If the services they provide can be documented adequately, there may be an argument for policy intervention that will insure the continuation of rice cultivation. However, we still lack compelling documentation of the relationship between rice acreage changes and ecological services, and of the market and non-market value of these services. The ecological analysis done for this report is the first step in establishing the necessary evidence. Nevertheless, we do not currently have strong support for expensive programs designed to curtail the decline in rice acreage. There are, however, some measures that can be taken toward the goal of maintaining rice production in Texas. This section discusses the relative merits of these measures.

INCREASING PROFIT

The economic analysis above indicated that if the marginal net benefits of rice production are greater than the benefits of any other use of the land, production can be expected to continue at some level. While a complete economic analysis was beyond the scope of this study, it was clear that the costs of production relative to market price are central elements in the economics of rice production. Circumstances that would improve profitability include 1) a higher market price for the long-grain rice that is most commonly grown in Texas, 2) access to world markets for this type of rice that are currently closed to producers, 3) improvements in technologies and rice varieties that would increase yield and/or reduce the costs of production, and 4) alternative or additional sources of income.

Access to new markets for rice is an important factor in the relatively good future projected for rice producers in California. This state profited from the newly opened international markets in Asia because the japonica rice grown in the state is the type in demand in Asian markets. The Uruguay Round Agreements (URA), at least in theory, made European markets more accessible to U.S. rice, including Texas rice, but the focus of Texas rice producers seems to have been on the more traditional markets for Texas long-grain rice, notably Iraq and some countries in Latin America. The reopening of these traditional markets hinges on other kinds of political decisions. Some attempts are currently being made to change the U.S. positions on the current trade embargoes that have limited international trade in long-grain rice. For example, the House Senate Conference Committee has proposed an amendment that would lift the embargo on food and medicine to Cuba and other countries that the U.S. has under trade sanctions for political reasons. Ironically, Representative DeLay (R-Sugarland, Texas) opposed the amendment being sponsored by Senator Ashcroft from Missouri (another rice-producing state). The Netherlands and Great Britain introduced to the U.N. Security Council a proposal to suspend the embargo on Iraq's exports, but the U.S. remains committed to retaining sanctions for imports to the country (Littlejohn, 1999).

Technical Innovation

There are also options for rice farmers in the form of technological improvements and in additional sources of income associated with rice cultivation. These vary in their economic potential and, thus, their potential to change the direction of rice production. They also have different potential impacts on the ecological services of this area of Texas.

The rice industry and its partners in agricultural research have primarily met the challenge of reduced marginal benefits with efforts to produce varieties that will require fewer inputs, and, therefore, reduce the costs of production. Approximately 75% of the work done at the Texas A&M Research and Extension Center at Beaumont is devoted to research on rice production issues such as disease, insect, and weed management (Texas A&M Research & Extension Center, Beaumont, 1992). At a visioning conference held there in the fall of 1998 (TAES Beaumont, 1998), expected improvements that were discussed included varieties that are characterized by cold resistance, earlier and more rapid maturity, greater vigor, and herbicide tolerance. Cold resistance will allow early planting and increase the time available for a ratoon crop. It is predicted that ratooning could be increased from the current 45% of acreage to as much as 85% of acreage. Since ratoon crops require fewer herbicide and other applications, these costs of production are lower, but the ratoon crop can add up to 40% more water to production costs (McCauley, 1998). Earlier and more rapidly maturing varieties require less water, and the time available for ratoon cropping is increased. Early maturing varieties, however, are generally characterized by low yields. The primary advantage of increased vigor is reduced seed costs. Herbicide tolerant rice would mean that red rice could be more easily controlled. This characteristic may also contribute to the need for fewer flushes of water.

Most of these advances will come as the result of work being done on the genetics of rice and will benefit from data produced by the rice genome project. Many of these advances are not expected to become available until 2010 at the earliest. Also on the horizon are strains of genetically modified rice capable of delivering unique nutritional and pharmaceutical payloads, thereby creating new markets for rice. These innovations will probably not be introduced before 2050. New rice varieties could introduce the tipping point on input costs that would once again make rice profitable even in the face of a continuation of a relatively poor market price. Innovations that conserve water will be especially helpful in reducing production costs and will also help farmers deal with the reduced availability of water for agricultural uses. The second set of innovations would introduce a value-added element to rice that could open important new market for the product. However, at current loss rates for rice acreage, the ability of producers to take advantage of these innovations may be impaired.

Two factors make it less likely that the rice industry will be able to wait out the time required to introduce these important changes. First, as discussed above, there is an interaction between tenancy patterns in the rice producing counties of Texas and the lack of production requirements to qualify for contract payments. With a poor market for Texas rice, there are few incentives for owners to continue to lease land to producers and share in the costs of production when support payments are available even if rice is not planted. The second factor reducing the ability of rice producers to take advantage of innovations is the current impact of acreage reductions on the rice milling and distribution infrastructure. This infrastructure requires a critical mass of producers to make a profit, and there have been significant reductions in this milling and distribution network in recent years. Without it, cost efficient rice production becomes problematic. Once this infrastructure is gone, the ability to respond to market improvements is greatly diminished, because start-up costs of reestablishing this infrastructure are substantial.

Improved irrigation is another type of technical innovation that is available now and would, in the long run, reduce the cost of the major input for rice production (water) as well as improve producers' ability to deal with reductions in future water supplies. In their study of water management in the Texas rice belt, Griffin et al. (1984) identified three primary water conservation techniques used by rice producers. These were water leveling, precision leveling, and underground pipe. With water leveling, traditional surveying methods are used to level land between levees. Precision leveling uses a land plane (usually laser-guided) to achieve more accurate leveling and a uniform slope to the fields. The use of underground pipe allows water to be delivered to each cut in the field. This increases the control over water leveling and reduces lateral losses. Of the three methods, water leveling is the most commonly used since it requires equipment the farmer generally has on hand and is the least costly to implement. Griffin and his colleagues (1984) maintain that although underground pipe should reduce water use and increase crop yield, the data to support this belief have yet to be gathered.

Improved irrigation technologies are available, and help for producers wishing to implement more effective systems exists in the form of the Linked Deposit Program. This program was developed to finance water pollution control projects through low-cost agricultural loans. In 1997, the Texas legislature allocated up to $10 million of the state's Linked Deposit Program to finance agricultural water conservation projects, such as improvements in irrigation methods (Rylander 1997). Another important program is the Agricultural Water Conservation Loan Program, run by the TWDB. This program makes loans to soil and water conservation districts, and underground water conservation districts that, in turn, make loans to individual farmers and ranchers for agricultural water conservation purposes. Loans can also be made to irrigation districts to improve their facilities. The loans may be used for capital equipment or materials, labor, preparation costs, and installation costs to improve water-use efficiency in existing irrigation systems, and to prepare dry land for more efficient use of natural precipitation.

The Water Plan (TWDB, 1997, sec. 2) describes the linear programming models developed to predict adoption of irrigation improvements. These included system costs and also took into account deficiency payments and land set-aside requirements for compliance with federal farm programs. The Plan acknowledged that the spread of new irrigation technology has not been rapid, and the implementation rate employed by the models included high levels of farm debt, land suitability, lack of knowledge, and reluctance to adopt. According to the 1984 study by Griffin et al., the larger landowner and, particularly the owner-producer, is more likely to utilize conservation improvements than to reduce rice acreage in response to water shortages or price increases.

If the goal is to continue rice production, it cannot be assumed that the existence of loan and other aid programs is enough to encourage change to more efficient water use, particularly to those landlords who may have little interest in introducing improvements when contract payments can be received whether rice is produced or not. Historically, owners who lease their land are less likely than owner-producers to introduce irrigation improvements even in times when rice was the primary source of income from land use (Griffin et al., 1984; TWDB, 1997). Particular attention, therefore, must be paid to incentives for owners who lease their land to producers.

Additional Source of Income: Inter-cropping

Even though the soils on which rice is grown in Texas are generally not suitable for many of the alternative commodity crops, there are a number of inter-cropping options suitable to clay soils. Such inter-cropping could provide rice producers with two agricultural products instead of one. The feasibility of these options has received little systematic study in Texas but has been considered in some of the other rice producing states and is being tested on a small scale here (Hill, 1999).

One of these options is the inter-cropping of crayfish and rice. Between 1991 and 1995, McClain et al. (1997) conducted a field test of crayfish / rice inter-cropping in Louisiana. In theory, the environment of the rice field could be used to increase crawfish size with minimal impact on rice production. Ponds used for crawfish alone can become over-crowded and oxygen poor, resulting in smaller crawfish size. McClain et al. used a randomized design except where pre-planting conditions necessitated forced randomization. The profitability of the relaying process was analyzed using the Mississippi State Budget Generator.

Findings were generally positive, more so for some inter-cropping designs than for others. Crawfish were relayed into fields already planted in rice. Fertilizers were applied prior to prior to planting and in advance of stocking. No fungicides or insecticides were used. Crawfish increased in size as expected. They were ready for harvest prior to rice maturity and, therefore, did not interfere with rice harvest. The presence of crayfish had relatively little effect on rice yield although it was found that the most effective method for harvesting crayfish was detrimental to rice yields, because it utilizes trapping lanes that reduce the acreage planted to rice. The analysis indicated that in fields or under conditions that produce lower rice yields, relaying becomes more profitable than rice-only production. Many variables impact the economic feasibility of the system, and decisions to implement it must be made on a case-by-case basis. Nevertheless, there is some evidence for a crawfish market in Texas. The Pettigrew Ranch in Navarro County started a crawfish operation in both constructed ponds and natural waterways that is reported to be thriving (Hill, 1999; also see Louwagie, 1999).

Other forms of aquaculture have been introduced to the rice growing area. Eel culture, for example has achieved some success in the Houston area (Kliewer,1999). Unlike the inter-cropping of crawfish, however, most forms of aquaculture require water in addition to what is needed for rice production. This is counterproductive in the current climate of concern over water resources. Furthermore, a careful market assessment would have to be done before the implementation of some sort of aquaculture. Profits might do little to offset the increased costs of water for producers.

The feasibility of farming crops other than rice are being investigated. Sugar cane and kenaf are among the alternative crops that appear to be relatively well-suited to the Gulf Coast soil and climate conditions. Both of these crops have equipment and infrastructure requirements that are different from those of rice, however. Their implementation as alternative crops would call for significant investments on the part of producers and communities (Associated Press, 1999). Respondents to our survey indicated little intention to plant alternative crops (see Figure 5-3), and there was no indication that producers intended to experiment with sugar cane or kenaf. Even if these prove to be viable crops for the rice-producing area, they are not flooded crops and would not provide the same ecological benefits for migrating waterfowl and geese.

Nonagricultural Uses for Rice Fields

The ecological services associated with rice production also provide opportunities for additional income. These opportunities include consumptive uses, such as hunting and fishing, and non-consumptive uses, such as bird watching and other wildlife viewing. The proceeds from these activities are generally considered to be substantial. The economic analysis above reviewed some of the literature on profit to be gained from them. The Texas Parks and Wildlife Department (TPWD) has reported $1.5 billion spent on fresh water fishing in the state. TPWD reported that another $56.6 million was made from hunting licenses in 1996 (TPWD, 1997a), and a report by the U.S. Fish and Wildlife Service (FWS) shows that 65 million adults in the U.S. report enjoying watching and feeding birds. The same report indicates that people annually spend as much as $5.2 million on bird watching (reported in National Wildlife, 1996). If the costs of equipment, transportation, lodging, meals, and other expenses are added to these calculations, the economic value of consumptive and non-consumptive uses of wildlife appears significant. However, these costs are widely distributed among service providers, manufacturers, retailers, and landowners, and, as pointed out in Chapter 4, there is little reliable data on the economic returns to producers from these activities.

Consumptive Uses of Rice Fields

Hunting leases are the most common way for landowners to profit from nonagricultural uses of land. Even though the most commonly hunted animal in Texas is the white-tailed deer (Pope et al., 1984), ducks and geese are more relevant to this study and will be the focus of the discussion below. A 1992 survey of rice farmers asked them to list the non-farming activities that took place on their land in 1991 (Cready and Thomas, 1995). The most common non-farming activity reported was non-fee hunting. Fifty-six percent of those surveyed reported some non-fee hunting, and 39% reported fee hunting. The same survey indicated that non-fee fishing was also common but more likely to take place in the eastern rice belt (29%) than in the western rice belt (18%). When asked what kinds of wildlife could be found on their land, 80% of those surveyed indicated that a variety of game birds were present (e.g. doves, quail, ducks, geese), and about half of the producers reported that these were hunted. As displayed in Table 5-2, our survey of rice producers indicates that 46.3% leased their land for fee waterfowl hunting to an outfitter and another 10.2% ran their own waterfowl hunting operation for a fee for a total of 56.5% participating in some kind of fee-based hunting. In addition, 34.3% of the sample allowed non-fee waterfowl hunting. Other types of fee-based hunting were reported by 6.5% who used an outfitter and 4.6% who ran their own hunting operation. Fishing was less prevalent, with 12% of rice producers surveyed allowing non-fee fishing and only one respondent (.9%) charging a fee for fishing.

In our sample of rice producers, participation in certain non-farm activities varies with the amount of rice being farmed. Rice producers who farmed a greater than average amount of rice acreage were more likely to participate in fee hunting operations than those who farmed a less than average acreage of rice. The difference is especially large for waterfowl hunting activities leased to an outfitter. On the other hand, those with smaller than average rice farms were more likely to report non-fee hunting. Thus, producers who farmed larger than average amounts of rice appear to be more likely to take advantage of the economic opportunities offered by hunting on their fields than those with smaller rice farms.

While the accuracy of these figures would have to be substantiated with a more comprehensive study, they do suggest that the proportion of fee-based hunting may have increased in the years that have followed the 1996 Farm Bill, but non-fee hunting still represents a significant portion of the hunting that is done. Our survey also indicates that income from off-farm work has increased in this period. Almost a quarter (23.1%) of the respondents said that they derive income from work off the farm, and almost three-quarters (72%) said that this source of income had increased as a proportion of total income since 1995. We cannot tell from these data, however, if this increasing percentage is a result of relatively less income from rice or more from off-farm work.

Table 5-2
Rice Producers' Participation in Non-agricultural Activities[a]

Type of Activity	Activity	Percent Participating, High Acreage	Percent Participating, Low Acreage	Percent Participating, Total
Consumptive	Waterfowl hunting, fee, leased to outfitter	57.1%	38.1%	46.3%
	Waterfowl hunting, fee, self-operated	11.9%	7.9%	10.2%
	Waterfowl hunting, no fee	26.2%	38.1%	34.3%
	Other hunting, fee, leased to outfitter	7.1%	6.3%	6.5%
	Other hunting, fee, self-operated	4.8%	3.2%	4.6%
	Other hunting, no fee	7.1%	11.1%	9.3%
	Fishing, fee	2.4%	0%	0.9%
	Fishing, no fee	9.5%	9.5%	12.0%
	Oil/gas production	38.1%	38.1%	37.0%
Non-consumptive	Bird watching, fee, arrangement with outside agency	2.4%	1.6%	1.9%
	Bird watching, fee, self-operated	0.0%	0.0%	0.0%
	Bird watching, no fee	21.4%	11.1%	14.8%

[a] N=108 for total sample column; "low acreage" refers to respondents who farm less that the mean acreage of rice for this sample (N=63), "high acreage" indicates respondents who farm greater than the mean level of rice (N=42). Three respondents did not give a valid answer regarding their rice acreage and are left out of the calculations in the first two columns. Thus, in two cases, the average for the total sample lies outside of the range of percentages for the first two columns.

Our survey of a cross-section of the state's population indicates that only 7.4% of the respondents engaged in goose and duck hunting. About half of these respondents (4.4%) reported hunting for a fee. This is consistent with findings from the last decade. In a survey of Texas hunters conducted in 1982, 21% of those sampled reported hunting duck, and 10% reported hunting geese. Among these hunters, 24% purchased a lease for duck hunting and 21% purchased a lease for goose hunting. The remaining 60-75% either hunted on their own land or on the land of relatives and friends (Pope et al., 1984). At the time of this survey, there was wide variation in the cost of hunt leases ($1-$5,000+) with the average cost of leases to hunt ducks and geese being $626 and $728 respectively. Even though there is a relatively small number of goose and waterfowl hunters, there may be some potential for increasing the income that rice producers can derive from duck and goose hunting. Our survey indicated that 41.1% of those surveyed were willing to pay more than they do now to lease property for hunting. However, only 25% were willing to pay more for hunting guides (see Table 5-3).

Table 5-3
The Public's Participation in Outdoor/Recreational Activities (N=300)

Type of Activity	Activity	Done for Fee	Done for No Fee	Total
Consumptive	Deer Hunting	10.7%	5.4%	16.1%
	Duck and Goose Hunting	4.4%	3.0%	7.4%
	Dove Hunting	7.0%	5.7%	12.7%
	Freshwater Fishing	18.7%	21.5%	40.3%
	Saltwater Fishing	10.1%	8.1%	18.1%
Non-consumptive	Bird Watching	1.3%	16.0%	17.3%
	Camping	17.3%	16.7%	34.0%
	Watching Wildlife	8.4%	22.7%	31.1%
	Hiking	5.7%	18.3%	24.1%
	Boating	9.4%	16.7%	26.1%

Non-Consumptive Uses

Non-consumptive uses of wildlife and natural resources also generate substantial amounts of money. There is evidence that these activities contribute to the economy generally, but there are important caveats to the apparent profitability of non-consumptive uses of wildlife as pointed out in Chapter 4. There is evidence that this contribution usually does not go to those most closely associated with the natural resources being utilized. As with consumptive uses of wildlife, money is spent at the point of origin – for travel and equipment/outfitting, for example. At the point of destination, money is often spent for guides, lodging, food, transport, and access fees. If an outfitter or eco-travel company is used, most of the expenditures at the destination site go to the outfitter or company rather than to the landowner. Local populations are likely to profit least from the tourism activity (e.g. see McLaren, 1998; Brandon, 1996; Boo, 1989).

Although our surveys indicate that both rice producers and the public are more likely to be involved in fee-based than in non-fee-based hunting activities, most non-consumptive activity, such as bird watching, takes place without the attachment of a fee. As shown in Table 5-2, only 1.9% of rice farmers in our sample charged a fee for bird watching on their land. Producers who farm greater than average amounts of rice are slightly more likely to charge a fee for bird watching, but they are also much more likely to allow free bird watching than those who farm smaller rice acreage. Furthermore, only 1.3% of the respondents to our survey of the general public reported bird watching for a fee, but 16% said that they engaged in non-fee bird watching (see Table 5-3). This could have been anything from backyard birding to watching in conjunction with other vacation activities, to organized watches on the land of friends and family. These percentages probably misrepresent the actual number of people who make up the birding market, because the coastal areas of Texas attract watchers from other parts of the United States. Resources are being committed to improving the experience for birders and other wildlife viewers in the coastal area (TPWD, n.d.). However, reliable information on the numbers of recreation seekers who participate in the various non-consumptive events and their demand for goods and services beyond those directly associated with the recreational activity, itself, has yet to be gathered. It is this kind of information that will be essential if strong arguments are to be made for the importance of addressing the loss of ecological services associated with declines in rice farming.

Our survey of the general public suggests that less than 20% are willing to pay more for access to hunting land. Because of the small numbers involved, birders were not singled out to ask about their willingness to pay for access to birding areas. However, evidence from other studies suggests that, unlike hunting, bird watching is an activity that usually does not require access to specialized areas. For example, Adams et al. (1997) found that although their sample of Texas birders reported taking more trips than waterfowl hunters and made trips to a wide range of areas, most of their trips were to roadside areas and to their own land. People who identify themselves as bird watchers and wildlife viewers are also a varied group. For the most part, they are not solely interested in the viewing activity. The implication is that to attract an audience like this, a variety of activity options must be available. For example, information from 517 visitors to the 1995 Hummer/Birder Celebration in Rockport, Texas (Kim et al., 1997) indicated that most of those surveyed were not serious birders as that term is generally understood. This birding event was for most of them a much broader experience. Even individuals who regarded birding as a serious activity engaged in a variety of birding-related activities.

Nature tourism, or eco-tourism as it is sometimes called, is currently expanding globally as a means for providing access to nature and wildlife in ways that are sensitive to the environment but still lucrative for people living in the tourist destination, some of which have few other exploitable resources. If this type of tourism is to be developed in Texas rice-producing areas, there are issues that must be addressed. One of them concerns the long-term impact of tourism on the destination sites. There is growing evidence that this type of tourism is not entirely benign. Lone tourists and touring groups can be destructive to the environment. Some of this destruction stems from practices such as littering and unsound waste disposal, and some stems from problems due to increased numbers of people in a limited area, such as soil compaction and effects of human contact on wildlife (e.g. see Erize, 1987; Holder, 1988; Jarvil, 1991; Knight and Gutzwiller, 1995; Liddle, 1997). The same kinds of impacts are noted on breeding and wintering waterfowl (Hume, 1976; Batten, 1977; Anderson and Keith, 1980; Henson and Grant, 1992). The pressures on businesses to expand their markets means that as the industry develops, the likelihood of at least some of this destruction will increase (Sirakaya and McLellan, 1998).

