Rice in the Western Hemisphere: Industry Dynamics and Opportunities for Waterbird Conservation

Photo credit: Daniel Blanco

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EXECUTIVE SUMMARY

Rice is a staple food for about half the world population. It can also serve as important wildlife habitat, particularly for waterbirds. In September 2007, the Rice and Waterbirds Working Group (RWWG) steering committee requested that a graduate student team from the University of Maryland Sustainable Development and Conservation Biology Program investigate the rice industry in the Western Hemisphere with the objectives of analyzing important social and economic trends and identifying possible industry contacts for future collaborations. The goal of this project was to enable the RWWG to interact constructively with members of the rice industry and to collaborate with them on waterbird conservation efforts.

The graduate student team conducted data and literature reviews of relevant information, corresponded with over fifty people involved in the rice industry or related fields in nine countries, and conducted phone interviews with seventeen people in seven countries. Based upon the information collected, this paper presents the structure of the rice industry in the Western Hemisphere, production and trade trends, land use practices, and major policy and social issues that affect the industry. The implications of these data for waterbird conservation are considered and next steps and opportunities for collaboration between the conservation community and the rice industry are identified.

Brazil and the United States (US) contain nearly two-thirds of the land from which rice is harvested in the hemisphere and together produce two-thirds of all rice produced in the hemisphere. Most of the remaining rice area harvested and rice production belong to thirteen other countries that each harvest at least 0.9% of hemispheric rice area. The rice industry is characterized by a four-stage rice supply chain that includes production, processing, commercialization, and disappearance. A wide variety of companies and associations can be involved in one or all stages of rice production and the extent of industry organization is variable among countries. Upland rice and irrigated rice are the two dominant forms of cultivation in the hemisphere, with the majority of rice being upland. Rice is a high cost, input-intensive crop relative to other crops, and the vast majority of rice is produced with the use of fertilizers and pesticides. Most industries in the hemisphere are oriented toward meeting domestic demand for rice, but some, such as the US, are oriented toward rice trade. Environmental policy and conservation policy relevant to rice agriculture are rare in the hemisphere, but notable exceptions exist. Policies related to subsidies, tariffs, and other industry support mechanisms, such as the US Farm Bill, are the most important policies for the rice industry.

Important pressures on the rice industry include high production costs, foreign competition, market volatility, access to credit, intensive land use, water scarcity, free trade, and lack of intergenerational recruitment into rice farming. All these factors can have important effects on the quality and quantity of rice habitat available for waterbirds. The next steps that could be pursued by the RWWG in creating a relationship with the rice industry are outreach, mutual education, and collaboration. Important opportunities for collaboration exist, particularly at the local scale and in the areas of new management practices, financial support, sustainable hunting, ecotourism, bird-friendly rice, and green marketing.

RESÚMEN EJECUTIVO

El arroz es un alimento principal para la mitad de la población global. También sirve como hábitat importante para la fauna silvestre, especialmente para las aves acuáticas. En septiembre de 2007, el Grupo Técnico de Arroz y Aves Acuáticas (RWWG), comité ejecutivo, pidió que un grupo de estudiantes de pos-grado del programa de Desarrollo Sostenible y Biología de Conservación (CONS) de la Universidad de Maryland investigara la industria arrocera del Hemisferio Occidental con las metas de analizar tendencias económicas y sociales importantes e identificar posibles contactos en la industria arrocera para colaboraciones en el futuro. El objetivo de este proyecto fue el de capacitar al RWWG para interactuar constructivamente con miembros de la industria arrocera y colaborar con ellos en esfuerzos de conservación de aves acuáticas.

El equipo de estudiantes de pos-grado llevó a cabo revisiones de datos y literatura relevante, correspondió con más que cincuenta personas involucradas en la industria arrocera u ocupaciones relacionadas en nueve países, e hizo entrevistas telefónicas con diecisiete personas en siete países. Basado en la información recopilada, este manuscrito presenta la estructura de la industria arrocera en el Hemisferio Occidental, tendencias de producción y comercialización, prácticas de manejo de tierra, y temas políticos y sociales importantes que afectan a la industria. Las implicaciones de estos datos para la conservación de aves acuáticas han sido consideradas, así como identificados los próximos pasos y oportunidades de colaboración entre la comunidad conservacionista y la industria arrocera .

Brazil y Estados Unidos (EEUU) contienen casi dos-tercios de la tierra de la cual el arroz es cosechado en el hemisferio, y juntos producen dos-tercios de todo el arroz en el hemisferio. La mayor parte del área restante donde se cosecha y produce el arroz pertenece a trece otros paises, que cada cual cosecha por lo menos 0.9% del área arrocera hemisferica. La industria arrocera está caracterizada por una cadena productiva de arroz de cuatro partes: producción, procesamiento, comercialización, y desaparición. Una gran variedad de empresas y asociaciones pueden ser involucradas en una o todas las partes de la producción de arroz y el grado de organización industrial varía entre países. Arroz seco y arroz de riego son los modos dominantes de cultivo en el Hemisferio Occidental, la mayoría siendo cultivado como arroz seco. El arroz es un cultivo de alto costo, y la gran mayoría del arroz es producido con el uso de fertilizantes y pesticidas. La mayoría de las industrias arroceras en el hemisferio están orientadas hacia la satisfacción de la demanda doméstica de arroz, pero algunas, como en los EEUU, están orientadas hacia la comercialización. Políticas ambientales y de conservación relevantes al cultivo de arroz son escasas en el hemisferio, pero existen excepciones notables. Políticas relacionadas a subsidios, tarifas, y otros mecanismos de apoyo a la industria, como el US Farm Bill, son las políticas más importantes para la industria arrocera.

Presiones importantes para la industria arrocera incluyen altos costos de producción, la competencia de paises extranjeros, la volatilidad del mercado, el acceso al crédito, el uso intensivo de la tierra, la escasez de agua, el libre comercio, y la falta de interés e ingreso de jóvenes a la producción de arroz. Todos estos factores podrían tener efectos importantes sobre la calidad y cantidad de hábitat de arroz disponible para aves acuáticas. Los próximos pasos que podrían ser seguidos por el RWWG para establecer relaciones con la industria arrocera son la creación de lazos con la industria, educación mutua, y colaboración. Importantes oportunidades para la colaboración existen particularmente a escala local y en las áreas de nuevas prácticas de manejo, apoyo financiero, caza sostenible, ecoturismo, eco-arroz, y mercadeo verde.

1. INTRODUCTION

Rice (*Oryza spp.*) is the most consumed cereal grain in the world and is a staple food for large proportion of the human population. It can be cultivated in a variety of terrains, from flat lowlands to steep hillsides. Such man-made environments have played an extremely important role in feeding large human populations over time. Rice agrosystems can also support a wide range of biodiversity depending on how they are cultivated. They can be important habitats for organisms such as aquatic plants, fish, aquatic invertebrates, amphibians, mammals, and waterbirds.

While no strict definition is universally recognized, waterbirds is a general term used to describe a diverse group of birds that are ecologically tied to bodies of water for some part or parts of their lives. Seabirds (gulls, terns, pelicans, skimmers, cormorants, petrels, shearwaters, storm-petrels, murrelets, auklets, puffins, penguins), waterfowl (ducks, geese, swans), shorebirds (oystercatchers, stilts, plovers, sandpipers, phalaropes), and wading birds (bitterns, egrets, herons, ibises, cranes, storks, rails, coots) can all be considered waterbirds. Waterfowl, shorebirds, and wading birds are the waterbird groups that utilize rice agriculture to the greatest extent, although cormorants, gulls, and terns may also utilize rice fields to varying degrees. While natural wetland habitat is critical to the survival of many waterbirds, these habitats are suffering drastic and accelerating declines in many areas around the world. As such, rice agriculture serves as important resting and foraging habitat for waterbirds, and in some regions, is the only wetland that remains after extensive conversion of natural habitat to agriculture. Therefore, rice agriculture has become an important component of the ecology and conservation of waterbirds.

The Rice and Waterbirds Working Group (RWWG) was formed to “promote conservation of aquatic birds using habitats associated with rice cultivation, by addressing needs associated with research, identification and promotion of best management practices, and outreach” (RWWG, 2007; “Rice and Waterbirds Working Group,” 2007). As of July 2006, the RWWG steering committee was composed of professionals from six different countries in the Western Hemisphere from institutions including government entities, conservation organizations and networks, universities, and museums; these include the Canadian Wildlife Service and US Fish and Wildlife Service; the Manomet Center for Conservation Sciences, PRBO Conservation Science, the Western Hemisphere Shorebird Reserve Network, and Wetlands International; Louisiana State University, the Universidade Catolica de Pelotas - Brazil, the University of Connecticut, and the Universidad de la Habana – Cuba; and the National Museum of Costa Rica (RWWG, 2006). The goals of the RWWG are 1) to develop capacity to conserve aquatic birds using rice habitats by engaging in productive dialogue with the rice industry and other stakeholders, 2) to understand the relationship between birds and rice cultivation including dimensions that are ecological, agronomic, economic and social, 3) to develop management and policy recommendations to optimize the bird/rice relationship, and 4) to communicate and promote conservation and related marketing strategies to and with all stakeholders (“Rice and Waterbirds Working Group,” 2007).

In September 2007, the RWWG steering committee requested that a graduate student group from the University of Maryland Sustainable Development and Conservation Biology Program (CONS) research dynamics within the rice industry in the Western Hemisphere, in order to further these primary goals: to gain a better understanding of the economic, policy-related, and social factors that affect the rice industry and to effectively engage industry members, build relationships, and initiate a productive dialogue on waterbird conservation. The RWWG intends to integrate industry factors into conservation agendas and hopefully to collaborate with rice industry members on waterbird conservation, for the benefit of all parties (RWWG, 2007).