A second issue is the infrastructure that is required by a thriving tourist industry. An infrastructure of roads, lodging, restaurants, and entertainment is essential to tourism development. The research reviewed here indicates that the largest market for these non-consumptive activities is one that is interested in a variety of activities and access to comfortable amenities. This infrastructure could have positive impacts on local communities and on rice farmers. However, it also represents potential stress to the environment (McLaren, 1998; Honey, 1999).

Changes in the market need to be considered as well. Adams et al. (1997) make an interesting observation in their study of birders and waterfowl hunters. They document that hunters and birders are largely white (99%). However, non-white and ethnic minorities are increasing as a portion of the population in Texas and elsewhere. Non-Hispanic whites are also expected to increase in numbers, though at a much lower rate, and their average age will be higher. The aging of the white population is a good sign for activities such as bird watching, as this tends to be an activity more popular with those middle aged and older (Adams et al., 1997). However, if the nature tourism market is going to continue to grow, the development of potential customer bases outside the state and the development of new Texas markets are recommended.

GREEN PAYMENTS AND OTHER SUPPORT MECHANISMS

Given the probable link between rice cultivation and some ecological services, programs of green payments could play an important role in supplementing the income of rice producers. The idea of green payment programs is to directly compensate farmers who voluntarily provide and/or maximize environmental benefits from farming practices (Heimlich, 1995). This approach is distinct from the non-specific, environmentally friendly financial assistance programs of the past. Green payment programs are designed to provide secure income support to farmers for providing the public good of environmental benefits through stewardship practices, without introducing distortions in commodity prices. Most of the programs aimed at restoring or improving wetland habitats assume that agricultural activity is detrimental to this goal. There are exceptions, however.

Existing programs, such as the Wetland Reserve Program (WRP) and the Wildlife Habitat Incentive Program (WHIP), provide landowners with an incentive to restore some of the wetland functions of the area that were eliminated when the land was improved for agricultural use. These programs also allow them to gain economic advantage from such restoration since hunting and fishing are allowed on the land. WRP is limited to areas that were once wetlands. The coastal prairie was formerly marked by ephemeral prairie wetlands, creeks, rivers and bayous which could, to some extent, be restored. The WHIP program, on the other hand, supports not only restoration but also development of wildlife habitat.

As defined in the 1996 Farm Bill, the Environmental Quality Incentive Program (EQIP) and the Wildlife Habitat Incentive Program (WHIP) are the best candidates for a pilot green payment program aimed at producers. In the wake of trade liberalization and global competitiveness, EQIP and WHIP furnish mechanisms to provide farmers with income in the form of direct payments for the production of desired environmental outcomes. Compliance with the General Agreement on Tariffs and Trade (GATT) has stimulated some of the agro-environmental reforms in the 1996 Farm Bill (Potter, 1998). The GATT agreement requires that green payments be part of clearly defined government environmental programs, have minimal trade distorting effects, and be limited to subsidizing the added cost or lost income from the practices adopted or technology shift accomplished (Potter, 1998; Batie, 1998). EQIP and WHIP programs would be considered GATT-legal because they would not be directly coupled with commodity production (Batie, 1998). These types of programs are also more likely to be politically palatable and defensible to the American public because they are targeted at addressing agro-environmental concerns (Potter, 1998) rather than simple direct welfare payments to farmers. Furthermore, EQIP and WHIP are not land retirement programs and require proactive measures toward environmental outcomes. The legislative intent of EQIP and WHIP is to provide such GATT-legal green payment programs, but how these programs function when implemented determines their potential agro-environmental policy impact.

Batie (1998) presents two policy relevant questions with respect to EQIP as a green payment program: (1) To what extent could (or should) green payments substitute for traditional commodity payments? and; (2) to what extent does EQIP reflect the characteristics of a well-designed GATT-legal green payment program? Her discussion of these two questions presents some interesting points as they may relate to rice production in Texas. The first question addresses distributional issues and is dependent upon what agro-environmental policy objective is targeted. Batie summarizes the issues as follows:

> "… assuming that the agro-environmental problems of most interest are those captured in a water-related environmental benefit index, the answer to the question of whether green payments could substitute for commodity program payments appears to be 'not well.' Furthermore, … as the fledgling EQIP program develops, we can expect to see it caught in a swirling set of political forces … some pulling it to duplicate the old commodity program payment distributions, some to target certain agro-environmental problems, some to target other agro-environmental problems, some to target certain types or sizes of farms, some to spend money, and some to save money."

These concerns complicate the implementation of a cost effective and environmentally targeted green payment program. The political problems with regard to influences on the distribution of payments echo situations presently occurring in Texas.

Batie (1998) examines the second policy question by looking at EQIP as implemented in Michigan. She discusses several "implementation hurdles" relating to the targeting, tailoring, and transparency of the EQIP program. In particular, developing effective allocation procedures, pressures to spend funds, data gaps, lack of agency resources, and funding limitations are hurdles that all states implementing EQIP must overcome.

The process of allocating EQIP funds needed to demonstrate that it was different from the previous agriculture conservation programs, targeted environmental outcomes, and overcame political pressures to maintain historical distribution patterns. The initial formula for ranking contracts was designed around a water quality oriented environmental benefit index (Batie, 1998). Strict adherence to this criterion would have resulted in drastic redistribution of funds, and thus the allocation method was revised to make the redistribution less extreme. This has long-term detrimental impacts on the effectiveness of EQIP as an environmental program. Because the contracts are multi-year, once ranking of the contracts is defined, there is a long-term commitment to fund those contracts even though allocation priorities may change over the contract period (Batie, 1998).

Pressures to spend dollars by the end of the fiscal year also compromises the efficiency (maximization of benefits per dollar spent) of any program (Libby, 1998). EQIP, as a grant-giving program, must relinquish funds not allocated by September 30. If the program fails to utilize the entire budget in any fiscal year, the next year's budget will be adjusted to reflect this lack of spending. Thus there is a tendency to fund contracts early in the fiscal year even though there is no deadline for application. This tendency may result in the exclusion of more efficient contract applications that are submitted later in the year.

From an ecological perspective, the determination of environmental priorities is hindered by insufficient data and resources, chiefly at the county level. This locally driven process is organized through the local conservation districts. Often there is a lack of institutional capacity and resources to manage the tasks of organizing broad participation of the relevant stakeholders, and sufficiently inform the process. EQIP is not designed or sufficiently funded to function as an outreach for farmers and other stakeholder groups (Batie, 1998). This difficulty is reflected in our survey finding of low levels of information about and interest in EQIP as well as most other wetlands conservation programs.

There is a bias toward self-identification in the contract application process as well. Some farmers may not know about EQIP opportunities, or may choose not to participate in EQIP for multiple reasons. Our survey indicates that the most common reason rice producers offer for not participating in EQIP and other environmental programs is they "don't know enough about them." The second most common answer is that the programs do not apply to the respondent, which could also reflect a lack of knowledge about these programs. Thus those farmers who identify themselves and request funds may not always be the farmers who could provide the greatest environmental benefit for the program dollars. The contract and priority area identification is further exacerbated by a lack of important data which link farming practices with environmental outcomes. Evaluating performance of contract holders or the EQIP program as a whole is difficult without adequate performance standards to act as quantified environmental quality objectives. There are spatial and temporal challenges in linking environmental quality with particular farming practices, and there are little or no baseline data or monitoring from which to begin an evaluation (Batie, 1998), and little funding directed toward such efforts.

As currently funded ($200 million per year for EQIP and ~$7.14 million per year for WHIP compared to $7-12 billion per year for historic income support payments), EQIP (and WHIP) may not have the means to encourage agricultural practices with more beneficial environmental outcomes. The programs lack the financial resources to be effective on any broad scale. The dollars required to implement the necessary changes from a whole farm perspective are often much more than the cost-share or incentive dollars provided by the programs (Hays, personal communication, May 1999). This suggests that from the producer's viewpoint, the funds are not enough to justify entering into the program, particularly for larger farms.

Although the 1996 Farm Bill altered some of the constructs determining fund allocation, it still does not provide clear environmental objectives for the agricultural sector. Without clear objectives, it remains difficult to ensure allocation of limited dollars to the most ecologically sensitive or important agricultural production areas of the nation. In order to be practical, green payments such as EQIP and WHIP are based on the use of a particular farming system or set of practices rather than ecological outcomes. Even though monitoring practices may be easier (thus more practical) than measuring outcomes, it still involves substantial technical, administrative, and political challenges (e.g., resource commitments, data requirements, manpower to approve plans, compliance determination and monitoring, prevailing beliefs and values impacting federal budget constraints). In addition, managing for practices rather than objectives does not stimulate the same response that setting clear measurable environmental objectives would precipitate. Damage by farming practices is uneven in scope and severity (by farm operation and location). At present, the science that can conclusively demonstrate the link between improved environmental quality and particular farming practices is inadequate, particularly with respect to water quality. Prescribing best practices is guesswork in many situations. Unless a clear scientific basis can be demonstrated, the ecological, political, and monetary cost of mandating and enforcing specific practices will be great. These costs may eventually dismantle EQIP and WHIP programs without explicit environmental objectives that can be effectively monitored.

Despite their limitations, programs such as WHIP and EQIP are important new programs. They are novel approaches that represent a transition in the agriculture policy arena. Improvements will likely be made to enhance flexibility, measurement, accountability, and program efficiency. As these changes occur, green payment programs may potentially become effective conservation enterprises in agriculture. Our surveys show that there is some potential for expanding green payments programs in Texas. Environmental group representatives were asked if their groups would be willing to financially contribute to three hypothetical programs that provide financial benefits to farmers who provide environmental benefits. The general public was asked if it would support these same hypothetical programs with tax dollars. The results are in Table 5-4 below. This table shows that at least 50% of environmental group representatives surveyed would be willing to contribute to such programs. The results for the general public are even more remarkable, with over 65% of Texans surveyed supporting using public money on such programs. We should be cautious of these results because of the hypothetical nature of the programs and their costs, but this does indicate that there is a potential for public support of expansion of green payments programs.

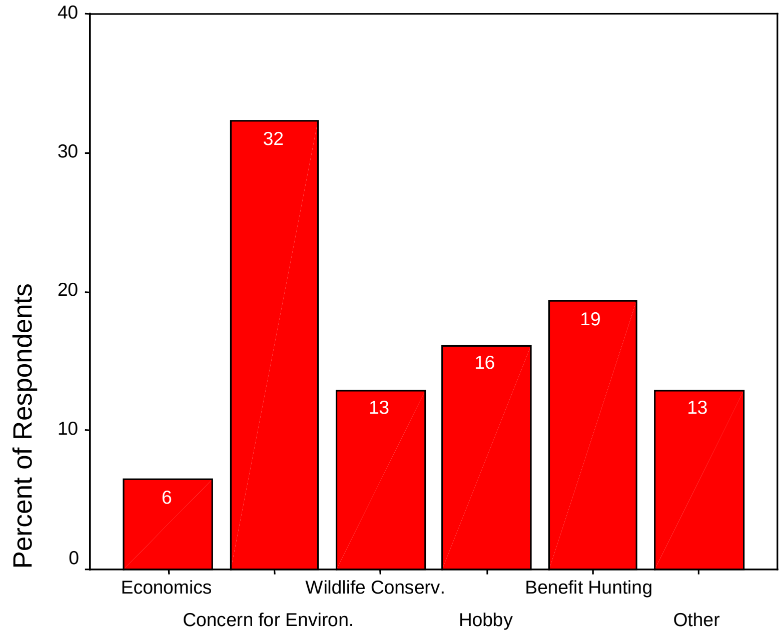
Table 5-4
Support for Hypothetical Farm Programs[a]

Hypothetical Program	Support Among Environmental Group Representatives	Support Among General Public
Financial benefits for farmers who use environmentally sound agricultural practices	56.3%	67.7%
Financial benefits for farmers who provide habitat areas for birds and animals	50.0%	69.3%
Financial benefits to farmers whose farming operations provide environmental benefits	50.0%	72.0%
Research into ways to blend good agricultural and good environmental practices	56.3%	75.3%
Financial benefits to farmers to keep farmers in business who would otherwise be consumed by urban sprawl	37.5%	71.7%

[a] For environmental representatives, N=16; for general public, N=300.

The problem of producer participation in such programs remains, however. The most well-thought out programs are not necessarily adopted voluntarily by those who will ultimately benefit from them. A GAO report in 1977 indicated that soil conservation programs had not been able to increase and maintain soil conservation on agricultural land used for crops to the extent projected, in spite of significant expenditures for this purpose since the implementation of the program in 1935 (US General Accounting Office, 1977). There is an extensive literature on the factors associated with successful adoption of new agricultural practices (see Rogers, 1995). It might be argued that the acceptance of environmental practices which often require taking land out of production is fundamentally different from the acceptance of practices developed to increase agricultural production. However, the literature suggests that many of the factors associated with the adoption of these two types of practices are similar. Of great importance is the perception that the innovation is needed or that a change in current practice is called for. In the case of soil conservation, the perception that soil erosion is a problem is essential for the adoption of remediation practices (Ervin and Ervin, 1982). The impact of the culture and values of farming on these perceptions is complex but important in understanding the adoption process.

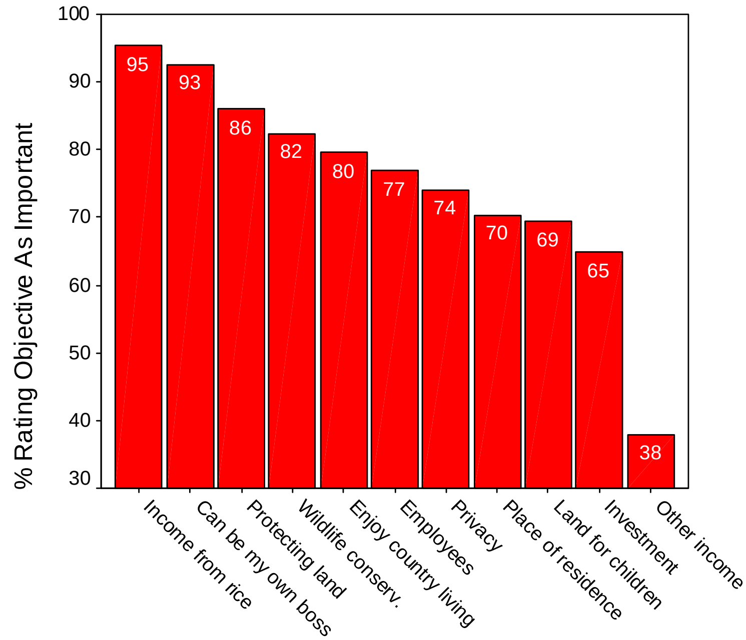
Figure 5-6
Reasons that Rice Producers Participate in Environmental Programs (N=75)



The reasons given by rice producers for participation in one or more of the conservation programs listed in our survey are informative. As shown in Figure 5-6, the most frequently given reasons for participating in one or more of the programs mentioned in the survey center around an expressed concern for the environment and/or a personal involvement with wildlife management. The economic return to be realized from participation was a poor second reason given by individuals who participated. The inconsistency between the importance given to non-economic values attributed to farming/land ownership (see Figure 5-7) and the generally low levels of participation in conservation programs has been recognized by other researchers. Peterson (1991), in her rhetorical analysis of interviews with farmers, has pointed to the same inconsistency between farmers' self-images as caretakers of the land and as technicians with the power to control nature for gain. In her interviews with farmers, she found that farms were often referred to as tools. Although the life of a tool can be prolonged with proper care, it is the fate of a tool to be used up in pursuit of productivity – "…to perform required tasks until it, ultimately, wears out" (Peterson, 1991:301). Furthermore, freedom for workers can be defined as the right to use tools as they see fit. The importance of personal commitment was also found by McCann et al. (1997) in their study of organic farmers. They found that organic and conventional farmers shared a concern for the economic risks associated with farming, but organic farmers were significantly more likely to also be concerned about the long-term sustainability of farming. This produced a greater willingness to take risks to insure it.

In addition to the value inconsistencies that are part of the tradition of farming in the U.S., there are several additional pressures that make reluctance to participate in conservation measures more understandable. One of these is the inherent uncertainty of farming. A cautious attitude toward new and untried behaviors is a common reaction in such a climate. In addition, under conditions of uncertainty, groups with strong identities tend to turn inward and to be suspicious of outsiders. American farmers have very successfully utilized technology to increase their efficiency and profitability of their production efforts. This very success contributes to their tendency to reject any non-technological approach to farming (Peterson, 1991). However, Harrison et al. (1998), among others asserts that payment for stewardship is a viable means of reconciling the duality between farming as business and farming as nurture.

Figure 5-7
Rice Producers' Perceptions of "Important" and "Very Important" Ownership Objectives (N=108)



COALITIONS AND ALLIANCES

Important opportunities for rice producers to form coalitions with other interested parties exist and should be pursued. Data from our survey of both environmentalists and the general public indicate that there is general support for farmers and farm practices that benefit the environment. There is also evidence, however, that this general supportiveness will require careful development.

Environmental group representatives are more knowledgeable than the general population about the economic conditions facing rice and are also more aware of some of the ecological services provided by it. The most widely recognized benefit of rice was providing habitat for wildlife. However, environmental group representatives are less informed than they might be on the link between rice and wintering waterfowl (see Table 5-5). They were also more likely than the general population to mention negative aspects of rice production. Interestingly, the destruction of wildlife habitat was most often mentioned by environmental group representatives as a negative aspect of rice production. Nevertheless, there is some official recognition of the positive ecological contributions made by rice production. For example, the Texas Wetlands Conservation Plan (TPWD, Chapter 3) specifically refers to rice fields in its discussion of Gulf Coast wetlands. Although rice fields do not fit the definition of natural wetlands, they are acknowledged as important for providing habitat for wintering waterfowl.

Table 5-5
Knowledge of Rice Production Among
Environmental Organization Representatives and the Public[a]

Knowledge Item Response	% Giving Response	
	Environmental Representatives	**General Public**
Rice is not produced in Texas	0.0%	17.3%
Rice production is decreasing	81.3%	22.4%
Rice provides habitat for wildlife	75.0%	7.3%
Rice provides wintering ground for waterfowl	43.8%	4.4%

[a] For environmental representatives, N=16; for general public, N=300.

Data from the survey of the public indicate that, generally speaking, Texans are not very well informed about rice production or its effects on ecological services (Table 5-5). While 17% of the general public said that rice is not produced in Texas; 82.7% knew that it is. However, 22.4% thought that production was decreasing. When this portion of the sample was asked why production was decreasing, very few (17%) had any response. Among those providing an answer, the most frequently mentioned reason was “weather.” The positive aspects of rice production are not widely known either. Only 11% of those responding to the survey mentioned any of the ecological benefits of rice, and the most frequently mentioned benefit was “feeding people.” Sixty percent of respondents said that they did not know any benefits of rice, and even more of the sample (70%) said that they did not know about any harmful effects of rice production. There were important variations among respondents. Duck and goose hunters were more knowledgeable about the decline of rice production in Texas than the general population surveyed, but they were not more knowledgeable about the environmental effects of rice production.

Generally speaking, respondents from the general population indicate high levels of support for farmers and practices that benefit wildlife and/or the environment (Table 5-4). This is a finding that warrants further study. Among the respondents who are more knowledgeable about the ecological services that are associated with rice production, there are even higher levels of approval for policies that would encourage the rice-ecology link. As can be seen in Table 5-6, those who had mentioned at least one positive benefit of rice production were also more likely than those who had mentioned none to be in favor of the use of public funds for the support of farmers who use sound environmental practices. For respondents from the general population, the difference between these two groups was in the neighborhood of 10% on all questions except the one asking if the respondent favors public support to keep farmers in business. Interestingly enough, the proportion of respondents stating that they would be in favor of general economic support for farmers (favor financial benefits to keep farmers in business) is surprisingly high for the sample generally. However, all of these figures should be considered in the current political context. Citizens do not vote directly for legislative policy but do so indirectly through their elected representatives. The fiscally conservative climate in Texas is such that the preferences of the public at large may have little effect on policy changes (Kraemer et al., 1999).

Our survey shows that duck and goose hunters are significantly more likely than the general public to support using public funds for programs that provide financial benefits for farmers who use environmentally sound agricultural practices, but they resemble the public on approval of other types of support (Table 5-6). Witt and Baker (1998) also found that those who hunt are also more likely to be in favor of environmental conservation measures. The fact that duck and goose hunters would appear to be natural allies of rice producers has been profitably exploited by Ducks Unlimited. The economic analysis in Chapter 4 pointed out that as small as the current returns on recreational activities are for rice producers, they potentially spell the difference between having a profitable or an unprofitable year. Participation in these kinds of recreational activities is important not only because participants represent potential customers for consumptive and non-consumptive uses of rice production benefits, but also because these activities affect general attitudes toward agricultural-environmental policy issues.