To address the objectives set forth by the RWWG, we–the graduate student research group–investigated the structure, function, and economic trends of the rice industry in the Western Hemisphere, as well as policy and social issues relevant to the industry and the conservation of waterbirds. We also investigated industry concerns and pressures, and individuals and organizations that could serve as points of contact between the rice industry and the RWWG. This was accomplished by reviewing data and literature, corresponding with more than fifty people in nine countries, and interviewing seventeen individuals from seven countries: the US, Mexico, Ecuador, Bolivia, Brazil, Argentina, and Spain. Interviewees included conservationists, government agents, company employees, industry organization leaders, and producers. Interviewees are listed in Appendix 1 and the list of interview questions is found in Appendix 2.

This paper guides the reader through an overview of the rice industry in the Western Hemisphere–including sections on production, industry structure, economics, land use, regulatory policy, and social issues–and is followed by an exploration of the pressures experienced by rice growers related to these themes. We then discuss the implications of industry trends for waterbird conservation and close with suggestions for possible next steps and opportunities for collaboration between the conservation community and the rice industry on waterbird conservation issues.

2. RICE INDUSTRY OVERVIEW

More than half the world's population depends on rice as an important food source ("IRRI homepage," 2007). In 2005, approximately 618 million metric tons (tonnes) of rice were produced on 154 million hectares throughout the world, which is equivalent to a land area slightly larger than the state of Alaska. The Western Hemisphere accounted for approximately 5.9% of global rice production and contained 5.3% of all hectares of rice harvested worldwide in 2005 (FAOSTAT database, 2007).

We investigated rice industry dynamics within and among the fifteen countries in the Western Hemisphere that had the greatest total number of hectares of rice harvested during the years 1990 through 2005. The area harvested is defined as the area from which a crop was gathered and excludes the area from which there was no harvest due to damage, failure, etc. (FAOSTAT glossary, 2007). This criterion was chosen over rice production quantity as the evaluation criterion because areas of rice cultivation can serve as surrogate wetlands for waterbirds. Hence, we made the assumption that the size of rice area harvested would be more indicative of a country's current and potential importance for waterbird conservation efforts than the amount of rice produced. (Notably, the top fifteen countries in the hemisphere in terms of quantity of rice produced between the years 1990 and 2005 are actually the same, though the rankings are different.) The Western Hemisphere's top fifteen countries in order of decreasing percentage of total hemispheric rice area harvested between the years 1990 and 2005 are: Brazil, the United States, Colombia, Ecuador, Peru, Cuba, Argentina, Venezuela, Uruguay, Bolivia, the Dominican Republic, Guyana, Panama, Mexico, and Nicaragua (FAOSTAT database, 2007).

We chose to focus on the time period from 1990 through 2005, the most recent year for which data from the United Nations Food and Agriculture Organization's FAOSTAT database is available, in order to gain a good sense of industry trends over approximately the past fifteen years. All statistics presented in this paper from this point on will be given as averages from 1990 through 2005 unless otherwise indicated.

2.1 INTRODUCTION TO RICE PRODUCTION IN THE WESTERN HEMISPHERE

2.1.1 Rice-Producing Regions and Areas Harvested

**The primary administrative territories–states, departments, and provinces–where rice is cultivated within each country are described in the following section and illustrated in Figure 1. Where information was available on the geographic distribution of rice area harvested within a country, only those administrative territories with five percent or more of a country's total rice hectares were included. All geographic information is from the Food and Agriculture Organization (FAO, 2002) unless otherwise indicated. Trends in the number of hectares of rice harvested between 1990 and 2005 are illustrated in Figures 2 and 3 and are based upon FAO statistics found in Table 1 in Appendix 3.*

Western Hemisphere Overview

Brazil and the US account for nearly two-thirds of all hectares (ha) of rice harvested in the Western Hemisphere. Colombia, Ecuador, and Peru contain between three and six percent of all hemispheric rice area harvested, while each of the remaining focus countries contain just two percent or less. We organized the rice-producing countries that were investigated into six regions: the United States, Mexico and Central America, Caribbean Islands, Northern South America, the Andes Chain, and Eastern South America.

United States

The United States (US) can be subdivided into four rice-producing regions that account for 99% of the country's rice production: 1) the Arkansas Grand Prairie, 2) the Mississippi Delta (including parts of Arkansas, Mississippi, Missouri, and Louisiana), 3) the Gulf Coast (Texas and Southwest Louisiana), and 4) the Sacramento and San Joaquin Valleys of California. The remaining 1% is mostly grown in Florida. Arkansas produces more rice than any other state and accounts for 45% of the total area of rice harvested in the country. California has the second highest production quantity and the highest yields. Louisiana is the third largest producer and has the second or third greatest number of areas harvested, depending on the year. Mississippi is the fourth largest producer (Childs & Livezey, 2006). The US has harvested an average of 1.3 million ha of rice per year since 1990 and accounts for 16.3% of all rice area harvested in the Western Hemisphere.

Mexico and Central America

Mexico harvests one of the smallest areas of rice among the fifteen countries investigated; it accounts for just 1.0% of all hemispheric rice area, with an average of 80 thousand ha harvested per year since 1990. Its primary rice-producing regions are Sinaloa and the Gulf states of Campeche, Veracruz, and Tabasco (Comité Sistema Producto Arroz, 2005; FAO, 2002).

Nicaragua also harvests a relatively small area of rice and accounts for 0.9% of hemispheric rice area harvested with an average of 70 thousand ha harvested per year. Rice is primarily grown along the Pacific Coast in the Northwest of the country in the departments of Matagalpa, Rio San Juan, Granada, Boaco, and Leon (Rivas, 2005).

Panama contains 1.3% of hemispheric rice area harvested with an average of 100 thousand ha of rice harvested per year. Rice is cultivated in every province in the country with the exception of San Blas; these are Bocas del Toro, Cocle, Colon, Chiriqui, Darien, Herrera, Los Santos, Panama, and Veraguas ("El Cultivo del Arroz en Panama," n.d.).

Caribbean Islands

In Cuba, rice is mainly produced along the western coast in the provinces of Granma, Pinar del Rio, Sancti Spiritus, Camaguey, and Matanzas. Cuba harvests 2.2% of hemispheric rice area and has averaged 170 thousand ha of rice harvested per year since 1990.

The Dominican Republic (DR) accounts for 1.5% of hemispheric rice area with an average of 110 thousand ha of rice harvested per year. Rice is mainly grown in the Yuna and Cuma River Basins.

Northern South America

In Venezuela, most rice is grown in the five states of Portuguesa, Guarico, Cojedes, Barinas, and Zulia. Venezuela harvests 2.1% of total hemispheric rice area and an average of 160 thousand ha per year.

Guyana annually harvests 1.5% of hemispheric rice area, or about 120 thousand ha of rice per year. The coastal belt is the primary rice-producing region of the country (UNEP, 2002).

Andes Chain

Colombia accounts for 5.8% of hemispheric rice area harvested, with an average of 450 thousand ha harvested per year. Rice is produced in the departments of Tolima, Casanare, Cordoba, Sucre, and Cesar.

In Ecuador, rice is produced in the Southeast near Guayaquil in the provinces of Guayas, Los Rios, and Manabi (FAO, 2002; E. David, pers. comm., November 8, 2007). Ecuador contains 4.5% of hemispheric rice area harvested and has harvested an average of 350 thousand ha per year since 1990.

Most rice production in Peru is located along the northern coast in the regions of San Martin, La Libertad, Piura, Loreto, Cajamanca, Amazonas, and Lambayeque and in the southern region of Arequipa. Peru contains 3.3% of hemispheric rice area harvested, with an average of 250 thousand ha of rice harvested per year.

In Bolivia, rice is primarily grown in the departments of Santa Cruz, Potosi, La Paz, Beni, Cochabamba, and Oruro. Bolivia accounts for 1.8% of hemispheric rice area harvested, with a yearly average of 140 thousand ha.

Eastern South America

Brazil contains nearly half of the entire rice area harvested in the Western Hemisphere (48.5%) and has harvested an average of 3.7 million ha of rice per year since 1990. Most rice is produced in the states of Rio Grande do Sul, Maranhao, Mato Grosso, Minas Gerais, Goais, and Piaui but smaller areas are harvested in other states throughout the country.

In Uruguay, rice is planted in river valleys and along the border with Brazil and Argentina, with most rice grown in the departments of Treinta y Tres, Rocha, and Cerro Largo (FAO, 2002; “A.C.A. – Exportacion arroz – Civil,” n.d.). Uruguay contains 2.0% of all hemispheric rice area harvested with an annual average of 150 thousand ha.

Argentina harvests 2.1% of hemispheric rice area with an average of 170 thousand ha of rice per year. Rice is primarily grown in the provinces of Entre Rios, Corrientes, and Santa Fe.

2.1.2 Rice Production Quantities and Yields

**The following rice production quantity and yield trends are illustrated in Figures 4, 5, and 6 and are based upon FAO statistics found in Tables 2 and 3 in Appendix 3. Production quantity figures encompass total domestic production of unprocessed or paddy rice, which includes non-commercial production and production from kitchen gardens. The FAO generally obtains yield figures by dividing the production data by the data on area harvested, as yield data are often not recorded (FAOSTAT glossary, 2007).*

Together Brazil and the US account for two thirds of all the rice produced in the Western Hemisphere, producing yearly averages of 10.2 and 8.6 million tonnes, respectively. However, Brazil harvests between two and four times as many hectares as the US, indicating relatively low rice yields in Brazil. In fact, average US rice yields per hectare have consistently doubled or tripled Brazilian yields since 1990. This may be because two thirds of total rice area in Brazil is upland rice, which produces much less per hectare than irrigated systems (MacLean et al., 2002).

While its average yields are consistently 6th to 8th highest in the hemisphere, Brazil is 10th in the world in terms of quantity of rice produced and the only country in the Western Hemisphere to rank among the top ten rice-producing countries in the world (“IRRI World Rice Statistics,” 2007). Interestingly, market demand for rice in Brazil is so high that despite being the hemisphere’s largest producer, the country still does not produce enough rice to satisfy domestic demand and must import on a regular basis (D. Guadagnin, pers. comm., November 19, 2007).

Colombia produces the third greatest quantity of rice in the hemisphere (2.1 million tonnes per year), followed by Peru (1.5 million tonnes per year), Ecuador (1.2 million tonnes per year), Uruguay (900 thousand tonnes per year), Argentina (860 thousand tonnes per year), and Venezuela (730 thousand tonnes per year). The remaining countries each produce less than 2% of all rice grown in the Western Hemisphere: DR (530 thousand tonnes per year), Cuba (490 thousand tonnes per year), Guyana (410 thousand tonnes per year), Mexico (350 thousand tonnes per year), Bolivia (290 thousand tonnes per year), Nicaragua (220 thousand tonnes per year), and Panama (220 thousand tonnes per year).

The US consistently maintains the highest rice yields in the hemisphere, with an average of 6800 kg/ha and a recent peak of 7800 kg/ha in 2004. It is closely followed by Peru and Uruguay with 6000 kg/ha and 5800 kg/ha, respectively, then by Venezuela (4600 kg/ha), Mexico (4400 kg/ha), Guyana (3500 kg/ha), Nicaragua (3200 kg/ha), and Brazil (2800 kg/ha). The remaining countries investigated maintain yields well below 1000 kg/ha and notably include Argentina, the 7th highest rice-producing nation in the hemisphere.

2.2 RICE INDUSTRY STRUCTURE

2.2.1 Supply Chains

Rice industry structure in the Western Hemisphere can vary a great deal depending on the region and country in which rice is grown and the market for which rice is produced. The importance of the rice industry from country to country can range from being “potentially the most dynamic force in the nation’s economy” in the case of Guyana (UNEP, 2002) to simply “important regionally and locally” (Childs & Livezey, 2006) in the case of the US. However, there are some basic similarities among rice supply chains that give a useful basic description of how rice gets from the field to the table.

The rice supply chain is characterized by four stages: production, processing, commercialization, and disappearance (Figure 7). Rice plants are typically seeded on farms as rice seedlings purchased from a specialized seedling grower, or less frequently by directly seeding fields. Rice plants are harvested either by manual labor or mechanized means. Mechanized harvest in which the rice grain and husk are instantaneously separated from the plant dominates in the Western Hemisphere, except on very small farms that mainly produce rice for household use and not for the larger industry. Harvesting rice from the field and separating the grain and husk from the plant constitutes the agricultural production stage of the rice supply chain. The next stage in the chain is processing. After rice in the husk, or rough rice, is harvested the rice must be milled to separate the grain of rice from the husk and make the rice fit for consumption. This is typically done at a facility specially designed for milling rice, called a mill. Milling constitutes the processing stage of the rice supply chain, and there are a variety of treatments and processes that can yield different kinds of rice at this stage. After the rice is milled, it is packaged, marketed and transported to stores and restaurants for human consumption, or is further processed for a variety of "industrial use" purposes, such as beer, cereal, snacks and pet food. Packaging, marketing, and transporting rice to buyers constitutes the commercialization or third, stage of the supply chain. The industrial use and human consumption of rice constitutes the disappearance stage of the supply chain. Specific supply chains for rice in different areas and for different markets can be extremely diverse (Figure 8), and there are hundreds of organizations involved in different sectors of the rice industry across the hemisphere.

The markets for which rice is produced also play a significant role in determining the structure of the industry and the nature of the supply chain. Rice that is destined for export may or may not be milled in the country that produced it. The US primarily exports rough, un-milled rice to Mexico; hence the main industry sectors involved in rice production for the Mexican market in the US are growers and export companies (K. Cox, pers. comm., November 15, 2007). In fact, about 43% of US exports consist of rough rice that is shipped in bulk and milled in importing countries (G. Yielding, pers. comm., October 29, 2007). However, US rice destined for export to Haiti is processed in rice mills in the US before being shipped to Haiti to be commercialized (K. McTitton, pers. comm., November 16, 2007).

The ultimate purpose of rice and its geographic destination can be used to characterize rice markets. More than half of the rice crop grown in the US is for domestic use, and of this amount, 60% of reported shipments is for direct food use. Of the remaining 40%, approximately 16% of reported domestic shipments is for use in processed foods (such as cereal, rice cakes, and package mixes), 15% is used in producing beer, 9% is used in pet foods, and a very small amount is used for seed (Childs & Livezey, 2006). Kellogg's and General Mills are major companies that purchase rice to be processed for cereal, while the largest purchaser of rice destined for beer is Anheuser-Busch (K. Cox, pers. comm., November 15, 2007). Anheuser-Busch owns a number of rice mills but also purchases rice from independent companies and grower associations. Nearly half of US rice production is destined for export, with most of this destined for direct food use by importing countries (G. Yielding, pers. comm., October 29, 2007).

The level of vertical integration–the extent to which several steps in the production and/or distribution of a product are controlled by a single entity–in the rice industry can vary greatly among different companies, countries, and regions. Growers, millers, packagers, and exporters may all be part of the same cooperative or company, or may be part of many different organizations. For example, Riceland Foods is one of the largest producers and processors of rice in the US. It is a grower-owned cooperative that mills and sells its own brand rice, or sells rice to other companies that sell it under a different private brand (K. Cox, pers. comm., November 15, 2007). In Brazil, there exist small cooperatives of growers of a variety of crops that sell their products to cooperatives of consumers in many cities (D. Guadagnin, pers. comm., November 19, 2007). The prevalence of private companies and grower associations depends on the specific sector of the industry in which they are involved, as well as the rice market and the country.

2.2.2 Industry Organizations

The extent of organization among rice farmers in different areas of the hemisphere varies greatly. (Note: the terms farmers, growers, and producers will be used interchangeably throughout this paper.) Within the US for example, growers in Louisiana are more commonly organized as independent farmers who harvest and sell their crop to a mill on their own (K. Berken, pers. comm., October 22, 2007). However, a large proportion of farmers in California are organized into farmer associations and cooperatives that share information, pool their harvests, and distribute the revenue earned from selling their rice to mills. The Farmers' Rice Cooperative is an example of a cooperative that not only incorporates farmers, but millers as well. In this organization, farmers own a share of the mill that processes their rice, which involves them in the production and processing areas of the industry (P. Buttner, pers. comm., December 14, 2007). The Arkansas Rice Growers Association is another association of growers that owns their own mills and markets rice (G. Yielding, pers. comm., October 29, 2007). Another interesting organizational type is independent Japanese rice colonies in Bolivia that produce a significant amount of the rice cultivated in that country (R. Renfrew, pers. comm., October 30, 2007). Other influential national groups that represent the US rice growers and industry are the USA Rice Federation, which represents a large proportion of rice industry in the US, and the US Rice Producers Association. The National Rice Producers Committee (Comité Nacional de Productores de Arroz) in Peru, the National Rice Growers Federation (Federación Nacional de Arroceros) in Colombia, and the Corrientes Rice Planters Association (Asociación Correntina Plantadores de Arroz) in Argentina are examples of regional and national groups in Latin America that are composed of and represent the interests of certain sectors of the rice industry. Such associations can be used to communicate with a large number of growers and people involved in the industry. While nearly every country has some sort of organization that represents or is composed of growers, millers, and other sectors of the industry, the effectiveness of these organizations in communicating with their members and their influence within the industry is highly variable.

In addition to industry associations, there is also a variety of organizations that advise farmers on growing practices and how to market their rice. While government ministries of agriculture often play an important role in supplying farmers with information and innovative management techniques, international organizations have greater influence in countries where government research and technical capacity is limited. In the US, several organizations exist that provide information for farmers, such as the United States Department of Agriculture's Cooperative Extension, and act as a hub for farmers to remain connected to the industry and to each other. The California Rice Commission represents growers and millers in California on a variety of key industry issues and participates in activities designed to promote California rice. The CRC also engages in some limited research projects. Another important industry association is the Rice Research Board, which addresses a variety of comprehensive research programs to develop new rice varieties, test pesticide products, and conduct related research (P. Buttner, pers. comm., December 14, 2007). In Latin America, farmers use the services of the national ministry of agriculture, rice-farming groups that exist within the country, and the International Center for Tropical Agriculture (Centro Internacional de Agricultura Tropical), or CIAT. These organizations contribute to the continued sustainability of the rice industry through technology transfer. Academic institutions and agricultural extension services can also play important roles in advising farmers on growing practices in certain regions, such as Brazil (D. Guadagnin, pers. comm., November 19, 2007).

2.3 RICE INDUSTRY ECONOMICS

2.3.1 Rice Trade

**The following rice export and import trends are illustrated in Figures 9 and 10 and are based upon FAO statistics found in Tables 4 and 5 in Appendix 3. Most FAO export and import data is unavailable for Cuba and the DR. Export and import quantities are given for the primary commodity, meaning unprocessed rice (FAOSTAT glossary, 2007).*

Exports

The majority of the countries in the Western Hemisphere produce rice almost exclusively for domestic use, with the exception of the US, Argentina, and Uruguay. (Brazil has also exported small quantities in recent years). The US is the largest exporter in the hemisphere and typically exceeds the average amount of rice exported by Argentina and Uruguay by a factor of thirty. US rice exports steadily climbed between 1990 and 2005, reaching a high of 2 million tonnes in 2003. In fact, despite its low share of total world rice production (2%), the US produces 12-14% of all rice traded on the global market and is the only major exporter that ships unmilled rice. The US rice industry depends on foreign markets for approximately 50% of its sales. The remainder of the US rice crop is absorbed by the domestic market and accounts for 85% of domestic rice disappearance (Childs & Livezey, 2006).

Latin America consumes about half of all US rice exports, much of which is grown in the southern US and shipped to Mexico. Exports from California are primarily sent to Japan, South Korea, and Taiwan. Other important markets for US rice are found throughout Central America and the Middle East, especially Iraq and Turkey. Second-tier markets include the Caribbean, the European Union, and Sub-Saharan Africa. Japan is the highest-valued single-country market for the US, followed by Mexico (Childs & Livezey, 2006).