Table 5-6
Support for Hypothetical Farm Programs Among Subgroups of the General Public

Hypothetical Program	Support Among Respondents Not Mentioning Benefits of Rice	Support Among Respondents Who Mentioned Benefits of Rice	Support Among Duck and Goose Hunters
Financial benefits for farmers who use environmentally sound agricultural practices	65.4%	76.2%	86.4%
Financial benefits for farmers who provide habitat areas for birds and animals	69.2%	77.8%	72.7%
Financial benefits to farmers whose farming operations provide environmental benefits	69.7%	79.4%	77.3%
Research into ways to blend good agricultural and good environmental practices	71.9%	85.7%	77.3%
Financial benefits to farmers to keep farmers in business who would otherwise be consumed by urban sprawl	71.4%	74.6%	68.2%
Number of Cases	185	63	22

There is other evidence that the public is increasingly concerned about environmental issues and willing to contribute to its preservation. For example, a comparison of surveys of Texans done in 1993 and 1995 (NuStats, 1993 and 1995) found that in this time period, there was an increase in the percentage of the Texas population willing to assume some personal responsibility for the health of the environment. The results of a TNRCC (1997) survey also indicated that the majority of Texans believed the environment to be important and that they believed in providing incentives for industries to introduce changes that would reduce pollution and resource use. However, none of these surveys (including ours) asked people to put the priority they place on the environment in the context of their other priorities. Witt and Baker (1998) in a study for TPWD asked a sample of Texans whether conservation is more important than economic development. Economic development was favored (45.8%) over conservation (31.7%) with about a fifth of the population (22.5%) stating that they did not have an opinion. Those who participated in outdoor activities (consumptive and non-consumptive) were somewhat more likely to opt for conservation over economic development.

Those who participated in outdoor activities are an obvious source of allies for rice farmers, and Texans report utilizing the natural environment for recreation in fairly large numbers. Much of the information that exists on the economic benefits of these activities has been gathered on hunters, and 10.7% of those responding to our survey reported that they go deer hunting. There is some evidence that most hunters do not hunt every season (Pope et al., 1984). However, if the 10.7% of our respondents, who report that they have hunted deer, is suggestive of the prevalence of this sport, there are Texans who are a potential market for this type of consumptive wildlife service. The economic analysis in Chapter 4 suggests that the economic benefits derived from the leasing of land for hunting are substantial enough to warrant more landowners considering leasing their land to hunters rather than allowing free access, especially if the land is leased on a daily basis. Work by Thomas et al. (1990) indicated that most leasing operations (the majority of which are for deer) are not managed as businesses in spite of the economic benefits gained. Unfortunately, as can be seen in

Table 5-3, the consumptive recreational activities most closely linked to rice production have the lowest reported participation rates. Nevertheless, this report speculates that there may be as many as 300,000 hunters of migratory fowl in Texas (see Chapter 4).

The potential for appealing to the public for support in building a profitable relationship between rice production and ecological preservation is probably greater among Texans who are knowledgeable about environmental issues or more active in their use of the environment for recreation. However, our data indicate that there is potential gain in informing the public about rice and its link to ecological services and to recreation. If the rice industry decides to court the goodwill of the general public, it can probably assume that the public is an audience with few preconceived ideas about rice and its impact on the environment. Viable coalitions will require willingness among all parties to examine their goals, and their practices, however. For example, in their 1992 survey of rice farmers, Cready and Thomas (1995) found that 69.3% of farmers in the lower Gulf Coast and 79.4% in the upper Gulf Coast listed wildlife damage to crops as a problem for them (Hill, 1998). The practice of poisoning blackbirds and other birds that feed on the rice crop before harvest is one that will not contribute to the image of the rice farmer as a steward of the land. Although there is evidence that coalitions with environmentalists are feasible and can benefit both environmental and agricultural production goals, the value inconsistencies discussed earlier in this chapter will have to be confronted. To be effective, solutions to the problems of meshing environmental and agricultural goals will need to be integrated into the culture and value system of both producers and environmentalists. The willingness of environmental interests to acknowledge the legitimacy of farmers' knowledge of the local area and its potential for contributing to local conservation goals is essential to the process of forming strong partnerships (Harrison et al., 1998). Otherwise, participation will remain low.

Currently, rice producers perceive several other obstacles to wildlife management. As displayed in Figure 5-8 personal liability is the most commonly cited "major obstacle" to wildlife management. On the other hand, many rice producers report taking part in several activities to benefit wildlife (Figure 5-9). Though admittedly, disking land and brush control are most likely done for agricultural, rather than ecological, reasons. Furthermore, large shares of those surveyed report willingness to take part in measures to educate the public on the environmental benefits of rice production (Figure 5-10). Thus, there are indications that many rice producers are willing to take part in coalition-building activities.

The California case exists as a model for beginning such integration. In California, environmental interests have acknowledged the importance of private property rights, and stressed the stewardship role of the farmer in managing a sustainable economic resource. It is not lost on California rice producers that the value placed by the public and environmentalists on rice-linked ecological services can be an effective means for garnering public willingness to support the industry and for keeping regulatory pressures at bay (USA Rice Federation, 1995).

The Texas Rice Industry Coalition for the Environment (Texas R.I.C.E.) was established in 1994 to educate the public about the various benefits of rice production, serve as a focal point for consensus building on important rice-related issues, and improve riceland resources such as waterfowl habitat. In 1996, there were 144 members. One of the major accomplishments of the organization is the creation of public access sites for waterfowl viewing. Rice producers with fields near major roads allow Texas R.I.C.E. to set up temporary viewing facilities on their property and flood the adjacent fields. These locations are developed with the following audiences in mind: amateur photographers, weekend travelers, and students from urban areas. These are exactly the kinds of activities that can contribute to greater public awareness of non-agricultural benefits associated with rice production. Targeting the non-serious birder and encouraging interest in wildlife viewing at younger ages are both good strategies for developing broad-based and long-term support for rice cultivation on the part of the public and environmental interest groups. Our research indicates that there is an audience for this type of effort and that greater participation on the part of rice producers is warranted.

Figure 5-8
Rice Producers' Perceptions of "Major Obstacles" to Wildlife Management (N=108)

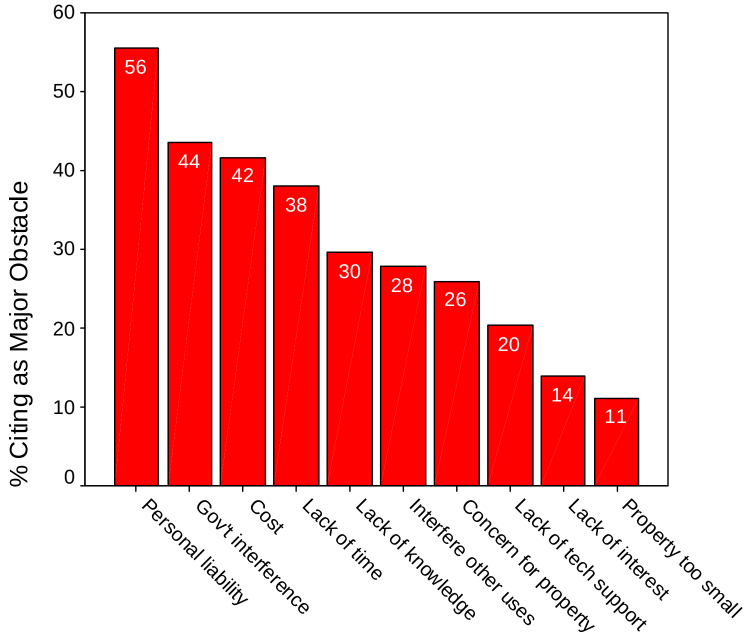


Figure 5-9
Activities Taken by Rice Producers to Benefit Wildlife (N=108)

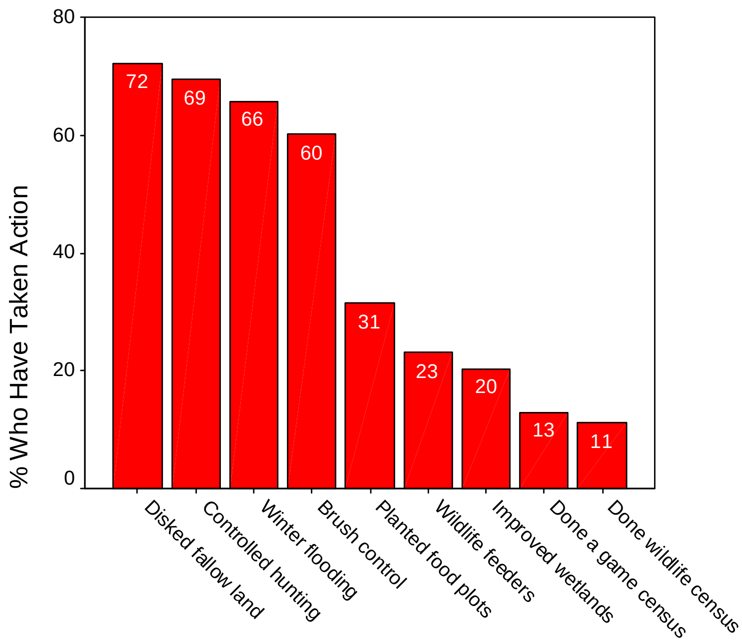
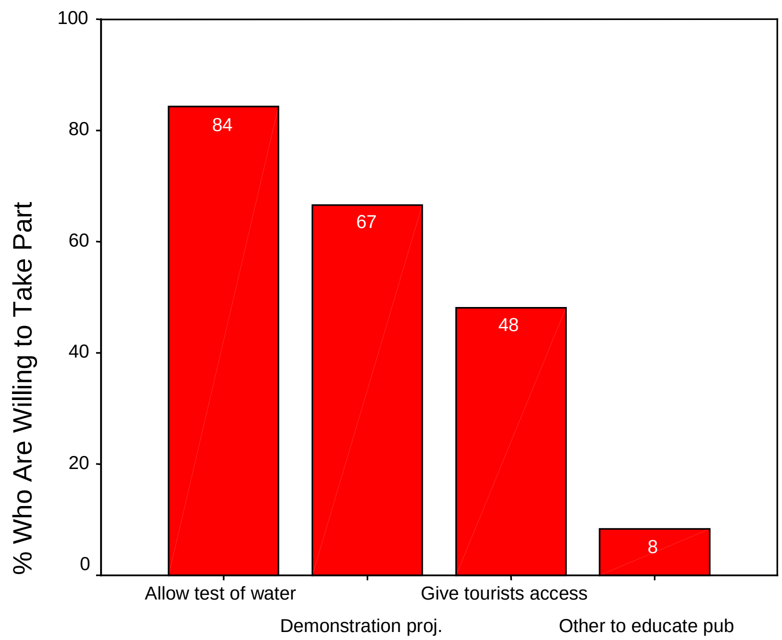


Figure 5-10
Measures Rice Producers Are Willing to Take to Educate Public on Environmental Benefits of Rice Production (N=108)



SUMMARY

Chapter 4 established that without government deficiency payments, the average rice farmer in Texas would have lost money in the 1980s and 1990s. Now that this subsidy is being phased out, rice producers in Texas face important challenges. Indeed, we find that around 51% of Texas rice producers surveyed expect to farm less rice or to get out of farming all together in the next five years while only 3% are planning on expanding their acreage. This chapter has evaluated technical, economic, and policy options for improving the profitability of rice production in Texas.

First, we argue that there are environmental, cultural, and economic constraints preventing rice farmers from responding to market forces by shifting their farming to other crops. For most farmers, the only viable agricultural alternative to rice production is conversion to pasture. Thus, if a strong agricultural presence in this region is to be maintained, efforts should focus on improving the profitability of rice rather than on investigating conversion to alternative crops.

The first method considered for increasing rice profitability is technical innovation. One important aspect of this is the development of new strains of rice that lower production costs, increase yield, or add new values to the product. While this is an exciting area of innovation, these technologies are not expected to make it into widespread application in time to significantly aid rice producers who are currently facing low profitability. A second aspect of technical innovation examined is improved irrigation. Given the high relative costs of water in Texas and the increasing competition for water in the state, programs that financially facilitate introduction of more efficient irrigation systems are seen as one possible method of improving long-term profitability of rice production. Incentives for owners who lease their land need to be considered, however.

A second possible measure to improve the profitability of rice production is inter-cropping, or combining other agricultural activities with rice production. Two examples that have been studied are inter-cropping rice with crawfish and eels. While both of these have some potential, there are still some drawbacks or uncertainties. Eel aquaculture may require extra water, thus increasing costs. Crawfish inter-cropping has been successfully applied in Louisiana, but systematic study of its profitability in Texas have yet to be made.

A third possible factor in increasing the profitability of rice production is for the farmer to take advantage of nonagricultural economic opportunities that are associated with their rice fields. These are divided into consumptive uses, including hunting and fishing, and nonconsumptive uses, with emphasis on bird watching. Many rice producers currently take advantage of consumptive uses, with leasing land to waterfowl hunters led by an outfitter and oil and gas production being the two most popular uses. Our survey indicates some potential for increasing profit from waterfowl hunters, although as mentioned in Chapter 4, more research is needed on the profitability of hunting operations. Few farmers take advantage of opportunities to charge bird watchers for access to their land, and our analysis suggests many reasons to doubt that bird watching can contribute significantly to rice producers' level of profit.

The possibility of supplementing rice producers' income through green payments programs was also examined. These programs give some support to farmers who provide environmental benefits, but cannot provide a replacement for the subsidy that is being phased out. Unfortunately, most rice producers surveyed had not heard of these programs and participation is very low. Familiarity and participation are highest for the Texas Prairie Wetlands Project sponsored by Ducks Unlimited. Perhaps better program application and greater education of farmers on these programs could lead to increased participation. Surveys of the public and environmental organization representatives showed considerable support for financially supporting hypothetical green payments programs. While we should be cautious of these results regarding hypothetical costs and hypothetical programs, they show that there is potential support for further development of such programs.

The latter finding also underlines the potential importance of developing alliances between rice producers and environmental interests. Environmental groups and the general public appear to view rice production sympathetically when it is framed in terms of its benefits for the environment. The general public, furthermore, seems sympathetic to rice production when it is framed as a buffer to urban expansion. Developing such alliances may require rice producers to reconsider certain practices that could affect their image as stewards of the land. Blackbird poisoning is an example of a practice that may be negatively perceived in a land stewardship context. Nevertheless, many of the producers surveyed indicated a willingness to take part in activities to educate the public on the environmental benefits of rice production.

SUMMARY

FINDINGS

ECONOMIC ANALYSIS OF RICE PRODUCTION

Since the early 1980s, rice acreage in Texas has declined gradually from an average of 347,000 acres in the 1983-86 period to 293,000 from 1995 to 1997. The economic analysis done for this report indicates that although the 1996 Farm Bill exacerbated the decline in rice production, this change in policy was not its cause. Nevertheless, if government subsidies are not included in the calculations, rice sales along the Gulf Coast have, on the average, been unable to cover all costs of ownership and production. In the absence of substantial changes in either the market for rice or in the costs of production of rice farming in Texas, the current farm policy as represented in the 1996 Farm Bill will result in continued reductions in the acreage devoted to rice cultivation. Without further study, it is not possible to say how far or how rapidly production will fall in as much as some rice farmers continue to make a profit from rice in the current economic environment. Once rice acreage is lost, its return to rice production will be problematic because of the rapid growth of invasive vegetation. The infrastructure that supports rice drying, milling, and transport is also declining, and the potential for a rapid and abrupt change in rice agriculture because of this decline is a significant risk to the industry. While it is assumed that when some critical point in its decline is passed, rice cultivation will no longer be possible, there have been no attempts to establish what this point is.

In addition to farming, ricelands are used for recreational hunting and bird watching. Landowners earn some income by leasing their land to hunters and guide operations. While small relative to operating expenses, this revenue can mean the difference between a profitable and unprofitable year for some farmers. The market for bird watching is still new and has yet to generate much income for riceland owners. Some have speculated that this market may be a substantial source of income, but recent studies suggest that the market for serious bird watching is quite limited, meaning that markets will not capture most of the non-consumptive benefits of wildlife.

Little is known about the magnitude of the non-market benefits of rice. Using an analysis of valuation studies of natural wetlands, it was found that wildlife habitat, a service that is also provided by ricelands, can be quite valuable socially. This finding demonstrates the need for future studies to determine the extent to which the ecological services provided by ricelands are substitutes for those provided by natural wetlands and the value that society places on these services.

ECOLOGICAL IMPACT OF RICE AGRICULTURE

The rice agronomic system contributes to a rich diversity of migratory birds. More than 70 species of birds have been documented in rice habitats. Christmas Bird Counts indicate that the region boasts 317 bird species west of Houston and 286 bird species east of the city. As shown in this report's ecological analysis, declines in waterfowl are correlated with declines in rice acreage on lands both west and east of Houston. Furthermore, reductions in rice acreage are likely to have continued negative impacts on the numbers of migrating waterfowl throughout the coastal plain. The analysis above indicates that waterfowl numbers have decreased as rice acreage has decreased. Goose numbers, while stable now, may well follow. If winter rice fields are no longer available to the relatively large numbers of geese, they will almost surely crowd into remaining wetlands and damage areas too small to accommodate them. In contrast, Dabbler and Ground Foraging guilds demonstrated increases in relative abundance in the same period, a change that may be related to increases in alternative crops in the southwest portions of the rice belt and increases in pasture. More studies like this one need to be done before the long-term effects of riceland loss on waterfowl, geese and avifauna generally can be determined. Through its impact on waterfowl numbers, the continued loss of rice acreage will have some impact on the growing hunting and wildlife viewing industry along the Gulf Coast plain.

Rice agriculture is highly dependent on water, and like most agricultural production, high rice yields depend in part on the use of fertilizers and pesticides. The Texas Natural Resources Conservation Commission (TNRCC) has identified 142 impaired water segments in the state that do not meet water quality standards. Of these, 81 fall within Texas rice-belt river basins. It is difficult, if not impossible, to attribute any of these effects to rice agriculture. Because agricultural drain water from rice fields is not categorized as point source pollution, and water in these rivers flows from many point and nonpoint sources upstream, it is largely unregulated, and therefore is not monitored by TNRCC or the Lower Colorado River Authority (LCRA). To date, Texas has not attempted any statewide evaluation of the impact of rice agriculture on water quality. Also, rice agriculture occurs on the lower reaches of these rivers where accumulated effects from the entire drainage would be most manifested. Very little has been published in the scientific literature on water quality in Texas rice agriculture, and data measuring agricultural run-off from rice fields does not appear to exist.

POTENTIAL TECHNICAL AND POLICY IMPROVEMENTS

There are several recent developments in the technical and policy areas that have some potential to improve the market position of rice production in Texas. Technological improvements that could increase efficiencies in the production of rice, such as new rice varieties are on the horizon. There are also new uses for rice that promise expansions in the demand for it, such as nutritional and pharmaceutical uses. It will be decades, however, before most of these improvements are available to Texas rice producers. Furthermore, the relative advantages that these improvements will give Texas producers will be short-lived. The same technologies and the same markets will be available to other producers in other parts of the country even if they are introduced here first.

There are, however, some policies that could have both short and long-term benefits for the rice industry. Two of these exist at the federal level. One is the amendment to the annual farm-spending bill that would lift the current embargo on food and medicine to Cuba and to other countries against which the U.S. has unilateral trade sanctions. If approved, this amendment would once more open markets to Texas-produced long-grain rice and places the state’s production in a much better economic position. Recent international initiatives to lift embargoes on food to Iraq may also reopen that market some time in the future.

Another policy option that has the potential to improve the market position of rice is one that would encourage improvements in irrigation technology. The constraints of the Texas Water Plan and the competing interests of industrial, municipal, and environmental usage, place substantial pressure on rice to increase the efficiency of its water use. The omnibus water bill of the 75th Texas Legislative Session, SB1 (TWDB, 1997), emphasizes the importance of water conservation and provides the means for implementing more efficient irrigation methods through its increased funding for loans for this purpose. Although producers who own their land have been more responsive to adoption of improved irrigation methods than have owners who lease their land, adoption rates for improved methods of irrigation remain relatively low. The Extension Service has a long history as an agent for change in the agricultural industry and could play an important role in promoting adoption of new irrigation technology.