Argentina and Uruguay's rice exports are primarily destined for Brazil. Smaller quantities are shipped from Argentina to Costa Rica, Paraguay, and Uruguay; from Uruguay to Argentina; and from both countries to Sub-Saharan Africa. Argentina and Uruguay compete with the US for some markets in the Western Hemisphere (Childs & Livezey, 2006; FAOSTAT agricultural trade flows map, 2007). MERCOSUR, the

Southern Common Market, is a regional trade agreement (RTA) among Brazil, Argentina, Uruguay, and Paraguay (“MERCOSUR – Portal Oficial,” n.d.) and likely facilitates rice trade within the southern South American region. While some data support the recognition of Guyana as a major rice exporter to the European Union and Caribbean markets (UNEP, 2002), FAO data do not readily support this (FAOSTAT database, 2007).

Imports

Mexico has steadily increased rice imports since the early 1990s, and is now the largest rice importer in the Western Hemisphere. Brazil has also imported large quantities of rice during this same time, with a yearly average of 260 thousand tonnes. Nicaragua has imported smaller but increasing quantities of rice in recent years, and imports to the DR, Panama, and Cuba increased in 2005. Almost all rice imported by Mexico and Central America is produced in the US (Childs & Livezey, 2006). Brazil primarily imports rice from Paraguay, Uruguay, Argentina, and the US. Nicaragua’s imports are largely from Costa Rica, Guatemala, and the US. Panama imports rice from the US, Costa Rica, Colombia, and Venezuela (FAOSTAT agricultural trade flows map, 2007). The origins of rice imported to the DR and Cuba were not available through the FAO.

2.3.2 Rice Producer Prices

**The following producer price trends are illustrated in Figure 11 and are based upon FAO statistics found in Table 6 in Appendix 3. All producer prices are in US Dollars and are for rough rice. They are calculated by multiplying producer prices in local currency times the exchange rate for the selected year (FAOSTAT glossary, 2007). The FAO’s producer price data is missing for Cuba and is for husked rice from the DR; hence the DR is omitted from the rough rice producer price graph.*

The majority of the countries investigated receive about US $185 per tonne of husked rice. Interestingly, Brazil and the US have received almost the same average amount for each tonne of rice over the years 1991 through 2005 (approximately US $150), though the US has received US $25 to US $80 more per tonne than Brazil in recent years. The prices received by producers in Brazil and the US are actually lower than the rice producer prices in at least ten other countries in the Western Hemisphere, including the DR, Panama, Venezuela, Nicaragua, Colombia, Peru, Argentina, Uruguay, Mexico, and Bolivia. Notably, Ecuador’s producer prices have risen from a low of US $6 in 1991 to US $191 2005, with a jump from US $57 to US $160 between 1999 and 2000, the year that Ecuador officially underwent dollarization.

Producer prices of milled rice from the DR are on average US $300 greater than the highest producer prices received for rough rice. However, because these prices are for a different form of the commodity, it is difficult to make meaningful comparisons with producer prices from other countries in the Western Hemisphere.

2.4 LAND USE

2.4.1 Management Practices

Rice is cultivated under a variety of systems in the Western Hemisphere. Water regime and landscape are often used to classify these systems, with the simplest classifications being flood-prone/deepwater, irrigated, rainfed lowland, and upland (Greenland, 1997). Flood-prone or deepwater rice is typically found in naturally flooding areas such as river floodplains or backswamp areas. Irrigated systems involve the diversion of water and the use of levees and canals to control water level. The rainfed lowland system is characterized by a seasonal variation in water depth and bunded fields (fields with embankments), which retain floodwaters and rainwater. Rice that is grown without the use of enclosed water and where no natural flooding occurs is defined as upland rice (Greenland, 1997).

Rice systems where water is retained within paddies for some part of the rice life cycle are important habitats for waterbirds. Irrigated rice systems are of particular importance since approximately half of global rice area harvested and three-quarters of global rice production is obtained from this type of cultivation, which is typically found in humid tropics and humid and subhumid subtropics (MacLean et al., 2002). The high yields that are obtained from irrigated systems are due in part to the high amounts of inputs, such as water, fertilizers, and pesticides that are used in this type of cultivation. Hence irrigated rice agriculture has very high energy and water demands (Greenland, 1997).

All rice in the US is produced by irrigated cultivation ("Distribution of rice crop area," n.d.) and is usually directly seeded by small machinery or by airplane (FAO, 2002). Rice is typically grown as a single crop in the four major producing regions of the US. The rice crop is sometimes ratooned, or left to regrow after it has been harvested, in the warmer areas of the Gulf Coast states (Maclean et al., 2002; G. Yielding, pers. comm., October 29, 2007).

Upland rice cultivation has more hectares under cultivation in Latin America than irrigated rice. This is due to Brazil having the highest percentage of hectares under rice production in the Western Hemisphere, 75% of which consist of upland systems, compared to 19% for irrigated systems ("Distribution of rice crop area," n.d.).

Production techniques throughout Latin America vary greatly within and among countries. Several of the selected focus countries have populations of farmers that produce rice on a small scale and whose techniques may involve slash and burn agriculture and less mechanization. Among the focus countries, rice is usually directly seeded except in Peru and Ecuador, where transplanting is the dominant method. Transplanting involves seeding rice in nursery beds and then transferring the seedlings to the paddy and is done manually. In the DR, both systems–direct seeding and transplanting–are used. Planting and harvesting times also vary among the rice-producing countries in the Western Hemisphere and largely depend on seasonal patterns of rainfall, temperature, and other climatic variables. These and other industry characteristics are reviewed in Appendix 4.

Flooding is primarily used to increase the decomposition of rice stubble and crop residue in harvested fields, as well as to control weeds and pests. A precisely leveled rice field will maintain a uniform water depth and make it easier to flood and drain the field (Sullivan, n.d.). Flooding practices have been adopted in several rice-producing regions of the US, including California and Arkansas, and serve to reduce soil erosion and provide habitat for waterfowl. Before flooding, straw may be chopped or incorporated into the soil or farmers may roll it after flooding occurs. Rice producers also may burn the straw, which is the most effective and cheapest way to dispose of rice (Hill et al., 1997). However, in California, rice straw burning is highly restricted. In Rio Grande do Sul, Brazil, farmers pump water into rice fields in winter after harvesting and use cattle to consume post-harvest crop residue (D. Guadagnin, pers. comm., November 19, 2007).

2.4.2 Chemical Inputs

Fertilizers are important inputs for the production of rice and help sustain high yields (Greenland, 1997). From 1960 to 1999, fertilizer consumption in South America increased dramatically to more than 8.6 million tonnes ("Total consumption of fertilizer," n.d.). The application of pesticides in agricultural systems such as irrigated and upland rice is also a common practice in the Western Hemisphere. Most farmers are dependent on chemical inputs to control crop pests and the extent to which pesticides adversely affect wildlife is variable throughout the Western Hemisphere. In the US, it has been noted that even with the use of pesticides, ricelands support a greater biodiversity than do most other agricultural crops (P. Buttner, pers. comm., November 15, 2007). However, waterbirds can suffer effects from some pesticides even though they are not the primary targets. For instance, monocrotophos, a popular insecticide in Bolivia that is harmful to the environment and highly toxic to people and birds (Renfrew & Saavedra, 2007), continues to be used despite its negative effects on non-target species because it is so effective against pests (D. Blanco, pers. comm., October 1, 2007). Another problem pesticide in the region is carbofuran, which has also been associated with bird mortality events (D. Blanco, pers. comm., October 1, 2007). While integrated pest management practices could be an alternative to such harmful pesticides, it may be difficult for farmers to adopt such practices because of their reluctance to give up pesticides and proven pest control techniques (D. Blanco, pers. comm., October 1, 2007).

2.4.3 Sustainable and Organic Systems

Organic rice makes up a small percentage of the total rice market (J. Hasbrook, pers. comm., November 19, 2007) but may have even greater environmental benefits than conventional rice, which already provides very valuable habitat for many species. Organic rice is produced in the province of Entre Rios in Argentina for export to the United States (Oryza News, June 6, 2007) and is being marketed in Rio Grande do Sul, Brazil (D. Guadagnin, pers. comm., November 19, 2007). In California, organic production currently makes up about 5% of the US industry (P. Buttner, pers. comm., October 15, 2007). Although less yield is obtained from organic rice production than from conventional rice production, one industry representative indicated that organic rice production is a trend and not a fad and added that there may be more potential for growth with sustainable agriculture (J. Hasbrook, pers. comm., November 16, 2007). The largest organic growers in California are SunWest Foods, Inc. and Lundberg Family Farms, who have 6,000 ha and 10,000 ha of organic rice under production, respectively (J. Hasbrook, pers. comm., November 16, 2007).

Organic production typically involves the use of natural fertilizers (e.g. plant or animal refuse) and green manures in lieu of chemical fertilizers. Leguminous green manures are a good source of nitrogen and can provide between thirty and fifty percent of the nitrogen required by high-yielding rice varieties (Sullivan, n.d.). However, as stated before, organic crops tend to have lower yields compared to conventional rice systems (J. Hasbrook, pers. comm., November 19, 2007). Profits for organic rice may be higher than those for conventional rice as organic rice is usually sold to consumers at a higher price and input costs, such as fertilizer and pesticides, are less relative to conventional rice. However, production costs for organic rice in California are similar to those for conventional rice (J. Hasbrook, pers. comm., November 16, 2007).

Challenges to organic farming include weed control, maintenance of soil fertility, and lower yields (Sullivan, n.d.). To overcome these challenges, farmers will farm rice for two to three years and then leave the land fallow or plant a dry crop such as wheat. Other options include extending the rotation from a two-year cycle of rice/soybean to a rice/soybean/grain crop in order to reduce the amount of weed seeds in the soil and to break weed life cycles. Flooding of fields is another effective weed control technique.

2.4.4 Water Use

Water is a vital requirement for rice production. The quantity of water needed to produce rice is greater than for any other major crop (Greenland, 1997). Irrigated systems use 70% of the world's freshwater depletions (Hundertmark & Facon, 2003). In fact, it takes between 5 million to 7.5 million liters of water to produce one ton of rice, which is equivalent to two to three Olympic-size swimming pools (MacLean et al., 2002). However, the precise quantity of water utilized for rice production depends on soil drainage characteristics, crop duration, landscape, weather, and water management practices employed (Greenland, 1997).

The two major water sources for rice production are groundwater and surface water (Greenland, 1997). Water is often pumped from wells, which adds greatly to production costs. Some farmers construct their own water reservoirs ("Arroz en Uruguay," n.d.), which decreases the risk of running out of water due to low rainfall (Greenland, 1997). The area covered by water, and not the volume of water used, is the typical measurement unit in systems where water use is charged. (Solh, 2003).

2.5 POLICY

This section describes policies adopted by the selected focus countries in the Western Hemisphere with regard to orientation of industries, industry protections, environmental policy, and conservation incentive policy. In areas where formal laws for certain issues do not exist, are little known, or are not adequately enforced, some general practices are discussed.

2.5.1 Orientation of Industries

There are three primary production and trade policy orientations of rice industries in the Western Hemisphere: domestic consumption, trade, and import. The majority of national rice industries in the hemisphere are oriented toward meeting domestic demand, in that most activity revolves around the cultivation, processing, and commercialization of domestically produced rice to satisfy domestic consumption needs. For example, rice agriculture in Bolivia is oriented toward food security; the most important thing is that rice is cultivated and there is enough for domestic consumers (M. Guzmán, pers. comm., November 6, 2007). However, some international trade of rice can occur in such countries, though not all of it is authorized. In Ecuador for example, the government has closed its northern border with Colombia to rice trade in order to stem the illegal export of rice (E. David, pers. comm., November 8, 2007). In other countries, maintaining high levels of rice trade is an important component of production policy.

One example of a trade-oriented rice industry is the US, which not only meets domestic demand for rice, but also sells significant amounts of rice to foreign countries. The US rice industry depends on foreign markets for approximately 50% of its sales (Childs & Livezey, 2006) and is an active promoter of US rice interests around the world. Some countries in the Western Hemisphere that buy large amounts of foreign rice, and thus have adopted an import-oriented rice policy, also have domestic rice industries that are in decline. Rice industries in Mexico and Nicaragua do not produce enough rice to meet domestic demand, and as such have adopted the policy of importing large amounts of rice from the US. Over the past few decades Mexico has experienced a decline in domestic rice production, area harvested, number of mills, and number of rice farmers (Comité Sistema Producto Arroz, 2005). The Nicaraguan rice industry fears that it will suffer a decline like that of Mexico, due to the free trade policies that the Nicaraguan government is adopting. Both countries have entered into free trade agreements (FTAs) with the US; Mexico joined the North American Free Trade Agreement (NAFTA) with Canada and the US less than two decades ago, and Nicaragua just recently entered into the Central American-Dominican Republic Free Trade Agreement (CAFTA-DR) with the US, the DR, Guatemala, Honduras, El Salvador, and Costa Rica. Free trade policies typically reduce subsidies, tariffs, and other protections for domestic agricultural industries, which causes a great deal of concern for rice industries in certain countries.

2.5.2 Industry Protection Policy

Rice is one of the most protected commodities in the world in terms of subsidies, tariffs, and other international trade barriers (Griswold, 2006; K. McTitton, pers. comm., November 16, 2007). The dependence of many Asian countries on rice as a vital component of their food security has led to strong protection of domestic rice production capacity in these countries. However, no country in the Western Hemisphere offers such strong protection to their rice industries, and the level of protection given to national industries in the Western Hemisphere is extremely variable with regard to subsidies and tariffs.

The US is the most wealthy and industrialized rice-producing country in the hemisphere. Rice farming is a large-scale, high-cost operation relative to other crops produced in the

US (Figure 12). As such, rice is one of the most heavily subsidized products in agriculture in comparison to other crops, and a significant share of rice farmers' revenue comes from subsides (Childs & Livezey, 2006). Since 1998, direct subsidies to the rice industry have totaled about US $1 billion, with an estimated average of US $700 million a year projected until 2015 (Griswold, 2006). Rice commodity program benefits in the US fall into three categories: direct payments to growers, countercyclical payments made when rice prices fall below a designated target price, and marketing loans. Subsidy policy is made under the US Farm Bill, a piece of legislation decided upon every six years in Congress that details US agricultural policy and support to farmers. Both growers and industry representatives are deeply involved in the crafting of this legislation, and maintain that the US Farm Bill is the single most important piece of legislation to the rice industry (G. Yielding, pers. comm., October 29, 2007; P. Buttner, pers. comm., October 15, 2007; R. Langley, pers. comm., November 27, 2007). The next US Farm Bill is currently (i.e. as of December 2007) being revised and debated upon by the US Congress, and various agricultural interest groups are lobbying lawmakers for protection and support for their particular crop and agricultural business. While the US rice industry seems to be pleased with the bill in its current form, if several proposed measures that limit the amount of support farms can receive are incorporated, it will pose a significant problem for the industry (R. Langley, pers. comm., November 27, 2007). The US rice industry contends that Farm Bill safety nets are absolutely vital to ensure a reliable food supply to domestic consumers and to allow farmers to stay in business while facing high production costs and competition from low-cost, high quality Asian rice imported to the US with no tariffs. (K. Berken, pers. comm., October 22, 2007). This sentiment is nicely summed up by a Louisiana rice farmer who stated, "Without subsidies, we don't farm" (K. Berken, pers. comm., October 22, 2007). Even with a relatively healthy industry and the highest subsidies and government support in the hemisphere, rice farmers in the US still work in a precarious business, and many Louisiana farmers have gone out of business (J. Durand, pers. comm., November 14, 2007).

In other parts of the hemisphere rice farmers and the industry in general receive relatively small amounts of support, if any at all. An important part of the government support that rice producers receive is technical advice and capacity building from agricultural extension services. In many countries, such as Mexico and Ecuador, agricultural inputs such as fertilizer and pesticides are subsidized by the government to varying degrees (E. David, pers. comm., November 8, 2007). In Brazil, if the domestic price of rice and other agricultural products (e.g. soybeans, wheat, and cattle) falls below a certain minimum price, the government buys up rice at the minimum price and then sells it on the market (D. Guadagnin, pers. comm., November 19, 2007). In Mexico, while the Procampo program is designed to give some form of direct support to agriculture, rice growers contend that subsidies only benefit rice millers and processors and not growers and that the current level of support given by the government is grossly inadequate (Comité Sistema Producto Arroz, 2005).

It is important to note that rice industries in countries that have signed free trade agreements with the US typically see industry protections disappear. Under NAFTA

(1994) provisions, Mexico currently has no tariffs on imported rice, and Nicaragua and the Dominican Republic will have to reduce their tariff protections to nothing over the next ten to twenty years under DR-CAFTA. Rice industries that must compete with US rice often see the high subsidies given to the US rice industry as unfair, in that they allow the US to sell rice at prices below its cost of production, prices with which domestic growers in Latin America cannot compete (Rosen, May 2, 2005). In turn, the entire Western Hemisphere faces similar pressures from highly-protected Asian rice industries.

2.5.3 Environmental Policy

Air Quality
While burning is the most efficient way for farmers to dispose of rice residue after harvest, this process also causes air pollution and health problems (E. David, pers. comm., November 8, 2007). Rice straw burning is so extensive in Arkansas that wrecks have been caused on highways due to smoke from rice fields (G. Yielding, pers. comm., October 29, 2007). Despite the negative effects of burning on air quality and safety, there seem to be few regulations against burning or that mandate alternative practices to straw disposal in the Western Hemisphere. In some areas, such as the southern US, many growers maintain that straw cannot be effectively broken down by flooding alone and that other practices are required (G. Yielding, pers. comm., October 29, 2007).

California appears to be the only rice-producing area with specific air quality guidelines regarding disposal of rice crop residues. The Rice Straw Burning Act of 1991 required a phase-down of the number of rice acres subjected to burning, forcing farmers to find alternative methods of rice straw disposal. As of 2001, only 25% of all planted rice acreage in California could be burned, and presently only about 12% of rice is actually burned. This has caused many farmers to rely on winter flooding to dispose of crop residues, despite the relatively high cost of incorporating stubble into the soil with flooding (US $45/acre) (P. Buttner, pers. comm., October 15, 2007) in relation to the cost of burning. Policies that encourage alternative uses of rice crop residue, such as using straw as cattle feed in Ecuador and for building material in both Arkansas and Ecuador (G. Yielding, pers. comm., October 29, 2007; E. David, pers. comm., November 8, 2007), may also affect air quality by reducing the amount of residue that is burned.

Pesticides
The extent to which pesticides are regulated in the Western Hemisphere is variable. Some countries have lists of permitted and restricted pesticides**,** such as the US, where the Environmental Protection Agency (EPA) and individual states are authorized to regulate pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and under state laws, usually through state agricultural extension services ("Laws and Regulations," 2007). The pesticide monocrotophos, which was associated with serious bird mortality in Argentina in the late 1990s, has now been banned in Argentina, Uruguay, and the US (Kegley et al., 2007; Fernandez, 2003). However, as previously discussed, rice farmers in Bolivia still use monocrotophos, and while these

farmers might like to switch to a less harmful option, they find that many alternatives are too expensive and too risky to be adopted (R. Renfrew, pers comm., October 30, 2007).