An additional opportunity that should be explored is alliances with selected nonagricultural interests. Problems of water quality and water availability will impact greatly on the future of rice, but because rice cultivation utilizes large amounts of water, there may be few non-agricultural interests that will support this activity without evidence that it also serves non-agricultural goals. The Water Plan acknowledges the importance of environmental needs in future water allocations, and the TPWD’s Texas Wetlands Conservation Plan specifically mentions the important ecological services that rice cultivation provides. With two exceptions, rice is reasonably well represented on the Regional Water Planning groups of the rice producing areas of Texas. The rice industry is, therefore, in a position to make a case for the legitimacy of its water needs, and natural allies in these negotiations over water use would be environmental interests and commercial interests that are linked to wetland health. Both coalitions and arguments would be stronger if the rice industry could convincingly demonstrate that it plays an important and positive role in the health of the coastal estuarine ecosystem as well as in the successful wintering of migratory waterfowl and geese. Policy that encourages farmers to engage in conservation practices has a long history, and green payments programs are a recent variation. Like income from hunting or birdwatching, green payments provide relatively little income. However, they do supplement income from other sources and demonstrate a link with environmental interests.

SUMMARY OF FINDINGS

In brief, findings are:

- Under current conditions (status quo) rice production will continue to fall.
- Numbers of migratory waterfowl will also continue to fall. The rice-agronomic system produces a variety of habitats used by a rich diversity of migratory birds, and the reduction in rice acreage is correlated with declines in the relative abundance of some bird populations, particularly migratory waterfowl.
- There are some reasons for optimism about the long-term viability of rice production along the Texas Gulf coast if it can be maintained at some level for the next few decades.
- The short-term viability of rice production along the Texas Gulf coast will be dependent upon the rice industry's ability to adopt a policy of cooperation with new allies and to employ a number of strategies for lowering production costs and increasing income. This includes increased participation in consumptive and non-consumptive recreational uses of land, participation in green payments programs, and the introduction of more efficient water use.

RECOMMENDATIONS

The findings that are summarized in this chapter describe an agricultural industry that is in danger of failing if current market conditions continue and measures are not taken by the industry itself to reduce its costs of production and broaden the scope of its income-generating activities. The recommendations that flow from these findings specifically address measures to be taken but have much broader implications for basic changes in the way agriculture relates to other parts of the social structure. Traditionally, agricultural production is seen as being in competition with other users for resources such as water and acreage. Our research points out the growing realization that there are overlapping interests among the various users of natural resources and the growing necessity of utilizing the same resources for multiple purposes. On the most general level, it is recommended that the U.S. Department of Agriculture adopt a broader perspective on agricultural production. Producers and their representatives need to become more attuned to the multiple output nature of agriculture and the implications of this for increased income, valuable alliances with powerful interest groups whose goals are complementary, and for a workable strategy for sustainable agriculture.

Specific recommendations for the rice industry include recommendations for tapping resources to reduce production costs and increase income, and for forming strategic alliances and coalitions with groups that share the rice industry's interest in the stewardship and conservation of natural resources.

ADDITIONAL INCOME SOURCES

Our research indicates that consumptive and non-consumptive uses of wildlife are a potential side benefit of rice cultivation. Hunting in the rice belt can easily generate between $5 and $8 per acre in value added and additional income to landowners. Survey results indicate that just over 50% of rice farmers earned revenues from waterfowl hunting, contributing an average of 8.6% of the farmers' revenue while contributing only 4.75% of their costs. Although non-consumptive activities, such as bird watching, probably have the potential to contribute significant amounts to local economies, their pay off for rice producers appears to be more limited than it is for hunting. The TAES 1998 Rice Production Guidelines does not include a single reference, however, to the management of these lands for hunting in addition to rice. Yet, it is the case that many farmers' choices are influenced in part by post-harvest activities. Preparation of the land, fertilizer rates in coming periods, and decisions regarding the ratoon crop are all influenced by waterfowl hunting. Extension agents should increase their ability to assist producers in the development of this kind of activity.

The development of these recreational sources of income will come at a price. They will require access to some portion of agricultural land by customers willing to pay for the privilege. This means, further, that producers will be required to give up some of the privacy and independence that they value so highly. On the other hand, public use of agricultural land for recreational purposes should strengthen public support for farm issues. The growing body of literature on consumptive and non-consumptive uses of the land also suggests that these uses need to proceed with caution.

CONSERVATION PROGRAMS

Greater participation in programs designed to encourage good environmental practices represents another means for offsetting some of the costs of production. Programs such as WHIP and EQIP are not funded well enough to make major financial contributions to support co-production of rice and wildlife habitat. However, they can make marginal contributions that may make the difference between profit and loss for some rice producers attempting to better manage wildlife and make environmental improvements.

In a general review of programs designed to encourage responsible environmental practices in farming, one shortcoming stood out - very few programs recognize any environmental value that accrues from farming. Most programs focus on the damage that farming does to the environment and require the retirement of land from productive use. The few that reward farmers for providing the kinds of ecological services offered by rice production were reported here. The interaction between rice and the environment may be unique among agricultural practices but this relationship needs to be both recognized and encouraged.

Another circumstance that decreases the effectiveness of environmental programs for rice producers is the assumption on the part of most programs that the owner and the producer are one and the same. Our survey indicates that there are significant differences in program participation among those who own all their land and those who do not, with owners participating at significantly higher levels. While a larger study would have to be done in order to provide substantiation of our findings, our survey indicates that there are surprisingly few differences in participation between producers who lease all and lease some of their land. Program requirements and payment schedules need to be scrutinized for the implications that the riceland tenure system has for participation. A more general observation is that environmental objectives are not clearly articulated in most of the programs reviewed.

BENEFICIAL ALLIANCES

Alliances between rice producers and environmental interests are also recommended. The alliances that are in progress in California show how such partnerships can be mutually beneficial. Our surveys of producers, the public, and environmental group representatives suggested that the public know far less about rice than it needs to if it is to become allies of rice producers. Environmental group representatives are more knowledgeable about rice cultivation and its ecological side benefits. Nevertheless, the perception by some environmentalists that rice cultivation is an activity that destroys habitat also points up the fact that even among environmentalists, there are competing views of what constitutes the best use of land. Producers, on the other hand, indicated relatively little interest in participating in wetland programs and expressed moderate to low levels of interest in wildlife management. Obviously, improvements in outreach and education are called for, and such efforts will have to come to grips with the contradictions that exist in farmers' views of themselves and their work. The Agricultural Extension Service, with its history of successfully introducing farmers to new ideas and new technologies, could play the most important role in this change.

In both our survey and others, the public indicates a willingness to see public money, such as taxes, used to assist farmers who are utilizing environmentally sound practices and providing such services as habitat for wildlife. Many factors can intervene between an expressed willingness to pay for environmental benefits, and actual payment for them. Nevertheless, studies of the natural wetlands have found substantial willingness to pay for some wetland services. Our understanding of the ecological services provided by rice fields is still limited. However, in some aspects, ricelands appear to offer services similar to natural wetlands and, therefore, may be highly valued by society for their ecological impact. Much additional work is necessary to quantify this agricultural system's non-market contributions to society.

SUMMARY OF RECOMMENDATIONS FOR RICE INDUSTRY AND POLICY MAKERS

Recommendations can be summarized as follows:

- The rice industry should consider developing consumptive and non-consumptive recreational uses of ricelands.
- Rice producers need to implement new irrigation technology that would allow them to reduce expenses by using water more efficiently. Special attention needs to be paid to incentives for owners as well as producers.
- Better ways to inform producers about the benefits of green payment programs such as the Environmental Quality Incentives Program, the Wildlife Habitat Incentive Program, and the National Waterfowl Habitat Program should be devised. These programs should be re-examined and their incentive structures revamped. Changes in tax laws such as federal tax credits for expenses assumed for improving or creating new habitat for wildlife and additional offsetting of property taxes on lands that provided habitat for wildlife are examples. These incentives should address the needs of owners as well as producers.
- Rice producers should be encouraged to form coalitions with environmental groups, similar to the activities of the Rice Industry Coalition for the Environment (R.I.C.E.), and with regional water planning groups.
- Better ways to inform both the public and environmental groups about the ecological benefits provided by rice production should be developed.
- The rice industry and the U.S. Department of Agriculture should adopt a broader perspective on agricultural production generally. With regard to rice, producers and their representatives need to become more attuned to the multiple output nature of rice production.
- State and federal agencies should expand programs that recognize and reward well-established links between particular agricultural practices and ecological benefits.

RECOMMENDATIONS FOR FUTURE RESEARCH

The successful implementation of the recommendations above will hinge, in part, on the ability of the rice industry and its allies to make a compelling argument for a positive role for rice in the health of the coastal environment. However, to do this requires a better understanding than we currently have of how agricultural practice and ecological processes interact. Furthermore, if relationships with other environmentally linked commercial activities such as hunting and fishing are to be added to this system without harming the resources necessary to all, more information is needed. There is also a scarcity of reliable and systematic information on how social and economic variables influence decisions that are made in this complex system, and on the kinds of policies and programs that will effectively encourage and sustain the kinds of relationship we are suggesting.

The rice industry is particularly suited to this kind of extended investigation. The first steps in establishing the links that rice production has to ecological services have been taken. The popularity that the coastal area of Texas has for different kinds of recreation seekers provides an existing base of environmentally linked commercial activity. There is an incentive for agricultural and non-agricultural interests to work together in the face of diminishing water and other resources. Finally, our survey indicates that neither producers nor environmental groups have entrenched positions that would make the formation of relationships impossible. The public is interested in the preservation of ecological services and is largely uninformed with regard to the role that the rice industry can play in this preservation. This analysis of the rice industry and its repositioning as a multiple-output industry cooperatively linked with other interests to create a sustainable environment could serve as a model to other agricultural sectors.

In order to firmly establish the important role that rice agriculture can play in ecological services, the following studies need to be done:

- Collect ecological information at the farm level to document changes in abundance of individual species of wetland dependent birds and to identify habitats used by key representatives of the various foraging guilds in the rice-cropping system.
- Conduct a comprehensive assessment of the use of rice agroecosystems by other vertebrates (mammals, reptiles, and amphibians, as well as the possible use of rice fields by fish) and relate these data to trends in abundance and distribution of these species in the coastal prairie region.
- Obtain data on the key invertebrates that are consumed by migratory birds during the annual cycle; the abundance and distribution of invertebrates associated with man-made and natural depressional wetlands are virtually unknown but have important implications for the health and abundance of avifauna in the region.
- Determine if rice agriculture provides water quality services that are present in natural wetland systems and investigate potential detrimental effects on water quality due to increased salinity from irrigation, nutrient loading from fertilizer applications, and contamination from pesticides.

While the impact of rice agriculture on the ecological environment are being done, parallel studies on the social and economic impacts of various aspects of the rice industry are also recommended. For example, our survey and other investigations have shown that the tenure system has implications for a number of critical decisions affecting rice cultivation and the ecological services associated with it. However, relatively little hard data exist describing the relationship between land tenure and decision making. Similarly, the conventional wisdom is the that is some point at which the rice infrastructure will no longer be able to sustain production, but hard data on this are not available. At a minimum, social science research would include the following:

- Identify the critical point at which the rice industry's infrastructure will no longer support rice cultivation in the region and quantify the economic impact that changes in the industry will have on regional economies.
- Perform a series of analyses to examine the effects of the tenure system on planting and practice decisions, on resource use, and on participation in conservation programs and non-agricultural activities.
- Develop and test policy options that made participation in practices and/or programs that have ecological benefit more attractive to owners who lease their land.
- Analyze the non-consumptive and consumptive recreational uses of agricultural land to ascertain the distribution of costs and profits and to establish the break-even points. Costs would have to include some measure of the cost to farmers of public access to private land.
- Analyze the ecological impact of current non-consumptive and consumptive recreational uses of agricultural land and model the potential impact of their expansion.
- Perform a full economic analysis of rice production in Texas to quantify the value of the market and non-market goods and services. The analysis should also focus on the secondary community-level impacts of the industry in the form of, for example, employment and local tax revenue.
- Fully assess the potential for strategic coalitions and both policy and programmatic means for facilitating them.
- Systematically examine the economic, social, and ecological outcomes of participation in green payment programs.

- Examine the advantages of various policy and program options of green payment and other conservation programs for their ability to increase the participation by various groups. This type of analysis would include an investigation of tax options that could contribute to a decrease in the fragmentation that often results when inheritance taxes require the breakup of land holdings.

It should be noted that most of these studies would be truly interdisciplinary, involving not only economists and policy scientists but ecologists as well because questions of ecological impact and soundness will be an important part of the research in many cases.

Finally, our research has indicated that there are both economic and ecological benefits that can be derived from alliances among rice producers, other environmentally linked commercial interests, and environmental interests. In addition, our survey and others have indicated that the public could be a valuable ally in this kind of effort. This is a relatively new concept, however, and little information exists on either its feasibility or its long-term consequences. We would recommend research to add to our knowledge base on the economic, political, social, and ecological feasibility and potential consequences of such alliances.

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Abraham, K.F., & Jefferies, R.L. (1997). High goose populations: causes, impacts and implications. In B.D.J. Batt (Ed.), *Arctic ecosystems in peril: Report of the arctic goose habitat working group.* (pp. 7 – 72). Washington, D.C.: U.S. Fish and Wildlife Service.

Adams, C.E., Leifester, J.A., & Herron, J.S.C. (1997) Understanding wildlife constituents: Birders and waterfowl hunters. *Wildlife Society Bulletin 25(3),* 653-660.

Albrecht, D.E. (1997). The changing structure of U.S. agriculture: dualism out, industrialism in. *Rural Sociology, 62*(4), 474-490.

Amacher, G.S., Brazee, R.J., Bulkley, J.W., & Moll, R.A. (1989). *Application of wetland valuation techniques: Examples from great lakes coastal wetlands.* Ann Arbor, MI: University of Michigan, School of Natural Resources.

American Farmland Trust. (no date, a). American Farmland Trust hails release of Central Valley Ag. Task Force report. Retrieved from the World Wide Web: http://www.farmland.org/Farmland/files/media/catask.htm. Also see http://farm.fic.niu.edu/fic-ta/tafs-fptool.htm.

American Farmland Trust. (no date). American Farmland Trust home page. Retrieved July 7, 1999 from the World Wide Web: http://www.farmland.org/

American Farmland Trust. (no date, c). Farmlands protection activities by state. Retrieved from the World Wide Web: http://www.farmland.org/Farmland/file/protect/matrix.htm

American Farmland Trust. (no date, b). Texas Blackland Prairie lower RioGrande Plain flagged as 4th and 8th most threatened agricultural areas in U.S. Retrieved from the World Wide Web: http://www.farmland.org/Farmland/files/foe/texas.htm

Anderson, J.K. (1997). *Texas wetland conservation plan*. Austin, TX: Texas Parks & Wildlife Department.

Anderson, D.W. and Keith, J.O. (1980). The human influence on seabird nesting success; conservation implications. *Biological Conservation, 18,* 65-80. Reported in Knight and Gutzwiller.

Andreu, V. & Gimeno-Garcia, E. (1999) Evolution of heavy metals in marsh areas under rice farming. *Environ. Poll, 104,* 271-282.

Associated Press. (1998, September 21). Going against the giant. Rice farmers consider switching to sugar cane when price supports end. *Dallas Morning News.*

Bailey, H.C., Alexander, C., Digiorgio, C., Miller, M., Doroshov, S.I., & Hinton, D.E. (1994). The effects of agricultural discharge on striped bass (Morone saxatilis) in California's Sacramento-San Joaquin drainage. *Ecotoxicol, 3,* 123-142.

Banks, A.S. and Mullen, T. C., (Eds.). (1998). *Political Handbook of the World.* Binghamton, New York: CSA Publications.

Barbier, E.B. (1994). Valuing environmental functions: Tropical wetlands. *Land Economics, 70*(2), 155-73.

Barbier, E.B., and Strand, I. (1998). Valuing Mangrove-Fishery linkages : A case study of Campeche, Mexico. *Environmental and Resource Economics, 12,* 151-66.

Barta, P. (1997, September 24). Game plan: Rice farmers, endangered, think green. *The Wall Street Journal,* T1,T3.

_____. (1998, June 3). Rice farmers consider shift to sugar cane. *The Wall Street Journal*, T1.

Bartoskewitz, T.A. & Cohen, W.E. (1999). Recreation waterfowl hunting enterprises: Operation and profitability. In *Proceedings of the Texas Waterfowl Conference*, Wharton, TX: Texas Agricultural Extension Service.

Batie, S.S. and Wilson, J.R. (1978). Economic values attributable to Virginia's Coastal Wetlands as inputs in oyster production. *Southern Journal of Agricultural Economics,* 111-118.

Batie, S. (1998). Green payments as foreshadowed by EQIP. *American Farmland Trust-Farmland Information Center.* Retrieved May 1999 from the World Wide Web: http://farm.fic.niu.edu/cae/wp/wp98-8.html

Batjes, N.H. & Bridges, E.M. 1993. Soil vulnerability to pollution in Europe. *Soil Use Management*, *9*, 25-29.

Batten, L.A. (1997). Sailing on reservoirs and its effects on water birds. *Biological Conservation*, *11*, 49-58.

Bell, F.W. (1989). Application of wetland valuation theory to Florida fisheries. Tallahassee, Florida: Department of Economics, Florida State University.

Bell, F.W. (1997). The economic valuation of saltwater marsh supporting marine recreational fishing in the southeastern United States. *Ecological Economics*, *21*, 243-254.

Bellrose, F.C. (1980). *Ducks, geese and swans of North America*. (3rd ed.). Harrisburg, PA: Stackpole Books.

Bergstrom, J.C., Stoll, J.R., Titre, J.P., and Wright, V.L. (1990). Economic value of wetlands-based recreation. *Ecological Economics*, 129-147.

Boo, E. (1989). *Ecotourism: The potentials and pitfalls*. Washington D.C.: World Wildlife Fund.

Boyle, K.J., Poe, G.L., & Bergstrom, J.C. (1994). What do we know about groundwater values? Preliminary implications from meta analysis of contingent valuation studies. *American Journal of Agricultural Economics*, *76(5)*, 1055-1061.

Braden, J.B. & Lovejoy S.B. (Eds.). (1990). *Agriculture and water quality: International perspectives.* Boulder, CO: Lynn Rienner Publishers.

Brandon, K. (1996). *Ecotourism and conservation:a review of key issues*. Washington D.C.: World Bank.

Breaux,A., Farber, S., Day, J. (1995). Using natural coastal wetlands systems for wastewater treatment: An economic benefit analysis. *Journal of Environmental Management*, *44*, 285-291.

Brennan, L.A. (1991). How can we reverse the northern bobwhite population decline? *Wildlife Society Bulletin, 19*, 544-555.

Brenneman, R.L. (1967). *Private approaches to the preservation of open land.* New London, CT: The Conservation and Research Foundation.

Brouder, S.M & Hill, J.E. (1995). Conjunctive use of farmland adds value: Winter flooding of ricelands provides waterfowl habitat. *California Agriculture*, *49*, 58-60 and 62-64.

California Department of Water Resources. (1998). California Water Plan. *Bulletin, 160-198*.

California Rice Industry Association (CRIA). (1998a). California Rice Industry Association Website. Retrieved October 8, 1999 from the World Wide Web: http://www.cria.org/working_wonders.html

California Rice Industry Association (CRIA). (1998b). Federal winter flooding funds. *CRIA Newsletter 8*. Retrieved July 1998 from the World Wide Web: http://www.cria.org/newsletter8_3.html

California Rice Promotion Board. (no date). Environment home page. Retrieved from the World Wide Web: http:// www.calrice.org/environment/environment_frame.html

Chabreck, R.H. (1979). Wildlife harvest in wetlands of the United States. In P.E. Greeson, J.R. Clark, and J.E. Clark (eds.), pp. 618-631. *Wetland functions and values: The state of our understanding*. Minneapolis, MN: American Water Resources Association.

Chamberlain, P.A. & Bolen, E.G. (1987). Marketing opportunities for waterfowl lease-fee hunting. In *Proceedings of the waterfowl hunting business conference*. Corpus Christi, TX: Texas Agricultural Extension Service.

Childs, N. (1995, June). Commodity programs in the spotlight. *Agricultural Outlook*, 17-20.

Constance, D.H., Rikson, J.S., & Ma, J.C. (1996). Landlord involvement in environmental decision-making on rented Missouri cropland: Pesticide use and water quality issues. *Rural Sociology*, *61(4)*, 577-605.

Cooper, J. and Loomis, J. (1991). Economic value of wildlife resources in the San Joaquin Valley: Hunting and viewing values. In Diner and Zilbermann (eds.), *Economic and management of water and drainage in agriculture*. Huwer Academic Publishers.

Cornacchia, J., Cohen, D., Bowes, G., Schnagl, R., & Montoya, B. (1984). *Rice herbicides: Molinate (Ordram) and Thiobencarb (Bolero)* (Special Projects Report 84-85P). Sacramento, CA: California State Water Resources.

Costanza, R., d'Arge, R., Groot, R., Sfaber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, *387(6630)*, 253.

Craigmiles, J.P. (1975). Advances in rice through research and applications. In J.E. Miller (Ed.), *Six Decades of Rice Research in Texas* (pp.1-8). College Station, TX: Texas Agricultural Experiment Station.

Cready, C.M., & Thomas, J.K. (1995). *Agricultural conservation beliefs and practices in the Texas rice belt*. (Tech. Rep. No. 95-2). College Station: Texas A&M University System, Texas Agricultural Experiment Station, Department of Rural Sociology.

Creel, M. and Loomis, J. (1992). Recreation value of water to wetlands in the San Joaquin Valley: Linked multinorminal logit and count data trip frequency models. *Water Resources Research*, *28*(10), 2597-2606.

Dillman, B.L., Beran, L.J., & Hook, D.D. (1993). Non-market valuation of freshwater wetlands: The Francis Biedler Forest, (Report 135). Clemson, South Carolina: South Carolina Water Resources Research Institute, Clemson University.

Domagalski, J. (1996). Pesticides and pesticide degradation products in stormwater runoff. *Water Resources Bulletin*, *32*, 953-964.

Doss, C.R. and Taff, S.J. (1996). The influence of wetland type and wetland proximity on residential property values. *Journal of Agricultural and Resource Economics*, *21*(1), 120-129.

Doss, C.R., and Taff, S.J. (1994). The relationship of property values and wetlands proximity in. Ramsey County, Minnesota, (Economic report 3-4). St. Paul, Minnesota: Department of Agricultural and Applied Economics, University of Minnesota.

Eaton, D. (1993, September). Rice irrigation surveys data. Austin, TX: LBJ School of Public Affairs, University of Texas.

Eisler R. (1985). *Carbofuran hazards to fish, wildlife and invertebrates: A synoptic review*. (USFWS Biol. Rep. 85[1.3]).

Elliot, L. and Mulamoottil, G. (1992). Agricultural and marsh land uses on Walpole Island: Profit Comparisons. *Canadian Water Resources Journal*, *17*(2), 111-119.

Erize, F. 1987. The impact of tourism on the Antarctic environment. *Environment International*, *13*(1), 133-136.

Ervin, C.A. & Ervin, D.E. (1982). Factors affecting the use of soil conservation practices: Hypotheses, evidence, and policy implications. *Land Economics*, *58(3)*, 277-292.

Ervin, D. (1994). Soil and water conservation down on the farm: A changing economic landscape. *Journal of Soil and Water Conservation*, *49(3)*, 232-234.

Ervin, E., Runge, C.F., Graffy, E., Anthony, W., Batie, S., Faeth, P., Penny, T., & Warman, T. (1998). Agriculture and environment: a new strategic vision. *Environment, 40(6),* 9-15 and 35-40.

Eubanks, T.L. (1994). History and characterization of the Katy Prairie. Presentation at the Katy Prairie Conference: Balancing Growth and Conservation. Houston, TX. April 29-30.

Fan, S., Wailes, E.J., & Young, K.B. (1997, October). Policy reforms and technological change in Egyptian rice production: A frontier production function approach. *Journal of African Economies*, *6*, 391-411.

Farber, S. (1987). The value of coastal wetlands for protection of property against hurricane wind damage. *Journal of Environmental Economics and Management, 14*, 143-151.

Farber, S. (1988). The value of coastal wetlands for recreation: an application of travel cost and contingent valuation methodologies. *Journal of Environmental Management, 26*, 299-312.

Farber, S. (1996). Welfare loss of wetlands disintegration: A Louisiana study. *Contemporary Economic Policy, 14*, 92-106.

Farber, S. and Costanza, R. (1987). The economic value of wetlands systems. *Journal of Environmental Management*, *24*, 41-51.

Feagley, S.E., Siqua, G.C., Bengston, R.C., Bollick, P.K., & Linscombe, S.D. (1992). Effects of different management practices on surface water quality from rice fields in south Louisiana. *Journal of Plant Nutrition, 15(8)*, 1305-1321.

Finlayson, B.J., & Faggella, G. (1986). Comparison of laboratory and field observation of fish exposed to the herbicides molinate and thiobencarb. *Trans. Am. Fish. Soc*, *115*, 882-890.

Finlayson, B.J., Harrington, J.M., Fujimura, R., & Isaacs, G. (1993). Identification of methyl parathion toxicity in Colusa Basin drain water. *Environ. Toxicol. Chem, 12*, 291-303.

Flickenger, E.L., King, K.A., Stout, W.F., & Mohn, M.M. (1980). Wildlife hazards from Furadan 3G applications to rice in Texas. *Journal of Wildlife Management, 44*, 190-197.

Flickenger, E.L., Mitchell, C.A., White, D.H., & Kolbe, E.J. (1986). Bird poisoning from misuse of carbamate Furadan in Texas rice field. *Wildl. Soc. Bull*, *14*, 59-62.

Folke, C. (1991). The societal value of wetland life-support. In C. Folke and T. berger (eds.), *Linking the natural environment and the economy: Essays from the Eco-Eco Group*, pp. Kluwer Academic Publishers.

Fouss, J., Cooper, C., Willis, G., Arnold, J., Harris, B.L., McCauley, G., Slack, R.D., Kaiser, R., & Bollich, P.K. (1998). *A research program proposal to determine and quantify the environmental and ecological impacts of rice production in the Gulf of Mexico coastal zone*. Unpublished white paper, USDA-ARS, Texas A&M University, and Louisiana State University.

Frerich, S.J., Mjelde, J.W., Stoll, J.R., &Griffin, R.C. (1989). *Institutions concerning wildlife on privately-owned land: Results from a survey of state wildlife departments*. (Staff paper series number SP-2, information report number DIR 89-1) College Station, TX: Dept. of Agricultural Economics, Texas Agricultural Experiment Station, Texas A&M University.

Gawlik, D.E. (1994). *Competition and predation of processes affecting community patterns of geese*. Unpublished doctoral dissertation, Texas A&M University, College Station, TX.

Glass, G.V. (1976). Primary, secondary and meta-analysis of research. *Educational Researcher*, *5*, 3-8.

Glazener, W.C. (1946). Food habits of wild geese on the Gulf Coast of Texas. *Journal of Wildlife Management, 10*, 322-329.

Gore, L. (1994). The Katy Prairie hunting-its history and economic benefits. Presentation at the Katy Prairie Conference: Balancing Growth and Conservation. Houston, TX, April 29-30.

Gould, F.W. (1975). *Texas plants: A checklist and ecological summary*. College Station: Texas A&M University.

Greene, R.P. & Harlin, J.M. (1995). Threat to high market value agricultural lands from urban encroachment: A national and regional perspective. *The Social Science Journal, 32*, 137-155.

Gren, I.M. (1995). The value of investing in wet-lands for nitrogen abatement. *European Review of Agricultural Economics*, *22*(2), 157-172.

Griffin, R.C., Perry, G.M., & McCauley, G.N. (1984) *Water use and management in the Texas rice belt region.* College Station: Texas A&M University, Department of Agricultural Economics.

Gupta, T.R. and Foster, J.H. (1975). Economic criteria for freshwater wetland policy in Massachusetts. *American Journal of Agricultural Economics, 57*, 40-5.

Hanley, N. and Crag, S. (1991). Wilderness development decisions and the Krutilla-Fisher Model. *Ecological Economics, 4*, 145-164.

Hansen, J.M. (1991). *Gaining access: Congress and the farm lobby 1919-1981*. Chicago, IL: University of Chicago Press.

Harrison, C.M., Burgess, J., and Clark, J. (1998). Discounted knowledge: farmers' and residents' understandings of nature conservation goals and policies. *Journal of Environmental Management, 54*, 305-320.

Hefner, J.M., Wilen, B.O., Dahl, T.E., & Frayer, W.E. (1994). *Southeast wetland: Status and trends, mid-1970's to mid-1980's.* Atlanta, GA: U.S. Department of Interior, Fish and Wildlife Service.

Heimlich, R. (1995, June). Green payments as a policy option. *Agricultural Outlook*, 21-25.

Heimlich, R.E., Weibe, K.D., Claassen, R., Gadsy, D., & House, R.M. (1998). *Wetlands and agriculture: Private interests and public benefits* (Agricultural Economic Report 765.10). Washington, DC: Resource Economics Division, ERS, USDA.

Henson, P. and Grant, T.A. (1991). The effects of human disturbance on trumpeter swan breeding behavior. *Wildlife Society Bulletin, 19*, 248-257.

Hill, J.M., Nyman, D.J., & Neal, M.E. (1982). Source determination of rice irrigation water in southwestern Louisiana from landsat images. Applied Modeling in Catchment Hydrology, (pp.545-554). Baton Rouge: Water Resources Publications, Louisiana State University.

Hill, S. (1998). Agriculture program agencies join forces against blackbirds. Retrieved from the World Wide Web: http://agnews.tamu.edu/stories/SOIL/Feb1798a.htm

Hill, S. (1999, June 9). *Wildlife-based enterprises can diversify income.* College Station: TAMU Ag News.

Hobaugh, W.C. (1985). Body condition and nutrition of snow geese wintering in southeastern Texas. *Journal of Wildlife Management*, *49*, 1028 – 1037.

Hobaugh, W.C. (1987). Waterfowl hunting leases: resources, economics and benefits. In *Proceedings of the Waterfowl Hunting Business Conference*. Corpus Christi, TX: Texas Agricultural Extension Service.

Hobaugh, W.C., Stutzenbaker, C.D., & Flickinger, E.L. (1989). The rice prairies. In L.M Smithe, R.L. Pederson, & R.M. Kaminsky (Eds.) *Habitat management for migrating and wintering waterfowl in North America* (pp. 367 - 383). Lubbock, TX: Texas Tech University Press.

Holder, J.S. (1988). Pattern and impact of tourism on the environment of the Caribbean. *Tourism Management*, *9*(2), 119-127.

Honey, M. (1999). *Ecotourism and sustainable development*. Washington, D.C.: Island Press.

Hosansky, David. (1996a, March 30). House easily clears rewrite of decades-old farm laws. *Congressional Quarterly*, 874-875.

Hosansky, David. (1996b, March 23). Farm policy on the brink of a new direction. *Congressional Quarterly*, 786-788.

Hovde, B. and Leitch, J.A. (1994). Valuing prairie potholes: Five case studies. Fargo: Agricultural Experiment Station, North Dakota State University.

Hovde, B. (1993). Dollar values of two prairie potholes. M.S. Thesis. Fargo: North Dakota State University. Hume, R.A. (1976). Reactions of goldeneyes to boating. *British Birds*, *69*, 178-179. Reported in Knight and Gutzwiller.

Huffman, J. (1996). *Rice agriculture and wetlands*. Webster, TX: Galveston Bay Foundation.

Jarvil, L. 1991. Responsible marketing of adventure travel and eco-tourism. In proceedings of the 1991 World Congress on Adventure Travel and Eco-tourism, pp. 68-70. Englewood, CO.: Adventure Travel Society

Johnson, C.B. (1992, August). Understanding wetlands and the 404 Process. *The Real Estate Appraiser*, 33.

Johnson, C.W. and Linder, R.L. (1986). An economic valuation of South Dakota wetlands as a recreation resource for resident hunters. *Landscape Journal*, *5*, 33-38.

Joworski ,E. and Raphel, C.N. (1978). Fish, wildlife and recreational values of Michigan's coastal wetlands. Michigan: Michigan Department of Natural Resources.

Joworski, E. and Raphel, C.N. (1980). Results of specific wetlands value study in Michigan.

Just, R.E., Hueth, D.L., & Schmitx, A. (1982). *Applied welfare economics and public policy*. Englewood Cliffs, NJ: Prentice-Hall.

Karankawa Plains. (1999). *Birding tours by KP*. Retrieved June 17, 1999 from the World Wide Web: http://www.karankawa.com/bird.htm

Kennedy, P. (1986). *A guide to Econometrics* (2nd ed.). Cambridge, MA: MIT Press.

Kim, S., Scott, D., & Crompton, J.L. (1997). An exploration of the relationships among social psychological involvement, behavioral involvement, commitment, and future intentions in the context of birdwatching. *Journal of Leisure Research*, *29*, 320-341.

Kim, C., Scott, D., Thigpen, J.F., & Kim, S.S. (in press). Economic impact of a birding festival. *Festival Management & Event Tourism.*

Kliewer, T. (1999, Sunday, March 14). Freshwater ranch near Houston nets U. S.-Asian market. *Houston Chronicle*. Section, A pp. 37,41.

Knight, R.L. and Gutzwiller, K.J. (1995). Wildlife and recreationists. Coexistence through management and research. Washington, D.C.: Island Press.

Knutson, R.D., Penn, J.B., & Boehm, W.T. (1995). *Agricultural and food policy*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Kosz, M. (1996). Valuing riverside wetlands: The case of the "Donau-Auen" National Park. *Ecological Economics,16*, 109-127.

Kraemer, R.H., Newel, C, and Prindle, D.E. (1999). *Texas Politics* (7th ed.). Belmont, CA: Wadsworth.

Lacher, T.E., Jr., Slack, R.D., Coburn, L.M., Goldstein, M.I. (1999). The role of agroecosystems in wildlife biodiversity. In W.W. Collins & C.O. Qualset (Eds.), *Biodiversity in agroecosystems* (pp. 147 - 165). Boca Raton, FL: CRC Press.

Lant, C.L. & Tobin, G.A. (1989). The economic value of riparian corridors in cornbelt flood plains: A research framework. *Professional Geographer*, *41*(3), 337-349.

Larson, J.S., Adamus, P.R., & Clairain, E.J. (1989). *Functional assessment of freshwater wetlands: A manual and training outline*. Amherst, MA: University of Massachusetts at Amherst.

Larson, O.F. (1978). Values and beliefs of rural people. In T.R. Ford (Ed.), *Rural U.S.A.: Persistence and change*. (pp. 93-111)Ames, IA: Iowa State University Press.

Leitch, J.A., and Hovde, B. (1996). Empirical valuation of prairie potholes: Five case studies. *Great Plains Research, 6*, 25-39.

Liddle, M. (1997). *Recreation ecology*. Chapman and Hall: New York.

Libby, L.W. (1998). Implementing good intentions: How rules and procedures may alter resource policy outcomes. In *Increasing understanding of public problems and policies*, (pp. 136-149). Oak Brook, Illinois: Farm Foundation.

Littlejohn, M. (1999). US says there is chance that Iraq embargo could be lifted, but not soon. *The Earth Times*. Retrieved from the World Wide Web: http://www.earthtimes.org/jul/economicdevelopmentussaysjul5_99.htm

Littrell, E.E. (1988). Waterfowl mortality in rice fields treated with the carbamate, carbofuran. *Calif. Fish. Game*, *74*, 226-231.

Lobpries, D. (1994). Waterfowl on the Katy Prairie. Presentation at the Katy Prairie Conference: Balancing Growth and Conservation. Houston, TX, April 29-30.

Loomis, J., Hanemann, M., Kanninen, B., & Wegge, T. (1991). WTP to protect wetlands and reduce wildlife contamination from agricultural drainage. In Diner and Zilbermann (eds.), *The economic and management of water and drainage in agriculture*. Huwer Academic Publishers.

Loomis, J.B. & White, D.S. (1996). Economic benefits of rare and endangered species: summary and meta-analysis. *Ecological Economics*, *18(3)*, 197-206.

Loong, L.H. & Zeckhauser, R. (1982, February). Pecuniary externalities do matter when contingent claims markets are incomplete. *Quarterly Journal of Economics*, *97*, 171-179.

Louwagie, P. (1999, April 11). Mudbug madness: Texans have gone crazy for crawfish. *The Times Picayune*, pp. A1, A10, and A12.

Lower Colorado River Authority (LCRA). (no date). Lower Colorado Regional Water Planning Group. Retrieved December 1, 1998 from the World Wide Web: http://www.lcra.org/water/waterco/

Lower Neches Valley Authority. (no date). Introduction to the Lower Neches Valley Authority website. Retrieved December 1, 1998 from the World Wide Web: http: www.lnva.dst.tx.us/intro.htm

Lynne, G.D., Conroy, P. and Prochaska, F.J. (1981). Economic valuation of marsh areas for marine production processes. *Journal of Environmental Economics and Management, 8*, 175-186.

Mahan,B.L. (1997). Valuing urban wetlands: A property pricing approach. Institute for Water Resources Report 97-R-1, U.S. Army Corps of Engineers.

Mandel, B.K., Vamadevan, V.K., & Pal, T.K. (1975). Water requirement of crop rotation with rice as a central crop. *Water for human needs: Proceedings of the World Congress on Water Resources*, 309-314.

McCann, E, Sullivan, S., Erickson, d, & DeYoung, R. (1997). Environmental awareness economic orientation and farming practices: A comparative of organic and conventional farmers. *Environmental Management, 21(5),* 747-758.

McCauley. (1998). Rice production needs. Presentation at The Texas Agricultural Experiment Station Workshop: The Texas Rice Industry-Visioning to 2050. Beaumont, TX, October 28, 1998.

McClain, W.R., Bollich, P.K., & Gillespie, J.M. (1997) Relaying: An intercropping approach to the co-culture of crawfish and rice. *Bulletin, 863.* Baton Rouge: Agricultural Center, Louisiana Agricultural Experiment Station, Louisiana State University.

McFarlane, R.W. (1994). Birdlife on the Katy Prairie –Section 4. In *Balancing growth and conservation: Proceedings of the Katy Prairie Conference*. Austin, TX: Texas Parks and Wildlife Department.

McLaren, D. 1998. Rethinking tourism and ecotravel. West Hartford, Connecticut: Kumarian Press, Inc.

Miller, D.L., Smeins, F.E., & Webb, J.W. (1996). Mide-Texas coastal marsh change (1931-1991) as influenced by lesser snow geese herbivory. *Journal of Coastal Research, 12*, 462-476.

Mineau, P. (1993). *The hazard of carbofuran to birds and other vertebrate wildlife.* (Technical Report Series no.177). Canadian Wildlife Service.

Mineau, P. (1998). The need for global restrictions of problem pesticides to protect migratory birds (Abstract 605). 19th Annual Meeting SETAC, November 15-19, Charlotte, NC.

MINITAB. (1996). MINITAB statistical software. [Computer software, Release 12]. State College, PA: MINITAB.

Molleur, R. & Loser, J. (1998, July). *Tools for watershed and landscape management*. Paper presented at the Soil and Water Conservation Society annual meeting. San Diego, CA.

Montgomery Central Appraisal District. (no date). Wildlife management valuation. Retrieved September 17, 1998 from the World Wide Web: http://www.mead.tx.org/wm.html

Morton, R.M. (1990). Community structure, density, and standing crop of fishes in a subtropical Australian mangrove area. *Marine Biology, 105,* 385-394.

Moulton, D.W., Dahl, T.E., & Dall, D.M. (1997). *Texas Coastal Wetlands: Status and trends, mid-1950s to early 1990s*. Albuquerque, NM: U.S. Department of the Interior, Fish and Wildlife Service.

Napton, D.E. (1994). The future of US agricultural policy. In A.W. Gilg, R. S. Dilley, O.F. Werseth, P. Lowe, G. McDonald & J. Murdock (Eds.), *Progress in rural policy and planning* (pp. 55-64). New York, NY: John Wiley & Sons.

National Agricultural Statistics Service, United States Department of Agriculture. (no date). *Published Estimates Data Base*. Retrieved July 8, 1999 from the World Wide Web: http://www.nass.usda.gov/ipedb/

National Institute for Policy Analysis. (no date). University of Alabama. Retrieved June 8, 1998 from the World Wide Web: http://bos.busingess.uab.edu/charts/cgi-bin/data.exe/CGI?fedda/gdp

National Wildlife. (1995/1996). A bird in the bush is worth big bucks. *National Wildlife, 34*, 8.

Nienaber, J., & Wildavsky, A. (1973). *The budgeting and evaluation of federal recreation programs*. New York: Basic Books.

Nustats. (1993 and 1995). A statewide survey of Texans' attitudes and behaviors, conducted for Sherr Matthews Advertising and Public Relations and Clean Taxes 2000. An environmental partnership program of the Texas Water Commission. Austin, Texas.

Outlaw, J.L., Rister, M.E., Falconer, L. & Smith, E.G. (1996) Landowner/tenant issues in the Texas rice industry, (AFPC policy issues paper; 96-3). College Station, TX: Dept. of Agricultural Economics, Texas A&M University.

Paarlberg, D. (1990). The changing policy environment for the 1990 Farm Bill. *Journal of Soil and Water Conservation, 45(1),* 8.

Paarlberg, D. (1964). *American farm policy*. New York: John Wiley and Sons, Inc.

Pandey, R. K. & Sarup, S. (1989, March). Study of rice production function in India. *Margin*, *21,* 52-61.

Pate, J. Loomis, J. (1997). The effect of distance on WTP values: A case study of wetlands and salmon in California. *Ecological Economics, 20*, 199-207.