Genetically Modified Rice

Formal regulation of genetically modified (GMO) rice in the Western Hemisphere is variable**.** However, most rice industries seem to be reluctant to commercially produce GMOs for fear of losing export markets due to the fact that consumers still do not widely accept GMO rice (K. McTitton, pers. comm., November 16, 2007). In 2006, trace amounts of "Liberty Link" LL601 GMO rice were detected in the US rice supply in the southern US (Childs & Livezey, 2006). This led to the loss of the European Union rice market and a Japanese ban on southern US long grain rice, despite the fact that Japan imported very little rice from the southern US. The incident also prompted Mexico to briefly halt US rice imports because such rice was not listed as safe for human consumption under the Biosecurity and Genetically Modified Organisms Law (Ley de Bioseguridad de Organismos Genéticamente Modificados) (Balboa, March 16, 2007). While GMO rice continues to be a concern for many countries, it is unlikely that it will be widely produced without greater acceptance of GMO foods. While the World Trade Organization (WTO) recently ruled against moratoriums on GMO foods by the European Union, there is debate on whether this will bring about any change in policy since European consumers, farmers, and an increasing number of governments remain generally opposed to GMO foods (Thomas, February 8, 2006).

2.5.4 Conservation Incentive Policy

Formal biodiversity conservation programs on agricultural land seem to be rare or little known in the Western Hemisphere. However, a few programs exist in the US that may be particularly relevant policies for conservation in rice agriculture. The Wetlands Reserve Program (WRP) promotes the conservation and restoration of wildlife habitat in the US by paying farmers to retire marginal cropland and put it under conservation easement to manage or restore the land for the benefit of wildlife. Conservation organizations and farmers consider this program to be extremely successful and extremely valuable for the Mississippi Flyway and the Prairie Pothole region of North America, where about 230 thousand acres are currently enrolled in the WRP (Ducks Unlimited, 2007). However, the National Resources Conservation Service (NRCS) of the USDA, which administers the program, recently modified how lands enrolled in the program are appraised. WRP advocates maintain that a revision of land appraisal processes and increased technical and financial assistance under the currently debated 2008 US Farm Bill are critical for the continued success of the program. The closely related Conservation Reserve Program (CRP) is in a similarly delicate situation. Another important conservation program administered by the NRCS is the Conservation Security Program (CSP), which uses financial and technical assistance services similar to those of the WRP to conserve natural resources on agricultural land ("Conservation Security Program," 2007).

Informally, rice agriculture is recognized by many in the rice industry as valuable habitat for a variety of wildlife (P. Buttner, pers. comm., October 15, 2007; K. Berken, pers. comm., October 22, 2007). In some areas the widespread destruction of natural wetlands has made rice fields the most important habitat for species such as waterbirds, and many rice growers actively encourage certain types of wildlife in their fields. However, it must be noted that while rice fields can serve as important surrogate habitat to natural wetlands, the expansion of rice agriculture can be a significant cause of biodiversity decline, as in the natural wetlands of Uruguay and the Brazilian Amazon (D. Guadagnin, November 19, 2007; "Uruguay Rice Exports and the Environment," 2007).

2.6 SOCIAL FACTORS

2.6.1 Mechanization and Labor

The rice industry is an important source of employment at all scales of production. Rice is the main source of employment, energy, and income for about one million farmers in Latin America and the Caribbean (MacLean et al., 2002). In Nicaragua alone, 75 thousand jobs are created each year because of rice activity, generating US $80 million (FAO, 2006). Those involved in the rice industry include both producers and workers employed in the post-harvest process, such as threshing and milling (FAO, 2003).

Several factors influence the number of laborers employed in the industry, including the extent of mechanization, management techniques, and holding size. Rice production in the US is highly mechanized and requires few laborers to manage production. For example, in Louisiana three people are able to work a holding of approximately 607 ha, or 1500 acres (K. Berken, pers. comm., October 22, 2007). Although the level of mechanization varies throughout the countries of Latin America and the Caribbean, on the larger farms in the region, rice cultivation is predominantly mechanized (MacLean et al., 2002). Uruguay has a highly mechanized industry. On average most holdings range from 200 to 300 ha and one person can work every thirty-three hectares of crop ("Arroz en Uruguay," n.d.). Other highly mechanized countries include Argentina, Guyana, Brazil, and Colombia. However, in the latter two countries, the use of traditional manual techniques remains part of their industries. In Peru, the average farm size is approximately 5 ha and manual transplanting is the most common planting system, which allows eighty to one hundred day-wages to be involved in the process and illustrates the significant social and economic value of rice cultivation (FAO, 2006).

2.6.2 Land Tenure

In the US, land cultivated for rice is often rented. In southern Louisiana, this is a common practice (K. Berken, pers. comm., October 22, 2007; P. Rauser, pers. comm., November 16, 2007). In Bolivia and Ecuador, the land is typically owned and worked by the family (M. Guzmán, pers. comm., November 6, 2007; E. David, pers. comm., November 8, 2007). In Brazil, landowners with large holdings often hire managers to run their fields and remain in the city (D. Guadagnin, pers. comm., November 19, 2007). As of 2002, the Cuban government had been allowing private production on farms previously owned by the state (Pulver, 2003).

2.6.3 Knowledge Transfer

The scientific community helped contribute to the Green Revolution that took place between the mid 1960s and the early 1990s. The revolution encompassed the use of modern rice varieties, pesticides, fertilizers, and an increased use of water for irrigation (Greenland, 1997; MacLean et al., 2002). Total rice production increased substantially during this period, almost doubling. The scientific community and rice research are therefore important to the viability of the rice industry, as are the accessibility and facilitation of the exchange of information. As described previously in the industry organization section, farmers use government and non-government agricultural entities for information sharing and expert advise on rice practices, as well as farmers' organizations for networking and voicing concerns over industry-related issues. Furthermore, technology transfer is important to promote more efficient practices to farmers (Solh, 2003).

Several rice producer associations in Latin America are organized into the Latin America Fund for Irrigated Rice (FLAR). FLAR promotes collaboration between organizations on an international scale and addresses the concerns of farmers. Therefore, it is an important hub for communication (Solh, 2003).

3. RICE INDUSTRY PRESSURES

3.1 ECONOMIC PRESSURES

The primary economic pressures faced by the rice industry in the Western Hemisphere are high productions costs, market competition with Asia, and volatility in markets for exports. In some regions, the opportunity cost of using land for rice production and obtaining credit create additional pressures. These will each be described in turn.

3.1.1 Production Costs

Rice is one of the most expensive crops to grow and requires high levels of inputs, such as fuel, water, and nitrogen fertilizer (Childs & Livezey, 2006; R. Langley, pers. comm., November 27, 2007). Highly mechanized farms can have costs of production that include rent, machinery, parts and repairs, plane rentals, freight and trucking, electricity and gas, fuel and oil, fertilizer, chemicals (pesticides and herbicides), hardware and supplies, office supplies, payroll, insurance, and professional fees (P. Rauser, pers. comm., November 16, 2007). In Arkansas, the cost for fuel, fertilizer, and rent on a typical rice farm is about US $500 per acre (G. Yielding, pers. comm., October 29, 2007). The biggest production costs are driven by the rising price of fuel, which is used to pump groundwater for irrigation, power farm machinery and vehicles, manufacture fertilizer, and ship the crop to market destinations (Childs & Livezey, 2006; P. Rauser, pers. comm., November 16, 2007; G. Yielding, pers. comm., October 29, 2007). One producer from Louisiana cited fertilizer as his highest production cost but said that all inputs were more expensive this past year (J. Durand, pers. comm., November 14, 2007). In Brazil, royalties paid to companies for use of GMOs are an additional production cost for rice producers. However, there is also a growing industry producing energy from rice husks in Brazil (D. Guadagnin, pers. comm., November 19, 2007), which may be able to offset some production costs.

3.1.2 Foreign Competition and Market Volatility

The large quantities of low price rice from Asian countries like Thailand, the largest rice-exporter in the world, and Vietnam, India, and Pakistan create strong pressures on exports from the Western Hemisphere ((Childs & Livezey, 2006; K. Berken, pers. comm., October 22, 2007; J. Durand, pers. comm., November 14, 2007). Even low-export countries in the Western Hemisphere, such as Ecuador, cited the price of rice on the international market as an economic pressure (E. David, pers. comm., November 8, 2007). Competition from Asia has increased in the past decade as Thailand and India have improved the quality of their export product (Childs & Livezey, 2006). This has made US rice producers price takers on the world market, not price makers, though California is able to move prices a little more than in the southern US because of differential demand for the rice varieties produced in California (P. Buttner, pers. comm., October 15, 2007). Additionally, the US government is able to protect domestic rice producers from many negative effects of low prices of foreign rice on the world market by subsidizing the production of rice through the Farm Bill (K. Berken, pers. comm., October 22, 2007; P. Rauser, pers. comm., November 16, 2007).

However, the low price of Asian rice still creates volatility in foreign markets, which puts additional pressure on exporters from the Western Hemisphere (J. Durand, pers. comm., November 14, 2007). For example, since 1994 the US has been losing market share in South Africa and the Middle East, primarily in Saudi Arabia, due to competition from India and Thailand (Childs & Livezey, 2006).

3.1.3 Opportunity Costs

In some areas, the opportunity cost of using land for rice production, rather than for alternate uses, puts economic pressure on rice producers. This is particularly the case in California, where residential and commercial development drive high prices for land. Revenues from rice production on a given hectare of land cannot compete with the land's actual value on the real estate market (P. Buttner, pers. comm., October 15, 2007), thus farmers operate at a net economic loss. Some parts of southern Louisiana and Texas are facing this problem as well (R. Langley, pers. comm., November 27, 2007), and a similar situation is occurring in one unique area of Ecuador, close to the coastal city of Guayaquil in the province of Guayas; in San Camonton, the construction of houses has driven the price of a hectare of land from five thousand to thirteen thousand US dollars. As a result of the high prices, some rice farmers are selling their land (E. David, pers. comm., November 8, 2007).