Patterson, J. (1997). Texas rice production trends. Paper presented at the 1997 Texas Rice Conference. Houston, Texas.

Paul, Ron. (1998). Introduction of the Rice Farmer Fairness Act to the House of Representatives. Retrieved August 3, 1999 from the World Wide Web: http://frwebgate5.access.gpo.gov/cgi-bin…oc

Peterson, T. (1991). Telling the farmers' story: Competing responses to soil conservation rhetoric. *Quarterly Journal of Speech*, *77*, 289-308

Peterson, T.R. (1997). *Sharing the earth: The rhetoric of sustainable development*. Columbia, SC: University of South Carolina Press.

Phillips, W.E., Haney, T.J., and Adamowicz, W.L. (1993). An economic analysis of wildlife habitat preservation in Alberta. *Canadian Journal of Agricultural Economics*, *41*(4), 411-418.

Poor, J. (1997). The value of additional central flyway wetlands in Nebraska's Rainwater Basin Wetland Region. 1997 WAEA selected paper.

Pope, C.A., Adams, C.E., Thomas, J.K. (1984). The recreational and aesthetic value of wildlife in Texas. *Journal of Leisure Research*, *16*, 51-60.

Potter, C. (1998). *Against the grain: Agri-Environmental reform in the United States and the European Union*. New York: CAB International.

Resource Management International. (1997). Environment: Special status wildlife species use of rice cultivation lands in California's Central Valley. Retrieved July 8, 1999 from the World Wide Web: http://www.calrice.org/environment/special-status/index.html

Respess, J.L., Swanson, H., & Dees, K.W. (1999). Value of waterfowl hunting to local communities: a survey of Colorado, Matagorda and Wharton Counties. In *Proceedings of the Texas Waterfowl Conference*. Kingsville, TX: Texas Agricultural Extension Service.

Richardson, J.W., Anderson, D.P., & Smith, E.G. (1999, October). A brief guide to farm programs: 1993-1996. Working paper, Texas Agricultural Experiment Station, Department of Agricultural Economics, Agriculture and Food Policy Center.

Richardson, J.W., Smith, E.G., Knutson, R., Zimmel, P.T., Anderson, D.P., Gray, A.W., & Outlaw, J.L. (1994). *Rice farm program elimination: Impacts on representative rice farms* (Policy Briefing Series 94-4). College Station, TX: Agricultural and Food Policy Center, Texas A&M University.

Rister, M. E., Grant, W.R., Harper, J.K., Smith, E.G., & Stansel, J.W. (1990). Impact of Government Farm Programs on Texas Rice Acreage, 1976-1987 and Results of a Projection Model for Rice Acreage in 1988 (working paper no.1707). College Station, TX: Texas Agricultural Experiment Station.

Rister, M.E., Smith, E.G. Aguilar, V.M., Anderson, D.P., & Lacewell, R.D. (1999). *An economic evaluation of sugarcane production and processing in Southeast Texas* (Environmental Issues/Sustainability DET 99-01). College Station, TX: Texas Agricultural Experiment Station.

Ritter, E.L. (1999). Development and management of small-grain agriculture and moist-soil management imopundments. In W.E. Cohen (Ed.). Proceedings of Texas Waterfowl Conference. Corpus Christi, TX: Texas Agricultural Extension Service.

Robertson, D.R. & Slack, R.D. (1995). Landscape change and its effects on the wintering range of a lesser snow goose *Chen caerulescens caerulescens* population: a review. *Biological Conservation*, *71*, 179-185.

Rogers, E.M. (1995). Diffusion of innovations. (4th edition). New York: The Free Press.

Rylander, C.K. (1997). Fiscal Notes: Watershed Legislation. Retrieved February 11, 2000 from the World Wide Web: http://www.window.state.tx.us/comptrol/fnotes/fn9709.html.

Salassi, M. (1992). The characteristics of production costs of U.S. rice farms, 1988. *Agriculture Information Bulletin No. 657*. Washington, D.C.: United States Department of Agriculture, Economic Research Service.

Salassi, M., Ahearn, M., Ali, M., & Dismukes, R. (1990). Effects of government programs on rice production costs and returns, 1988. *Agriculture Information Bulletin Number 597*. Washington, DC: United Stated Department of Agriculture.

Sauer, J.R., Schwartz, S., & Hoover, B. (1996). The Christmas bird count home page, Version 95.1. Laurel, MD: Patuxent Wildlife Research Center.

Schmidt, F.L. & Hunter, J.E. (1977). Development of a general solution to the problem of validity gereralization. *Journal of Applied Psychology*, *62,* 529-540.

Schnepf, R.D. and Just, B. (1995). *Rice background for 1995 farm legislation*. Washington, D.C.: Department of Agriculture.

Scotchmer, S. (1986, November). Local public good sin an equilibrium: How pecuniary externalities matter. *Regional science and Urban Economics*, *16*, 463-481.

Scott, D., Baker, S.M., & Kim, C. (1997a). *An evaluation of the Great Texas Birding Classic*. Unpublished manuscript, Texas Parks and Wildlife Department.

Scott, D., Baker, S.M., & Kim, C. (1999). Motivations and commitments among participants in a birding competition. *Human Dimensions of Wildlife*, *4(1),* 50-67.

Scott, D., Stewart, W.P., Cole, J.S. (1997b). *An examination of activity preferences and orientations among serious birders*. College Station, TX: Department of Recreation, Park and Tourism Sciences, Texas A&M University.

Shabman, L.A. and Batie, S.S. (1987) Mitigating damages from coastal wetland. *Marine Resource Economics, 4*, 227-248.

Shanmugam, T. R. (1994, June). Measurement of technical efficiency in rice production. *Margin*, *26*, 756-62.

Sheridan, P.F., Slack, R.D., Ray, S.M., McKinney, L.W., Klima, E.F., & Calnana, T.R. (1989). Biological components of Galveston Bay. In *Galveston Bay: Issues, resources, and management – Series 13*. Washington, DC: National Oceanic and Atmospheric Administration.

Sirakaya, E. and McLellan, R.W. (1998). Modeling tour operators' voluntary compliance with ecotourism principles: A behavioral approach. *Journal of Travel Research, 36*(3), 42-45.

Slack, R. D. (1999). Waterfowl in a human-dominated landscape. In W.E. Cohen (Ed.) *Proceedings of Texas Waterfowl Conference* (pp. 11-15). Corpus Christi, TX: Texas Agricultural Extension Service.

Small, S.J. (1989). *The federal law of conservation easements.* Washington, D.C.: Land Trust Alliance.

_____. (1992). *Preserving family lands.* Boston, MA: Landowning Planning Center.

Smith, C.P. & Kellert, S.R. (1996). *Wildlife value orientation and information needs of non-industrial private forest landowners*. Results from an East Texas wildlife survey. New Haven, CT: Yale University.

Smith, V.K. & Huang, J.C. (1995). Can markets value air quality? A meta analysis of hedonic property value models. *Journal of Political Economy*, *103(1),* 209-227.

Smith, V.K. & Osborne, L.L. (1996, November). Do contingent valuation estimates pass a "Scope" Test? A meta analysis. *Journal of Environmental Economics and Management*, *31*, 287-301.

State Water Resources Control Board (SWRCB). (no date). California's rivers and streams: working toward solutions. Retrieved June 2, 1999 from the World Wide Web: http://www.swrcb.ca.gov/pubs/[riversst.htm]

Stevens, T.H., Benin, S., and Larson, J.S. (1995). Public attitudes and economic values for wetland preservation in New England. *Wetlands*, *15*, 226-231.

Stuart, K. & Runge, C.F. (1997). Agricultural policy reform in the United States: An unfinished agenda. *The Australian Journal of Agricultural and Resource Economics*, *41(1)*, 117-136.

Stutzenbaker, C.D., & Weller, M.W. (1989). The Texas coast. In L.M. Smith, R.L. Pederson, & R.M. Kaminiski (Eds.), *Habitat management for migrating and wintering waterfowl in North America* (pp 385-405). Lubbock, TX: Texas Tech University Press.

Sugden, R. & Williams, A.H. (1978). *The principles of practical cost-benefit analysis*. New York, NY: Oxford University Press.

Sumner, D. A. & Lee, H. (1998). Economic prospects of the California rice industry approaching the 21st Century. Retrieved September 15, 1998 from the World Wide Web: www.calrice.org/california_rice/index.html

Taylor, E.L., Rister, M.E., Goodwin, H.L. & Waller, M.L. (1993). *The economic impact of the Texas rice industry* (Faculty paper series; FP 93-6). College Station, TX: Dept. of Agricultural Economics, Texas A&M University.

Terry, K.L. (1996). *An evaluation of avian use of a rice-wetland system*. Unpublished master's thesis, Texas A&M University, College Station, TX.

Texas A&M Research and Extension Center, Beaumont. (1992). Improving rice production for Texas. Retrieved October 29, 1999 from the World Wide Web: http://agresearch.tamu.edu/pubs/beaumont/rice.html

Texas Agricultural Experiment Station (TAES), Beaumont. (1999). Bottom lines: An overview of research and extension projects. Texas Rice Research and Evaluation Program. Nine Decades of Progress Edition. (4th Edition). Beaumont: The Texas A&M University System Agricultural Research and Extension Center.

Texas Agricultural Experiment Station (TAES), Beaumont. (1998). The Texas Rice Industry-Visioning to 2050. Beaumont: The Texas A&M University System Agricultural Research and Extension Center.

Texas Agricultural Extension Service. (1998, March). Estimated values of agricultural production and related items, 1995-1998, 1999 projected. College Station, TX: The Texas A&M University System.

Texas Agricultural Statistics Service. (1980-1998). Texas crop statistics prior to 1996. Washington D.C.: USDA, National Agricultural Statistics Service.

Texas Natural Resource Conservation Commission (TNRCC). (1999a). 1998 State of Texas Water Quality Inventory for Planning Basin groups B and C. Retrieved April 22, 1999 from the World Wide Web: http://www.tnrcc.state.tx.us/water/quality/[index.html]

Texas Natural Resource Conservation Commission (TNRCC). (1999b). Water Resource Management, Water Quality, Data Collection. Retrieved April 24, 1999 from the World Wide Web: http://www.tnrcc.state.tx.us/water/quality/data/

Texas Parks and Wildlife. (1997a). *Texas Wetlands Conservation Plan*. Austin, TX: Texas Parks and Wildlife.

Texas Parks and Wildlife. (1997b). *Texas Land Trust Directory*. Austin, TX: Texas Parks and Wildlife.

Texas Parks and Wildlife Department. (no date) Farm Bill Conservation Retrieved May 1999 from the World Wide Web: http://www.tpwd.state.tx.us/conserve/

Texas Rice Task Force. (1993). *Future of the Texas rice industry*. College Station, TX: Department of Agricultural Economics, Texas A&M University.

Texas Water Development Board (TWDB). (1997). *Water for Texas: A consensus-based update to the state water plan* (Document no. GP-6-2). Austin, TX: Texas Water Development Board.

Texas Water Development Board. (no date). Texas Water Development Board. Retrieved December 1, 1998 from the World Wide Web: http://www.twdb.state.tx.us/

Thibodeau, F.R. and Ostro, B.D. (1981). An economic analysis of wetland protection. *Journal of Environmental Management, 12,* 19-30.

Thomas, J.K., Adams, C.E., & Thigpen, J. (1990). Texas hunting leases: Statewide and regional summary. (Report). College Station, TX: The Texas A&M University System.

Thompson, T.N., Rister, M.E., Grant, W.R., Klosterboer, A.D., McCauley, G.N., Stansel, J.M., Krausz, J.P., Drees, B.M., Turner, F.T., Bollich, C.N., Marchetti, M.A., Way, M.O., Webb, B.D., Whitney, N.G., Pinson, S.R.M., Schebert, C.R. (1994). *A first step toward understanding observed variation in rice producers' main and ratoon crop yields and quality* (Department Technical Report, DTR-1994-1). College Station, TX: Dept. of Agricultural Economics, Texas A&M University.

Tietenberg, T. (1996). *Environmental and natural resource economics* (4th ed.). New York, NY: HarperCollins College Publishers.

Turner, F. (1998). Cost of production with new technologies. Presentation at The Texas Agricultural Experiment Station Workshop: The Texas Rice Industry-Visioning to 2050. Beaumont, TX, October 28, 1998.

U.S.A. Rice Federation. (no date). Federation comments on WHIP. *The Rice Conservationist.* Retrieved September 28, 1999 from the World Wide Web: http://www.usarice.com/tech/environ/conserv3.html

U.S.A. Rice Federation. (1995). Rice conservationist profile. *The Rice Conservationist, 1(1),* 4-5. Retrieved September 28, 1999 from the World Wide Web: http://www.usarice.com/tech/environ/conserv1.html

U. S. Department of Agriculture (USDA). (1999). International agricultural baseline projections to 2007 (Report No. 767: report coordinators: R. Landes, P. Westcott, & J. Wainio). *Agricultural Economic.* Washington, DC: Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture. Retrieved June 16, 1999 from the World Wide Web: http://www.econ.ag.gov/epubs/pdf/aer767/

U. S. Department of Agriculture (USDA). (1998). *Rice Yearbook* (Stock #89001). Washington, DC: Economic Research Service, United States Department of Agriculture. Retrieved June 16, 1999 from the World Wide Web: http://usda.mannlib.cornell.edu/data-sets/crops/89001/

U.S. Department of Agriculture (USDA) Economic Research Service. (1999). Foreign Agricultural Trade of the United States. Retrieved October 29, 1999 from the World Wide Web: http://www.econ.ag.gov/db/FATUS/

U. S. Department of Agriculture (USDA) Economic Research Service. (1998). *Rice Yearbook*. Retrieved June 24, 1999 from the World Wide Web: http://usda.mannlib.cornell.edu/reports/erssor/field/rcs-bby/rice_yearbook_summary_.09.23.98

U. S. Department of Agriculture (USDA) Economic Research Service. (1997). Rice: Situation and outlook yearbook, 1997. (Document #RCS-1997). Washington D.C.: USDA, Economic Research Service.

U. S. Department of Agriculture (USDA) National Agricultural Statistical Service. (1997). Acreage data from 1997 Census of Agriculture. Retrieved March 3, 1999 from the World Wide Web: http://www.nass.usda.gov/census/census97/highlights/tx/tx.htm

U. S. Department of Agriculture (USDA) Natural Resources Conservation Service. (no date). Farm Bill Rules. Retrieved May 1999 from the World Wide Web: http://www.nhq.nrcs.usda.gov/OPA/FB96OPA/FBRules.html

U. S. Department of the Interior (USDI), Fish and Wildlife Service (USFWS) and U.S. Department of Commerce, Bureau of the Census. (1997) *1996 National survey of fishing, hunting, and wildlife-associated recreation*. Washington, D.C.: US Department of the Interior, Fish and Wildlife Service.

U. S. Environmental Protection Agency (USEPA). (1998). Louisiana Coastal Wetland Project. Retrieved October 11, 1999 from the World Wide Web: http://www.epa.gov/docs/ecoplaces/parts/site7.html

U. S. Environmental Protection Agency (USEPA). (no date, a). Clean Water Act. Retrieved June 2, 1999 from the World Wide Web: http://www.epa.gov/earth1r6/6en/w/[cwa.htm]

U. S. Environmental Protection Agency (USEPA), Office of Water. (no date, c). Wetlands. Retrieved June 3, 1999 from the World Wide Web: http://www.epa.gov/OW/resources/9698/chap5.htm

U. S. Fish and Wildlife Service (USFWS). (1998). *Analyses of selected mid-winter waterfowl survey data (1955-1998)*. Albuquerque, NM.

U. S. General Accounting Office (USGAO). (1977). *To protect tomorrow's food supply, soil conservation needs priority attention*. (CED-77-30). Washington, D.C.: U.S. General Accounting Office.

University of California Agricultural Issues Center. (1992). *Maintaining the competitive edge in California's rice industry*. Davis: Author.

University of California Agricultural Issues Center. (1994). *Maintaining the competitive edge in California's rice industry (revised)*. Davis: Author.

Van Cooten, G.C. (1993). Preservation of waterfowl habitat in western Canada: Is the North American Waterfowl Management Plan a success? *Natural Resources Journal, 33*(3), 759-776.

Van Vuuren, W. and Roy, P. (1993). Private and social returns from wetland preservation versus those from wetland conservation to agriculture. *Ecological Economic, 8*, 289-305.

Wahl, R.W. (1989). *Markets for federal water: Subsidies, property rights, and the Bureau of Reclamation.* Washington, DC: Resources for the Future.

Way, M.O., McEwen, G., Avriett, G., Bochat, M., Engbrock, J., Lesikar, M., McCown, M., & Shively, M. (1999). Controlling blackbirds in winter roosts with DRC-1339 in 1999. In *Texas rice research and education program*. Texas A&M University System. B992.

Weimer, D. & Vining, A.R. (1989). *Policy analysis, concepts and practice*. Englewood Cliffes, N.J.: Prentice Hall.

White, H. (1980, May). A heteroscedasticity consistent covariance matrix estimator and a direct test for heteroscedasticity. *Econometrica, 48*, 817-38.

White, J.B. (1993). Conservation easements: An analysis of donated development rights. *Journal of the American Planning Association, 59*, 487-493.

Whitehead, J.C. (1990). Measuring WTP for wetlands preservation with the contingent valuation method. *Wetlands, 10*(2), 187-201.

Whitehead, J.C. (1992). Measuring use value from recreation participants. *Southern Journal of Agricultural Economics, 24*(2), 113-119.

Wimberly, L. (1996). Woodward or Wagstaff? West Texas authorship of the Water Priorities Act of 1931. *West Texas Association Yearbook*, *72*.

Winn, J. (Ed.). (1998). *1998 Rice production guidelines* (Report D1253). College Station, TX: Texas Agricultural Extension Service, Texas A&M University.

Witt, P.A. and Baker, J.E. (1998). Attitudes of Texans concerning selected environmental and property issues. Technical report completed as part of Texas Outdoors: A vision for the future. Austin, TX: Texas Parks and Wildlife Department.

World Wildlife Fund. (1994). Ban carbofuran now. In Dover, P., (Ed.), *Working for wildlife*. Toronto, Canada: World Wildlife Fund.

Wu, J. & Babcock, B. (1995). Optimal design of a voluntary green payment program under asymmetric information. *Journal of Agricultural and Resource Economics*, *20(2)*, 316-327.

Young, E. & Shields, D.A. (1996). Provisions of the 1996 Farm Bill: the Federal Agricultural Improvement and Reform (FAIR) Act. *Agricultural Outlook* (Suppl. April), 1-21.

AAA .... Agricultural Adjustment Act
AFT .... American Farmland Trust
ARP .... Acreage Reduction Program
CFO .... Conservation Farm Option
CRP .... Conservation Reserve Program
CVM .... Contingent Valuation Method
CWA .... Clean Water Act
cwt .... Hundred weight, one-hundred pound unit of measurement
EQIP .... Environmental Quality Incentives Program
FSA .... Farm Service Agency
GATT .... General Agreement on Tariffs and Trade
HP .... Hedonic Pricing Method
LCRA .... Lower Colorado River Authority
NPDES .... National Pollutant Discharge Elimination System
NRCS .... Natural Resources Conservation Service
NWHP .... National Waterfowl Habitat Program
PIK .... Payment In Kind Program
PLD .... Paid Land Diversion Program
SB1 .... Senate Bill 1 of the 75th Texas Legislature
SWRCB .... State Water Resources Control Board
TCP .... Texas Conservation Passports
TMDL .... Total Maximum Daily Load
TNRCC .... Texas Natural Resource Conservation Commission
TPWD .... Texas Parks and Wildlife Department
TWDB .... Texas Water Development Board
UCAIC .... University of California Agricultural Issues Center
URA .... Uruguay Round Agreement
USDA .... U.S. Department of Agriculture
USDI .... U. S. Department of the Interior
USEPA .... U.S. Environmental Protection Agency
USFWS .... U.S. Fish and Wildlife Service
WHIP .... Wildlife Habitat Incentive Program
WRP .... Wetland Reserve Program
WTP .... Willing to Pay

Confidence Interval............................... A numerical range in which a value is predicted to fall with a stated level of statistical confidence.

Contingent Valuation............................ A method for valuing goods or services that are not typically provided by markets. The method uses surveys to determine how much individuals would be willing to pay to obtain the services.

Deficiency Payment............................... A payment made to farmers equal to the difference between market prices and government set target price.

Externality .... An unintended consequence.

Heteroscedasticity.................................. Unequal sample variances.

Hundred Weight ($/cwt)...................... A unit of weight equal to 100 pounds.

Linear Regression .... A statistical procedure that describes the variance in a dependent variable as a linear function of the independent variable.

Marginal Analysis................................... Economic analysis of small changes in the quantity of a good or service. For example, the marginal cost of rice production is the cost that would be required to increase production by one unit.

Non-market Goods and Services........ Goods and services that are not bought and sold in markets.