Higher profits for substitute commodity goods can also create opportunity costs for rice production. In southern Louisiana, growing sugarcane can be more profitable than growing rice. However, most of the land used for rice production in this region is not actually suitable for sugarcane (J. Durand, pers. comm., November 14, 2007). Higher profits from growing soybeans were also cited as creating an opportunity cost for producing rice. and one farmer foresaw a potential substitution of rice for soybean production if soybean prices remain high and rice prices low (J. Durand, pers. comm., November 14, 2007). The biofuel boom, which is driving the high price of corn to produce ethanol, creates an additional pressure on rice production, as rice producers may switch to growing corn (P. Buttner, pers. comm., October 15, 2007; G. Yielding, pers. comm., October 29, 2007; R. Langley, pers. comm., November 27, 2007). For example, one producer in Arkansas reduced his rice production from 3000 acres to 75 acres, in order to take advantage of the high corn prices (G. Yielding, pers. comm., October 29, 2007). Limitations to switching crop production will be discussed in a future section.

3.1.4 Credit
Credit and obtaining the funds necessary to produce rice each year put additional economic pressures on many rice growers in Latin America. In Ecuador, rice farmers who have no resources or collateral and cannot obtain bank loans at a twelve percent APR are forced to borrow money from *chulqueros*, financiers with the available liquidity, who charge an average *monthly* interest rate of ten percent. These rice farmers thus wind up paying the majority of their salaries to the *chulqueros* (E. David, pers. comm., November 8, 2007). In Bolivia, it is also difficult for farmers to obtain loans at interest rates less than thirty percent. One option is to request credit from the millers, who will lend money at lower interest rates of sixteen and seventeen percent (M. Guzmán, pers. comm., November 6, 2007). The difficulties of finding loans and credit options with low interest rates are not unique to Latin America as one farmer in southern Louisiana cited obtaining financing as a barrier to the younger generation becoming farmers (P. Rauser, pers. comm., November 25, 2007).

3.2 LAND USE PRESSURES

3.2.1 Land Conversion and Substitute Crops
Land modifications are necessary to produce rice. Wetlands have been converted to rice-producing fields throughout the world (Van Tran, 1998). In California, 95% of historic wetlands have been removed, and it is important to note that not all of the loss is attributable to agricultural development. However, rice area expansion is limited by land and water resources (Solh, 2003), and over the last few decades increasing yields have meant an increase in rice production with only a slight expansion of rice-producing land (Greenland, 1997). The use of semi-dwarf rice varieties that are high yielding, which were promoted by the scientific community, have contributed to the increasing rice production that is seen in many countries (Greenland, 1997). Irrigated rice production is also increasing and upland rice production is decreasing in Brazil (FAO, 2006). Therefore, more land will be converted to accommodate irrigation systems and, thus, more water will be needed.

In many areas, crop rotation–i.e. periodically switching rice cultivation with the cultivation of another crop–is a common practice to rejuvenate soil and control weeds and pests (J. C. Cirera, pers. comm., October, 26, 2007; G. Yielding, pers. comm., October 29, 2007). However, increased interest in growing crops for the biofuels market and low prices for rice has caused a more permanent shift in crop cultivation in parts of Latin America and the Caribbean, where farmers are reducing their rice fields by 15% to plant crops like corn and sugarcane (Oryza News, April 11, 2007). In Ecuador, there have been increased shifts away from rice to the production of corn and sugarcane for biofuels (E. David, pers. comm., November 8, 2007), and plans for increased sugarcane cultivation for ethanol are being drawn up in Bolivia (M. Guzmán, pers. comm., November 6, 2007). While biofuels have not had large effects on rice cultivation in the US to date, farmers in Louisiana have begun planting more biofuel crops to take advantage of the higher prices they currently command (K. Berken, pers. comm., October 22, 2007). The US Farm Bill currently being considered by Congress contains a number of programs and incentives to promote biofuels, especially ethanol. Improved cellulosic ethanol technology may allow rice stubble to be utilized as biofuel in the future (R. Langley, pers. comm., November 27, 2007).

As noted previously, farmers are not only substituting rice production for corn and sugarcane cultivation, but are also switching to soybean production in areas with the proper soil, when soybean prices are higher than rice (J. Durand, pers. comm., November 14, 2007). In Mexico, rice areas have been lost as farmers have switched from rice production to the cultivation of more profitable vegetable crops (Pulver, 2003).

However, switching to another crop is not always feasible for rice farmers. Investments in specialized equipment may make the switch cost-prohibitive. The option to produce an alternative crop is also limited by regional soil type and climate (Childs & Livezey, 2006). The clay-like soil of many California rice-producing areas does not allow for any other crop to be cultivated except for rice (P. Buttner, pers. comm., October 15, 2007).

3.2.2 Water Use

As water becomes increasingly scarce, concern over the quantity and quality of water used in rice production systems will also increase. Specific concerns include the increasing costs of expanding water storage/distribution systems; the siltation of reservoirs and canals, which has caused existing systems to become degraded; rising water tables that cause waterlogging; and decreasing water tables where pumps are used in irrigation systems (Greenland, 1997).

Cuba, the DR, Mexico, and Peru have limited irrigation water supplies (MacLean et al., 2002). Cuba’s production has been limited because of water shortages, which decrease the potential to expand the cultivation area (Pulver, 2003). However, water scarcity does not seem to be affecting rice production in most of the focus countries in Latin America, as yields remain steady. The source of water can be a concern if it is being directed away from wetland habitats. In Uruguay, rivers and marshlands are the main sources of water for irrigated systems, which has contributed to changing the biodiversity in these regions (“Uruguay Rice Exports and the Environment,” 1997).

Water demand from urban and industrial users competes with crop production and decreases the availability of water for rice cultivation (Greenland, 1997). In California, decreasing water supplies have led to restrictions that include limited water access for rice farmers with “junior” water rights (P. Buttner, pers. comm., October 15, 2007). Also in California, district water boards may establish a water market whereby water can be sold for agricultural purposes. Instead of producing rice, farmers will sell water because higher profits can be made compared to rice production, leaving some rice fields unflooded (J. Hasbrook, pers. comm., November 16, 2007). On the other hand, water scarcity is not a problem in Arkansas (G. Yielding, pers. comm., October 29, 2007).

Poor drainage is associated with waterlogging, toxicity, water pollution, and salinization. Salinization is caused by salt water entering the fields from the sea in coastal regions, through soil capillary action that pumps saline water, and by evaporation that has occurred too quickly, leaving a layer of salt on the surface of the soil (Van Tran, 1998). Hurricanes Katrina and Rita caused salt intrusion problems for producers in southern Louisiana in 2005 (K. Berken, pers. comm., October 22, 2007; P. Rauser, pers. comm., November 16, 2007).

3.2.3 Inputs

Large quantities of pesticides and fertilizer can change soil and water quality over time (Van Tran, 1998). Continued cropping depletes soil nutrients, therefore, increasing quantities of fertilizer will be needed to sustain rice yields (Greenland, 1997).

3.2.4 Global Climate Change

Rice production can contribute to climate change, as the submerged soils that result from irrigated systems create an anaerobic environment that produces methane. Methane is a greenhouse gas, second in importance to carbon dioxide (CO_2), and is produced by rice fields, of which irrigated systems are the biggest contributor (MacLean et al., 2002). During the past two hundred years, concentrations of methane have more than doubled. However, the amount of methane produced by rice agriculture is highly dependent on the type of management practices utilized.

Rice production can also be affected by climate change. Increasing CO_2 concentrations in the atmosphere may be beneficial for rice plants and cause an increase in rice yields (Greenland, 1997). However, increasing temperatures in certain regions of the world due global climate change means that rice varieties will be needed that will be able to survive under these changing conditions. Temperature increases may cause any benefits gained from the increased CO_2 levels to be lost, as higher temperatures shorten the rice plant's growing period (MacLean et al., 2002). Furthermore, the predicted global sea-level rise may be detrimental to farmers located in coastal zones, such as in the coastal belt of Guyana, as salt-water intrusion and salinization could potentially occur. Rising groundwater and floodwater levels could possibly damage rice crops (Greenland, 1997).

While interviewees did not cite climate change as a major concern, its effects may already be apparent. In past years, farmers seeded their rice crops in October in Santa Cruz, Bolivia. Now they plant in November and December because of changing climatic conditions (M. Guzmán, pers. comm., November 6, 2007). According to Óscar Rodríguez (pers. comm., November 19, 2007), the dry season in Veracruz, Mexico is more prolonged than in previous years, which has affected water levels and production, especially as production in that area is dependent upon rain. In Guayaquil, Ecuador, an extension agent noted that temperatures are warmer than in the past (E. David, pers. comm., November 8, 2007).

3.3 POLICY PRESSURES

As an increasing number of governments and international financial institutions have embraced free trade over the last few decades as a way to alleviate poverty and promote development, there has been a strong drive to relax and even eliminate barriers to the international flow of goods. The reduction and elimination of import tariffs, decreasing government subsidies to certain sectors of the economy, eliminating government involvement in the free market, and setting of import and export quotas for countries are just a few of the many neoliberal economic reforms that have been promoted by institutions such as the WTO, as well as national governments such as the US. Bilateral trade treaties, such as those the US has signed with Peru and Chile, along with regional free trade agreements such as NAFTA and CAFTA-DR are examples of trade policies that can have important effects on rice production in the Western Hemisphere.

While the effects of the free trade agreements (FTAs) that have been established in the Western Hemisphere are varied and complex, the general position of those involved in the agricultural sectors of Latin America is that FTAs established with the US harm Latin American farmers by opening up national markets to relatively cheap, abundant products from the US and reducing protections for domestic producers. For example, tariffs will be immediately eliminated on approximately 80% of US exports to participating countries under CAFTA-DR, with all tariffs being eliminated after ten to twenty years (US Chamber of Commerce, n.d.). However, the US rice industry will continue to receive substantial support for the US government. Some contend that the amount of subsidies given to US rice every year may be greater than Nicaragua's entire national budget (Rosen, May 2, 2005). Given the relatively large amount of US agricultural subsidies, high degree of mechanization, and readily available technical expertise, many people involved in agriculture in Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and the DR are worried that cheap US imports will have a negative effect on their livelihoods. Similarly, rice farmers in the US contend that high subsidies for rice and tariffs in Asian countries and the open nature of the US economy make high subsidies for US rice essential to the survival of their industry.