Pearson Correlation .... A correlation is a measure of the degree to which two variables covary, or in other words, whether they are interdependent. The Pearson correlation, also known as the product-moment correlation, is just one of several methods for calculating the strength of a correlation.

Precision.. The degree to which repeated estimates are similar in value.

Real Value... A value that has been adjusted for inflation, e.g., real price.

Sample Variance .... An estimate of the dispersion of a variable about its mean. It is equal to the difference between the mean of the squared values of the variable and the square of the variable's mean.

Social Value.. The aggregate value to society, including all market and non-market benefits and costs.

Socially Efficient..................................... A characteristic of an allocation indicating that the aggregate benefits to society cannot be increased by altering the allocation.

Standard Deviation .... An estimate of the dispersion of sample values about the mean. It is the square root of the sample variance.

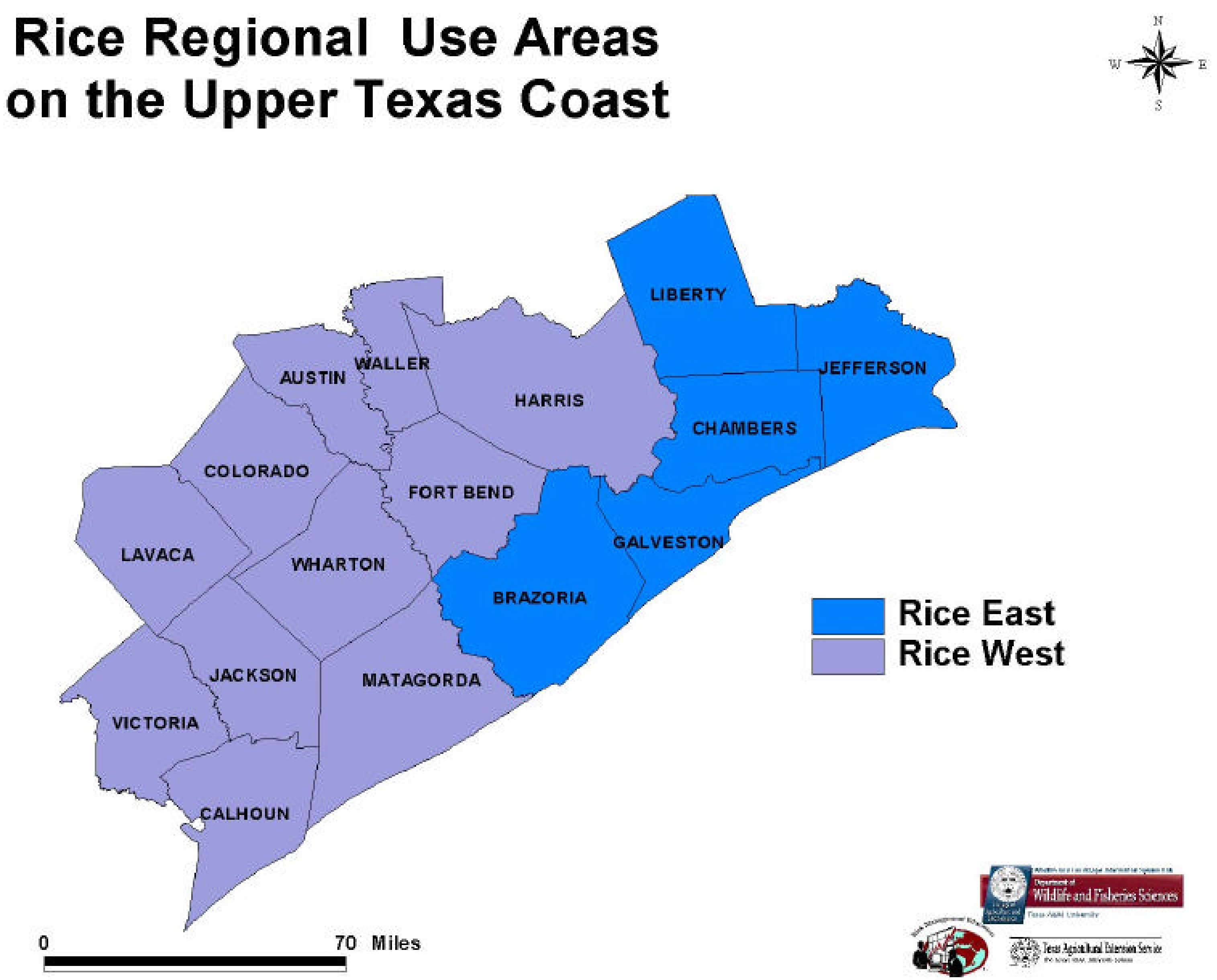
Statistical Error.. There are two basic forms of statistical error. A type I error is the probability of rejecting a null hypothesis when it is in fact true. A type II error is the probability of accepting a false null hypothesis. Type I error is controlled by the investigator when setting the level of statistical significance (p-value) in an experiment. Type II error is difficult to control and is frequently unknown.

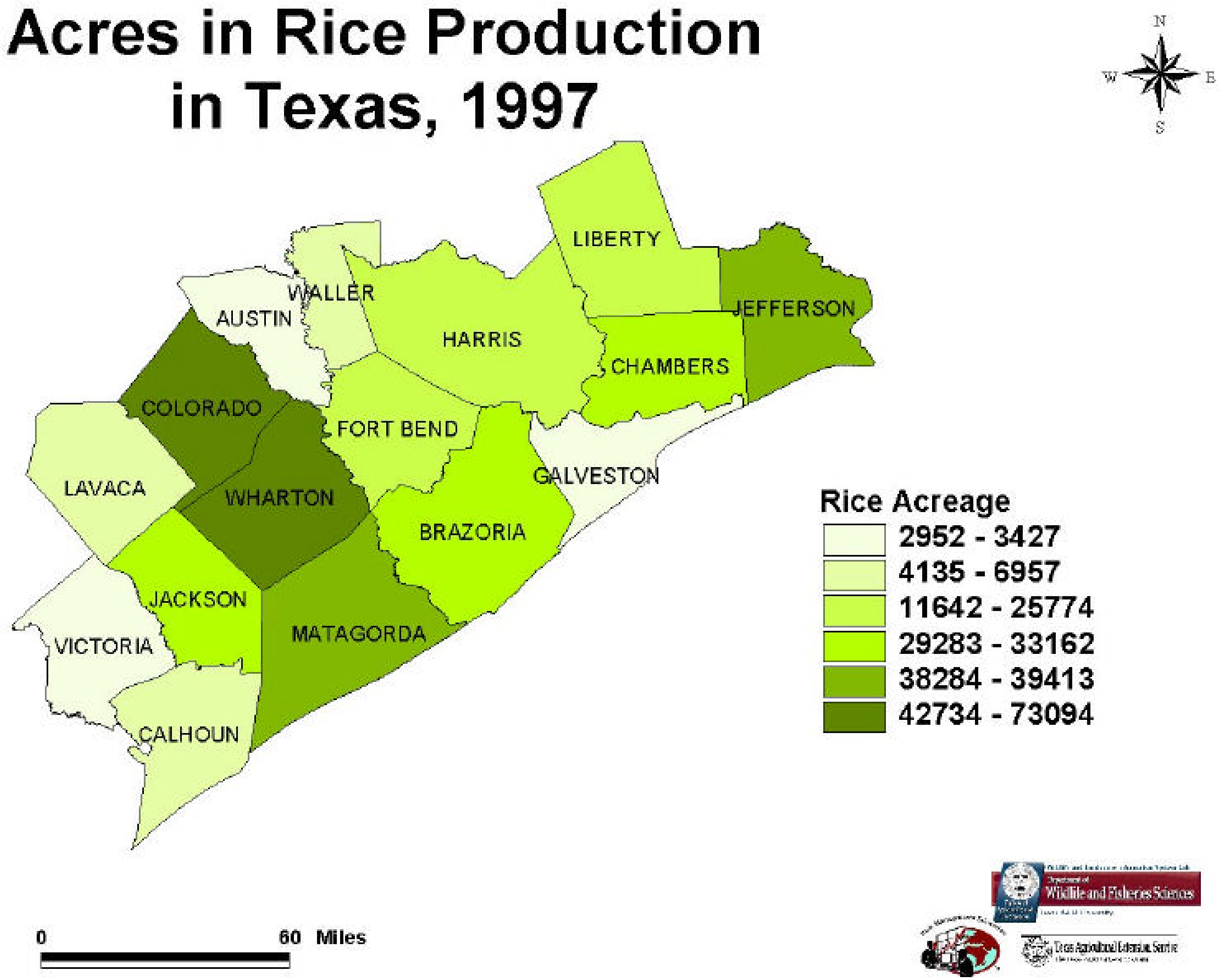
Statistical Significance (p-value) .... A probability level set by the investigator and based upon a theoretical probability distribution of observing sample statistics more extreme than an expected range of values. The level is set such that these values are thought to represent real differences; therefore, this level is frequently small (e.g. $p \leq 0.05$) to avoid a large type I statistical error.

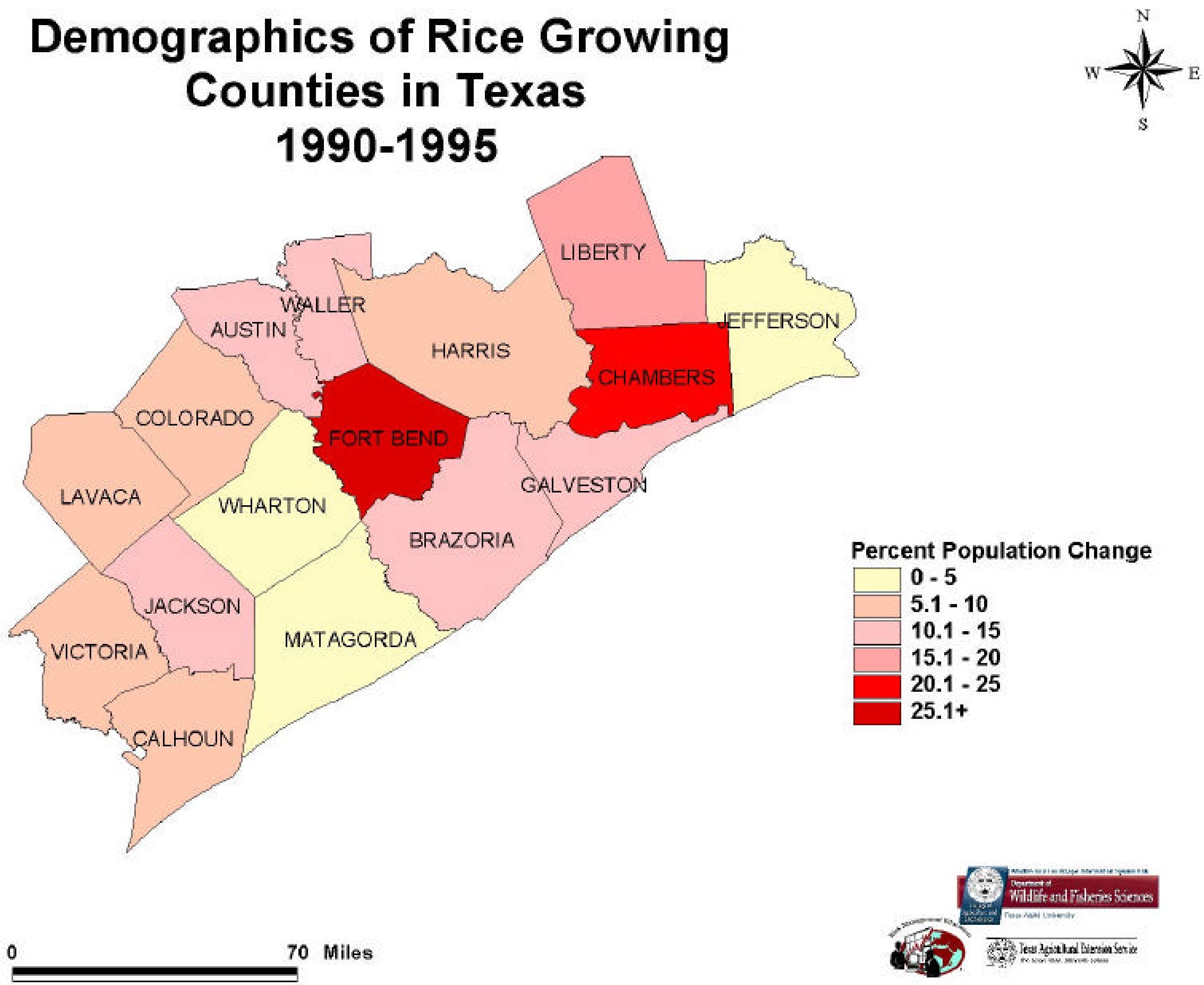
Target Price... A government-set minimum unit price for an agricultural commodity.

T-statistic.. A statistic used to evaluate whether an estimated parameter is statistically different from zero, equal to the parameter's value divided by its standard deviation.

Appendix A


Rice Regional Use Areas
on the Upper Texas Coast
N
W
E
S
LIBERTY
JEFFERSON
WALLER
AUSTIN
HARRIS
CHAMBERS
COLORADO
FORT BEND
GALVESTON
LAVACA
WHARTON
BRAZORIA
JACKSON
MATAGORDA
VICTORIA
CALHOUN
Rice East
Rice West
0
70 Miles


Acres in Rice Production in Texas, 1997
N
W
E
S
LIBERTY
WALLER
AUSTIN
HARRIS
JEFFERSON
CHAMBERS
COLORADO
FORT BEND
LAVACA
WHARTON
GALVESTON
BRAZORIA
JACKSON
MATAGORDA
VICTORIA
CALHOUN
Rice Acreage
2952 - 3427
4135 - 6957
11642 - 25774
29283 - 33162
38284 - 39413
42734 - 73094
0
60 Miles
Wildlife and Fisheries Sciences


Demographics of Rice Growing
Counties in Texas
1990-1995
N
W
E
S
LIBERTY
WALLER
AUSTIN
HARRIS
JEFFERSON
CHAMBERS
COLORADO
FORT BEND
LAVACA
WHARTON
GALVESTON
BRAZORIA
JACKSON
VICTORIA
MATAGORDA
CALHOUN
Percent Population Change
0 - 5
5.1 - 10
10.1 - 15
15.1 - 20
20.1 - 25
25.1+
0
70 Miles
Wildlife and Fisheries Sciences
Texas Agricultural Extension Service

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Appendix B

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Costs and Returns to Gulf Coast Rice Agriculture
Region Averages in 1990 Dollars Per Acre

ITEM	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
GROSS VALUE OF PRODUCTION																				
Rice	772.47	650.40	737.01	689.55	687.01	482.94	489.94	483.80	483.29	249.51	294.41	406.88	403.91	343.79	407.62	335.28	247.81	355.06	380.36	489.03
Total, Gross Value of Production	772.47	650.40	737.01	689.55	687.01	482.94	489.94	483.80	483.29	249.51	294.41	406.88	403.91	343.79	407.62	335.28	247.81	355.06	380.36	489.03
ECONOMIC (FULL OWNERSHIP) COSTS:																				
Variable Cash Expenses**	344.63	355.30	372.21	395.58	401.82	446.31	418.81	389.86	393.96	371.89	359.21	354.67	351.04	346.50	348.61	316.80	309.55	320.80	315.40	332.99
General farm overhead	47.30	42.98	40.14	43.61	36.40	26.29	25.41	25.08	26.03	22.98	21.73	24.91	22.98	25.22	21.87	16.48	19.54	20.25	20.85	19.09
Taxes and Insurance	12.63	13.45	14.97	14.44	12.29	12.68	13.45	12.54	13.20	10.91	11.39	11.94	11.67	11.37	11.07	16.64	22.20	24.43	23.74	25.39
CAPITAL REQUIREMENTS	66.92	91.93	103.65	101.66	105.27	100.94	97.72	73.81	70.63	55.37	54.30	74.08	79.32	79.45	79.95	78.35	77.22	82.46	82.22	79.50
Land	119.61	116.32	137.70	106.38	109.07	54.61	58.94	68.62	70.13	11.18	20.63	53.06	55.89	42.86	52.52	60.21	42.80	68.27	73.34	78.26
Unpaid Labor	17.85	21.03	22.21	21.65	22.22	22.61	21.85	29.84	23.02	34.31	33.68	33.55	33.53	34.00	33.25	30.01	28.52	27.57	28.19	29.02
Total Economic Costs	608.93	641.01	690.88	683.33	687.06	663.44	636.17	599.74	596.98	506.65	500.93	552.21	554.43	539.39	547.27	518.49	499.83	543.78	543.75	564.26
Residual Returns to Management and Risk	163.54	9.39	46.14	6.22	-0.05	-180.50	-146.22	-115.94	-113.69	-257.15	-206.52	-145.33	-150.52	-195.60	-139.65	-183.21	-252.02	-188.72	-163.38	-75.23
Direct Government Payments	105.76	0.00	34.04	0.00	0.00	8.05	162.39	61.24	254.39	158.35	187.79	239.08	245.44	261.91	197.63	221.34	250.22	183.94	126.33	104.55
Haying / Grazing on ACR and CU Acreage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.06	0.04	0.00
Estimated Revenues From Hunting and Other Wildlife Activity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Adjusted Returns to Management and Risk	269.30	9.39	80.18	6.22	-0.05	-172.45	16.17	-54.70	140.70	-98.79	-18.73	93.75	94.93	66.31	57.98	38.16	-1.75	-4.72	-37.02	-75.23
Harvest-Period Price (dollars / cwt.)	19.33	15.45	18.29	17.96	15.68	10.88	12.10	10.72	9.99	4.74	5.81	8.04	8.40	6.59	7.82	6.40	5.10	6.56	7.41	8.78
Yield (cwt. / planted acre)	39.96	42.09	40.30	38.40	43.82	44.40	40.48	45.15	48.36	52.65	50.63	50.61	48.11	52.15	52.11	52.36	48.58	54.12	51.32	55.70

Source: USDA (1998); Schnepf and Just (1995); and National Institute of Policy Analysis (n.d.).

Appendix C

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Summary Data From Wetland Valuation Studies

SOURCE	LOCATION	SIZE (ACRES)	VALUE PER ACRE (NOMINAL)	TOTAL VALUE	WETLAND SERVICES CONSIDERED
Amacher, G.S. (1989)	MI	1,700	22.2	37,740	1
"	MI	8,500	114.4	972,400	1
"	MI	6,000	220.3	1,321,800	1
"	MI	6,000	409.5	2,457,000	1
"	MI	6,000	1,475.0	8,850,000	1
"	MI	6,000	602,360.0	3,614,160,000	1
Barbier, E.B. (1994)	Nigeria	1,803,830	63.5	114,543,205	1
Barbier & Strand (1998)	Mexico	206,329	564.0	116,369,556	2
Batie, Wilson (1978)	VA	63,915	1.1	72,224	1
"	VA	5,614	1.6	9,207	1
"	VA	6,622	1.9	12,449	1
"	VA	436	4.2	1,849	1
"	VA	6,287	13.6	85,692	1
"	VA	2,282	107.2	244,676	1
"	VA	1,128	141.5	159,567	1
Bell (1989)	FL	0	35.6	28,871,328	1
Bell (1997)	FL	431,266	79.7	34,371,900	1
"	FL	95,882	525.8	50,414,756	1
Bergstrom, Stoll, et al. (1990)	LA	3,250,000	8.4	27,365,000	2
Breaux, Farber, Day (1995)	LA	2,860	53.8	153,982	1
"	LA	570	150.1	85,557	1
"	LA	6	4,306.0	26,697	1
Chabreck, R.H. (1979)	LA		3.9	0	1
"	LA		9.6	0	1
Chabreck, R.H. (1979)	LA	446,720	0.5	241,229	1
"	LA	194,320	0.6	110,762	1
Cooper, Loomis (1991)	CA	85,000	194.0	16,490,000	1
"	CA	85,000	761.0	64,685,000	1
Creel, Loomis (1992)	CA	85,000	82.0	6,970,000	1
"	CA	85,000	388.0	32,980,000	1
"	CA	85,000	476.0	40,460,000	1
Dillman, Hook (1993)	S C	2,500	721.1	1,802,825	9
"	S C	2,500	819.5	2,048,675	9
"	S C	2,500	1,770.1	4,425,125	9
"	S C	2,500	2,069.3	5,173,225	7
Doss, C.R., & S.J. Taff (1994)	MI	9,878			1
Doss, C.R., & S.J. Taff (1996)	MI	9,878			1
Elliot (1992)					
Farber (1988)	LA	160,000	0.4	64,000	1

Summary Data From Wetland Valuation Studies (continued)

SOURCE	LOCATION	SIZE (ACRES)	VALUE PER ACRE (NOMINAL)	TOTAL VALUE	WETLAND SERVICES CONSIDERED
Farber (1988)	LA	650,000	10.0	6,513,000	3
"	LA	7,300,000	37.5	273,458,000	1
Farber, Costanza (1987)	LA	7,300,000	678.0	4,949,400,000	4
Farber, Costanza (1987)	LA	7,784	96.4	750,066	9
Folke, C. (1991)	Sweden	8,000	52.2	417,760	3
Gren (1995)	Sweden		427.7	0	1
Gupta, Foster (1975)	MA	8,422	76.8	646,978	1
"	MA	1,567	167.9	263,099	2
"	MA		2,800.0		1
"	MA	500,000	14.0	7,007,741	3
Hanley, Crag (1991)	Scotland	3	6.1	18	3
Hovde, Brett (1993)	ND	4	4.5	18	1
"	ND	8	5.1	41	2
"	ND	17	11.2	190	4
"	ND	2,200	19.6	43,186	3
"	ND	1,307,159	25.9	33,855,418	1
Johnson, Linder (1986)	SD	105,855	651.0	68,911,605	4
Joworski, Eugene (1978)	MI	650,000	6.5	4,238,000	3
Kosz (1996)	Austria	28,417	212.7		3
"	Austria	28,417			4
Lant, Tobin (1989)	IL	2,109	102.6	216,383	3
"	IOWA	1,108	1,129.7	1,251,741	3
"	IL	105,855	1,399.0	148,091,145	5
Loomis, Hanemann (1991)	CA	85,000	9,090.0	772,650,000	3
"	CA	125,000	10,629.0	1,328,625,000	3
Lynne, Conroy (1981)	FL	501,424	0.3	137,892	1
Morton, RM (1990)	Australia	591	2,068.0	1,222,188	2
Pate, Loomis (1997)	CA	125,000	339.7	42,459,502	1
Phillips, Haney (1993)	Canada	120,000	263.3	31,592,871	4
Poor, Joan (1997)	NE	25,000	1,568.0	39,198,750	1
Shabman, L.A. & Batie (1987)	LA	47,975	108.1	5,186,098	1
Thibodeau, Ostro (1981)	FL	2,680	259.7	695,996	1
"	MA	8,535	1,533.0	13,084,155	3
"	MA	8,535	2,000.0	17,070,000	1
Thibodeau, Ostro (1981)	MA	8,535	100.9	861,096	3
"	MA	8,535	150.0	1,280,250	1
"	MA	8,535	1,560.0	13,314,600	1
Vuuren, Roy (1993)	Canada	741	83.6	61,936	1
"	Canada	371	113.5	42,084	1
"	Canada	49	131.3	6,487	1
Whitehead (1990)	KY	5,000	870.0	4,350,000	7

Appendix D

SURVEY AND SAMPLE DESCRIPTION

To facilitate our understanding of the policy context associated with rice production in Texas, surveys of three groups were conducted. In each case, the surveys were conducted over the telephone by the Public Policy Research Institute at Texas A&M University. First, a survey of rice producers was conducted. The sample consists of 108 respondents randomly chosen from a list of 1553 people identified by the Texas Agricultural Extension Service as being involved in rice production. Maximum sampling errors for this survey varied from ±9% to ±18%, depending on the number of respondents answering a particular question.

Second, a survey of environmental group representatives was conducted. Nineteen environmental organizations operating in Texas were identified using various directories and group web pages and then 34 leading officials in these groups were identified. Attempts were made to contact all of these officials, and sixteen agreed to participate. The maximum sampling error for this survey was ±27%, which is a function of the small sample used.

Third, a survey of the general public was conducted. A random sample of 300 Texans was chosen using random digit dialing. The maximum sampling error for this sample was around ±6%.

While the sampling errors are rather high in some cases, these surveys do offer interesting initial results that can be followed up with more complete surveys in the future. Furthermore, several of these findings are in line with findings from previous surveys.

The rice producers survey is the most comprehensive, covering various aspects of their farming business, their expectations about the future, and their attitudes toward environmental practices and programs. The general population survey seeks to ascertain Texans' knowledge of rice production and its environmental effects, their participation in outdoor activities, and their attitudes toward hypothetical programs to aid farmers. The environmental organizations survey was the shortest, with questions pertaining to environmental representatives' knowledge of rice production and its environmental effects and their attitudes toward hypothetical programs to aid farmers. Questions on these surveys were largely closed-ended, but respondents were sometimes given the opportunity to answer in an open-ended manner. In developing the survey, we attempted, where possible, to duplicate questions asked in previous surveys, so as to provide the means to make longitudinal comparisons of attitudes. The three questionnaires are attached.

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SURVEY OF RICE PRODUCERS

Introduction: Hello, I am____________ calling from the Public Policy Research Institute at Texas A&M University. May I speak to an adult, someone over the age of 18?

We are helping faculty from Wildlife and Fisheries, Agricultural Economics, and Policy Sciences at Texas A&M conduct an update on a survey of rice farmers in the state of Texas.

1. Do you produce rice on your land or do you own land which someone else produces rice on?

    Yes 1 **(Continue with survey)**
    No 2 **(Thank you very much for your time) Code as (UQ)**

1a. Has the extension agent in your area told you to expect a call about this survey?

    Yes 1
    No 2

2. Which of the following best describes your rice operation?

    I own all the land I grow rice on 1
    I lease all the land I grow rice on 2 **(Skip to Q2a)**
    I own some land & lease some land 3 **(Skip to Q2b)**
    I own land but am not personally involved in rice production 4

2a. What percent is leased for cash, and what percent is leased for shares?

    % Leased for cash_________ % Leased for shares_______
    DK 8
    RF 9

2b. What percent is owned and what percent is leased?

    % Owned__________ % Leased____________
    DK 8
    RF 9

[CATI: For Q3, let program compute % (at end?), not to be asked by interviewer.]

3. What was your 1998 acreage for each of the following? For crops, count only harvested acres.

    Rice
    ______ # of acres ______% of total
    DK 8
    RF 9

    Ratoon crop
    ______ # of acres ______% of total
    DK 8
    RF 9

    Pasture
    ______ # of acres ______% of total
    DK 8
    RF 9

Soybeans
______ # of acres ______% of total
DK 8
RF 9

Wheat
______ # of acres ______% of total
DK 8
RF 9

Other crop (specify)_______________
______ # of acres ______% of total
DK 8
RF 9

Fallow land
______ # of acres ______% of total
DK 8
RF 9

Unfarmed wildlife habitat
______ # of acres ______% of total
DK 8
RF 9

DK 8 **(Interviewer, use this disposition only as last resort. PROBE)**
RF 9 **(Interviewer, use this disposition only as last resort. PROBE)**

4. What county or counties is your rice production operation in? ____________________.

5. How many years have you been farming rice in Texas? Please include all years, even if there was a break in your farming. ______________________**(Record actual number)**

6. Do you have any relatives who farm or have farmed rice in Texas?

Yes	1	DK	8
No	2	RF	9

7. Compared to 1995, have you changed the type or percentage of different crops you farm?

Yes	1 **(Skip to Q8)**	DK	8 **(Skip to Q9)**
No	2 **(Skip to Q9)**	RF	9 **(Skip to Q9)**

8. Specifically, do you now have more or less acreage in rice?

More	1	Don't grow	3
Less	2		

pasture?

More	1	Don't grow	3
Less	2		

feed grains?

More	1	Don't grow	3
Less	2		

soybeans?

More	1	Don't grow	3
Less	2		

cotton?

More	1	Don't grow	3
Less	2		

wheat?

More	1	Don't grow	3
Less	2		

another crop?

More	1	Don't grow	3
Less	2		

9. Within the next 5 years, which of the following possibilities are the most likely for the land you currently farm? **(Interviewer: Read list, choose one)**

I will be farming more acres in rice.	1 **(Skip to 9a)**
I will be farming fewer acres in rice.	2 **(Skip to 9b)**
I will be farming the same # of acres of rice.	3 **(Skip to Q12)**
I will not be farming	4 **(Skip to Q11, then Q13)**
I will have sold land to developers	5 **(Skip to Q11 then Q13)**

9a. How many more acres of rice do you expect to farm? __**(Record #, Skip to Q12)**

DK 8 **(Skip to Q12)**
RF 9 **(Skip to Q12)**

9b. How many fewer acres of rice do you expect to farm?

______**(Record #, Skip to Q10 (including a, b and c), Q11, then Q13)**
DK 8 **(Skip to Q10, (including a, b and c), Q11, then Q13)**
RF 9 **(Skip to Q10, (including a, b and c), Q11, then Q13)**

10a. What will you do with the acres taken out of rice production? Will you **(Read options, choose**

Put in pasture 1 **(If this option chosen, ask 10a1)**

10a1. What is the number of acres for this purpose? __________

Put in another crop 2 **(If this option chosen, ask 10a2)**

10a2. What is the number of acres for this purpose? __________

Convert to wildlife habitat 3 **(If this option chosen, ask 10a3)**

10a3. What is the number of acres for this purpose? __________

Let them lie in fallow 4 **(If this option chosen, ask 10a4)**

10a4. What is the number of acres for this purpose? __________

Sell the land 5 **(If this option chosen, ask 10a5)**

10a5. What is the number of acres for this purpose? __________

Other (specify) ____________ 6 **(If no categories apply, ask R to be specific about what he/she will do). (If this option chosen, ask 10a6)**

10a6. What is the number of acres for this purpose? __________

10b. Can you grow crops that are alternatives to rice on your land?

Yes	1
No	2 **(Skip to Q11)**
DK	8 **(Skip to Q11)**
RF	9 **(Skip to Q11)**

10c. What percentage of your acreage can be farmed to another crop?

___________%

DK	8
RF	9

[CATI: If respondent answered fewer acres or not farming, ask]

11. Of the following factors, which ones would be very important, important, slightly important or not important factors in a decision to plant less rice? How about…

A Cost of water?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

B Competition for scarce water?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

C Depletion of wells?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

D Deterioration of water quality?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

E Uncertainty over state water policy?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

F Lack of competent seasonal labor?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

G Reduction in price supports because of FAIR act?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

H Costs of pesticides?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

I Costs of chemical fertilizers?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

J Costs of equipment?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

K Costs of fuel?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

L Drying costs?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

M Storage costs?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

N Lack of support industries?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

O Market price for rice?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

P Lack of financing?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

Q Profitability of alternative crops?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

R Low yields?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

S Poor crop quality?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

T Retirement anticipated?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

U Landowner's decision?

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

[CATI: Skip to Question 13 after all above have been asked]

[CATI: If respondent answered same or more acres, ask]

12. How would you rank the following factors for their importance to effect the profitability of your rice production? Would you say very important, important, slightly important, not important?

A Market price of rice

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

B Cost of water

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

C Competition for scarce water

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

D Cost of fuel

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

E Cost of equipment

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

F Cost of fertilizer

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

G	Cost of pesticides				
		Very important	1	DK	8
		Important	2	RF	9
		Slightly important	3		
		Not important	4		
H	Cost of labor				
		Very important	1	DK	8
		Important	2	RF	9
		Slightly important	3		
		Not important	4		
I	Drying costs				
		Very important	1	DK	8
		Important	2	RF	9
		Slightly important	3		
		Not important	4		
J	Storage costs				
		Very important	1	DK	8
		Important	2	RF	9
		Slightly important	3		
		Not important	4		
K	Cost of other support industries				
		Very important	1	DK	8
		Important	2	RF	9
		Slightly important	3		
		Not important	4		
L	Damage by black birds				
		Very important	1	DK	8
		Important	2	RF	9
		Slightly important	3		
		Not important	4		
M	Damage by migratory waterfowl				
		Very important	1	DK	8
		Important	2	RF	9
		Slightly important	3		
		Not important	4		
N	Red rice				
		Very important	1	DK	8
		Important	2	RF	9
		Slightly important	3		
		Not important	4		

13. For each ownership objective below, indicate whether it is very important, important, slightly important or not important to you. How about…

A Passing land on to children/grandchildren

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

B Protecting natural state of land

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

C Wildlife conservation

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

D Enjoying country living

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

E Income from rice production

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

F Income from hunting/other use

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

G Investment

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

H Privacy

Very important	1	DK	8
Important	2	RF	9
Slightly important	3		
Not important	4		

I	Place of residence				
	Very important	1	DK	8
	Important	2	RF	9
	Slightly important	3		
	Not important	4		

J	Commitment to employees				
	Very important	1	DK	8
	Important	2	RF	9
	Slightly important	3		
	Not important	4		

K	Can be my own boss				
	Very important	1	DK	8
	Important	2	RF	9
	Slightly important	3		
	Not important	4		

14. What would you say are the 3 most important problems facing you as a rice producer**? (Interviewer: Do not read categories. Mark the ones mentioned –First mentioned=1; Second =2 and Third =3)**

___Competition for scarce water
___The cost of water
___Lack of competent seasonal labor
___Wildlife damage to crops
___Urban land development
___Damage by trespassers
___Pesticide bans
___Market prices
___Low yields
___Costs of production (fertilizers, equipment, etc)
___Other **(specify)** ________________________________

15a. Do you do any paid work off your own farm?

Yes	1	DK	8
No	2 **(Skip to Q16)**	RF	9

15b. What kind of work do you do? ____

15c. What percentage of your household income comes from off-farm work? _________%

15d. Has this percentage of household income from off-farm work increased or decreased since 1995?

Increased	1	DK	8
Decreased	2	RF	9
Stayed about the same	3		

16. In 1998, did you receive any non-farm income from sources such as income from investments, mineral leases and so forth?

Yes	1	DK	8
No	2	RF	9

17. Which, if any, of the following non-agricultural activities took place on the land you farmed in 1998? How about… **(Interviewer: Choose all that apply)**

Fee hunting for waterfowl-lease to outfitter	1
Fee hunting for waterfowl–self-operated	2
Non-fee waterfowl hunting	3
Other fee hunting-lease to outfitter	4
Other fee hunting-self-operated	5
Other non-fee hunting	6
Fee fishing	7
Non-fee fishing	8
Oil/gas production	9
Timber for harvest	10
Fee bird watching-arrangement with outside agency	11
Fee bird watching-Self-operated	12
Non-fee bird watching	13
Other (specify) ____________________	14
None	15 **(Skip to Q18)**

[CATI: For each activity R chooses above, ask following questions for EACH activity.]

17a. What percent of the land is used for this purpose? _________%

DK 8
RF 9

17b. What percent of your operating costs are involved? _________%

DK 8
RF 9

17c. What percent of gross receipts does this activity account for? _____%

DK 8
RF 9

18. Have you ever <u>considered</u> allowing any of the following on your land?

A Hunting?

Yes	1	DK	8
No	2	RF	9

B Fishing?

Yes	1	DK	8
No	2	RF	9

C Bird watching?

Yes	1	DK	8
No	2	RF	9

19. Which of the following statements best captures your attitude toward non-farming use of your rice farmland, such as use for hunting and/or bird watching?

It's a hassle	1
It's a hobby	2
It's something I make available to friends & family	3
It's something I would consider to supplement my income	4
It's an important part of this land's financial performance	5
It's a small part of this land's financial performance	6
It costs too much	7
Other (specify) ______________________	8

20. Overall, how much interest would you say you have in managing wildlife on your land?

Great interest	1	DK	8
Moderate interest	2	RF	9
Slight interest	3		
No interest	4		

21. Please indicate whether you have done any of the following activities to benefit wildlife in the last 5 years? **(Read list, choose all that apply)**

Winter flooding for waterfowl	1
Planted food plots	2
Improved wetlands	3
Done a wildlife census	4
Done a game census	5
Brush control	6
Maintained wildlife feeders	7
Disked fallow land	8
Controlled hunting	9
None of the above	10

22. I am going to read a list of programs. Please tell me which ones you have heard of.

Private Lands Enhancement Program (PLEP)	1
Private Lands Initiative (PLI)	2
Wetlands Project Site Registry	3
Partners for Fish and Wildlife (PFW)	4
Conservation Reserve Program through TDPW	5
Environmental Quality Incentives Program (EQIP)	6
Wildlife habitat Incentives Program (WHIP)	7
Wetland Reserve Program (WRP)	8
Ducks Unlimited (Texas Prairie Wetlands Project)	9
Wetland Habitat Alliance of Texas (WHAT)	10
Conservation Easement arrangement	11
Any land protection/ land trust program like the Katy Prairie Conservancy or the Legacy Land Trust	12
The Nature Conservancy's wetland management program	13
Any registry programs such as the Land Stewards' Society	14
National Waterfowl Habitat Program	15

[CATI: For EACH option chosen above, ask the following question]

22a. Do you participate in any of these programs? **(Reread options chosen, check yes for all that apply)**
[CATI: If respondent is not participating in any programs, Skip to Q24]

[CATI: If respondent is participating in one or more programs, ask]
23. What is your primary reason for participating? **(Interviewer: Do not read list, choose all that apply)**

Economics	1
Concern for environment	2
Labor	3
Other (specify) ____________	4

24. What are your reasons for not participating? **(Interviewer: Do not read list, choose all that apply)**

Payment or cost share is not high enough	1
Landlord doesn't want to participate	2
Too many restrictions	3
Too much physical work	4
Too much paperwork	5
Can't afford to lose crop base	6
Waiting to see if a bonus payment will be added to the per acre government payment in a future sign up	7
Fear of loss of control over land	8
Don't know enough about them	9
Does not apply to me	10
Other (specify) ______________	11

[CATI: If more than one reason is given in Q24, ask]
24a. What would you say is the most important reason for not participating? __________

25. Where do you go to get good information on best agricultural management practices, or ways to make your production more efficient? ______________________________

26 Where do you go to get good information on best environmental management practices?
____

27. I am going to read a list of obstacles to wildlife management. Please indicate whether it is a major obstacle, a slight obstacle or not an obstacle to your participation in wildlife management programs.

A	Lack of interest				
	Major obstacle	1		DK	8
	Slight obstacle	2		RF	9
	Not an obstacle	3			
B	Lack of time				
	Major obstacle	1		DK	8
	Slight obstacle	2		RF	9
	Not an obstacle	3			
C	Interference with other land practices				
	Major obstacle	1		DK	8
	Slight obstacle	2		RF	9
	Not an obstacle	3			

D	Cost				
		Major obstacle	1	DK	8
		Slight obstacle	2	RF	9
		Not an obstacle	3		
E	Lack of knowledge				
		Major obstacle	1	DK	8
		Slight obstacle	2	RF	9
		Not an obstacle	3		
F	Lack of technical support				
		Major obstacle	1	DK	8
		Slight obstacle	2	RF	9
		Not an obstacle	3		
G	Property is too small				
		Major obstacle	1	DK	8
		Slight obstacle	2	RF	9
		Not an obstacle	3		
H	Potential government interference				
		Major obstacle	1	DK	8
		Slight obstacle	2	RF	9
		Not an obstacle	3		
I	Concern for property damage from wildlife				
		Major obstacle	1	DK	8
		Slight obstacle	2	RF	9
		Not an obstacle	3		
J	Personal liability exposure				
		Major obstacle	1	DK	8
		Slight obstacle	2	RF	9
		Not an obstacle	3		

28. There are many organizations that are concerned in some way with the well being of the environment. In your opinion which non-farm organizations could farmers like you work with successfully to promote joint agricultural and environmental interests? ________________________ **(Record verbatim, all mentioned)**

29. Of the four items I am about to read, what, in your opinion, is the most pressing environmental issue affecting your rice production? Would you say…

Pesticide bans	1	DK	8
Competition for water	2	RF	9
Water quality issues	3		
Other (specify) _________	4		

30. Alliances such as Texas Rice Industry Coalition for the Environment (R.I.C.E.) were formed to benefit rice producers and to support the environmental benefits of rice. If the goal were to educate the public on the environmental benefits of rice production, which of the following would you be willing to do? **(Interviewer: Check all that apply)**

Allow testing of the water in your rice fields	1	DK	8
Allow tourists such as bird watchers access to some parts of your property for watching wildlife	2	RF	9
Participate in a demonstration project on the environmental benefits of rice production	3		
Other **(specify)** __________________	4		
None of the above	5		

31. What is your education?

Grade school	1	DK	8
Some high school	2	RF	9
High school graduate	3		
Some college	4		
College graduate	5		
Beyond college	6		

32. How many people, including yourself, live in your household? _________________

33. Are there other family members who work with you on the farm?

Yes	1	DK	8**(Skip to Q34)**
No	2 **(Skip to Q34)**	RF	9 **(Skip to Q34)**

33a. Who are these family members? **(Interviewer: Don’t read, record all that apply)**

Wife	1
Sons or daughters	2
In-laws	3
Grandchildren	4
Other relatives	5

34. How many employees do you have?

Full time _______	DK	8
Part time _______	RF	9

35. What was your household income in 1998 as reported on 1040F?

Less than $20,000	1	DK	8
$20-30,000	2	RF	9
$30-40,000	3		
$40-50,000	4		
$50-70,000	5		
Over $70,000	6		

That completes our survey. Thank you very much for your time.

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