Nearly fifteen years have passed since Mexico joined the US and Canada as a member of NAFTA. A few years prior to Mexico joining NAFTA, the country ceased to be a self-sufficient producer of rice, and began importing rice primarily from the United States ("Disminuye producción nacional de arroz," February 3, 2004). Since then, rice production, harvest area, and even the number of rice farmers has steadily declined in Mexico, while the amount of rice imported from the US has skyrocketed. In 1998 there were 14,500 rice producers enrolled in the Federación Nacional de Productores de Arroz (FENAPARROZ), the year in which it was created. By 2004, 5,600 producers remained (Comité Sistema Producto Arroz, 2005). Mexican farmers credit the decline of their industry to the increasing availability of Asiatic rice, the signing of NAFTA and the opening of Mexico to US rice, and the inattention and lack of support of the Mexican government. By 2003 protective tariffs on imports of most farm goods completely disappeared in Mexico, and currently, Mexico has no tariffs for rice.

It is difficult to determine the direct effect FTAs have on rice production. A number of factors may be responsible for declines in rice production in a given country, such as insufficient government support, inadequate technical capacity, or FTAs that eliminate industry protections such as tariffs and subsides, all of which undoubtedly have a significant effect on rice industries. While only in its infant stages, rice farmers in Nicaragua have already voiced vigorous opposition to CAFTA-DR and support immediate withdrawal from the treaty (Olivares, 2004). Rice farmers from the DR have joined their Nicaraguan counterparts in Washington, DC to protest against CAFTA-DR, even though they benefit from modern irrigation, multiple annual harvests, and a higher level of productivity than farmers in Nicaragua (Rosen, May 2, 2005). They argue that the subsidies that US rice farmers receive make trade unfair and grossly distort the price of US rice. As time passes and more CAFTA-DR provisions take effect, the treaty's impact on rice production in their countries will increase. According to CAFTA-DR provisions, tariffs pertaining to rice agriculture in participating countries will be reduced every year until they are completely eliminated in seventeen to twenty years ("Central American-Dominican Republic," March, 2005).

Free trade agreements can cause major changes in a country's economy. While they are large-scale occurrences, they have real effects on small businesses, especially on small farmers. It seems that while the US rice industry will benefit from increasing free trade (Childs & Livezey, 2006 ;K. McTitton , pers. comm., November 16, 2007), rice cultivation in the rest of the hemisphere may be negatively impacted. Free trade agreements are an important element to consider in terms of the challenges and concerns people involved in the rice industry must face.

3.4 SOCIAL PRESSURES

3.4.1 Mechanization and Labor

As rice production becomes increasingly mechanized and commercialized, fewer laborers will be needed. Farmers who are solely dependent on rice production for income will, therefore, be affected. A status change in the rice farming culture is predicted to occur such that the social value of rice will decline (Greenland, 1997).

In the southern US, farmers who rent the land on which they produce rice are hesitant to invest capital for possible long-term improvements on productivity (MacLean et al., 2002). Therefore, land tenure may affect decisions regarding rice management practices.

3.4.2 Intergenerational Recruitment

The economically active population in agriculture–defined as the number of employed and unemployed individuals seeking work in agriculture, fishing, forestry, or hunting and also known as the agricultural labor force (FAOSTAT glossary, 2007)–has changed considerably within several countries in North, Central, and South America. Of the selected focus countries, the agricultural labor force has increased only in Bolivia and Peru. Of the thirteen remaining countries that we investigated, agricultural labor forces have either decreased or remained, for the most part, similar since 1990 (FAOSTAT

Database, 2007).

The decreases in rice prices on the world market over the last several decades, which were caused in part by technical improvements, affected the livelihoods of small farmers by creating a lack of confidence in food security and by motivating migration from rural to urban settings (FAO, 2003). This trend of decreasing market prices and resulting migration may possibly explain why the agriculture labor force is loosing workers in some of the selected focus countries.

The advancing age of farmers raises the concern for a potential mass exodus of farmers from the agricultural sector in the near future and underscores the need to recruit younger farmers to take their place (Hoppe et al., 2007). In Ecuador, such a mass exit of farmers is predicted to happen in the next few years (E. David, pers. comm., November 8, 2007). The lack of continued participation in the rice industry by younger generations could mean a significant decrease in rice production.

4. IMPLICATIONS

The industry structure, economic trends, management practices, policies, social issues, and pressures faced by the rice industry and its participants in the fifteen countries highlighted provide valuable insights and implications for the continued conservation and protection of waterbirds in the Western Hemisphere. Because the rice industry plays such an important role in providing surrogate wetland habitats for waterbirds, an understanding of and support for the industry by the RWWG and other conservation practitioners is essential if a mutually beneficial relationship is to be established. The enormity of the number of hectares that are under rice production in the Western Hemisphere, over 8 million ha (FAOSTAT, 2007), suggests that the effects of trends and practices within the rice industry on the numerous waterbird species that utilize rice fields during their life cycles are not insignificant.

In general, the rice industry’s view of waterbirds is positive or neutral, although local instances of conflict may occur. Any pressures felt by industry that might reduce areas of rice production could cause a reduction in the amount of available waterbird rice habitat, and any trends that might increase the area of rice production could cause an increase in the amount of rice habitat available for waterbirds. Trends in rice-producing areas within the US and Brazil will be particularly important, because these two countries account for two thirds of all rice area harvested in the Western Hemisphere. Planting and harvest times are also important to note as they may provide an idea as to when waterbirds will utilize rice paddies and how habitat quality and quantity may change over the course of the year.

Some of the pressures currently facing the rice industry in the Western Hemisphere could negatively affect the amount of rice paddy habitat available to waterbirds. Increased competition with Asian rice growers and volatility in export markets have the potential to decrease habitat area by squeezing out growers in the Western Hemisphere and reducing the amount of rice area cultivated. High production costs due to the rising cost of fuel and opportunity costs resulting from the high prices of land and high profits from producing other commodities could also reduce the size of rice areas harvested. Additionally, challenges in obtaining credit to finance rice production could also contribute to reduced rice production and hence reduced rice habitat area. Reductions in the numbers of individuals participating in the agricultural labor force and low intergenerational recruitment of rice farmers could mean that rice fields may be taken out of production or consolidated into larger, more mechanized farms, potentially affecting the habitat quantity and quality of waterbirds. Water scarcity also poses a risk to rice production and to the suitability of rice habitat for waterbirds. As water increasingly becomes a limiting factor because of competition with urbanization and industrialization uses, it has been suggested that growers should reduce the quantity of water used for rice production in irrigated systems, which could be detrimental to waterbird habitat (Solh, 2003). Land tenure issues also have the potential to affect waterbirds, as renters of land may not want to make large investments either in capital to improve productivity (MacLean et al., 2002) or in new management practices that could aid waterbird conservation but have long-term payoffs.

However, other trends and practices could positively affect the availability of rice paddy waterbird habitat. The conversion of some upland rice systems in Brazil to the higher-yielding irrigated system could provide waterbirds with more rice habitat. High levels of industry connectivity through entities such as producers' organizations could also facilitate the transfer of knowledge about waterbird-friendly rice production practices. Other potential scenarios that could increase the quantity and quality of habitat available to waterbirds are swapping of stubble burning practices for flooding, either voluntarily or through regulation; bans on harmful pesticides; and high producer prices that draw more farmers into the industry.

Finally, some trends and practices may have mixed effects. Increasing yields could have no effect on waterbird habitat or could decrease it, depending on whether a country sets a cap on production and reduces the amount of rice area cultivated due to high yields. Trends in imports and exports may shift areas of rice harvested; as exports and imports grow, exporting countries may increase the area of rice harvested, thus providing more waterbird habitat, while importing countries may reduce the size of their rice industries, thus decreasing waterbird habitat. Subsidies may protect rice production in one country and hence protect waterbird rice habitat too, but this may occur at the expense of another country that can't compete with subsidized producer prices and loses waterbird rice habitat. Similarly, free trade agreements may cause shifts in rice habitat area due to shifts in production. Any emerging environmental policies could impact waterbirds and farmers' adoption of conservation-compatible practices. Additionally, the growing human population may increase demand for rice production, necessitating larger areas of rice cultivation. This could improve the availability of waterbird rice habitat if farmers switch from producing other crops to producing rice. However, if this phenomenon results in the clearing of additional natural wetlands for agricultural purposes, the effect of human population growth on waterbird habitat would be negative. The effects of global climate change and GMOs, on the availability and suitability of waterbird habitat are unknown.

5. NEXT STEPS AND OPPORTUNITIES

The next steps in initiating rice-waterbird conservation projects would be outreach by the Rice and Waterbirds Working Group (RWWG) to the rice industry and other interested parties, educational exchange, and collaboration on mutually beneficial opportunities.

5.1 OUTREACH

There is great potential to initiate relationships between members of the rice industry and the RWWG. Farmers' groups, agricultural extension services, and representatives of the rice industry are all entities that the RWWG could contact, and many of these entities are described in the Rice Industry Guide (Appendix 5) with key contacts highlighted. Farmers' groups represent communication hubs from which information can be disseminated to growers. Agricultural extension services, including ministries of agriculture, provide assistance and outreach to members of the rice industry and, therefore, could be approached regarding establishing connections with farmers. We have identified and initiated communication with a number of key contacts within the Western Hemisphere who are enthusiastic about communicating with the RWWG: Paul Buttner, Environmental Affairs Manager at the California Rice Commission; Reece Langley, Senior Director of Government Affairs at the USA Rice Federation; Greg Yielding, Executive Director of the Arkansas Rice Growers Association and representative of the US Rice Producers Association; Jeff Durand, Louisiana rice and crawfish farmer who holds many positions statewide and nationally, including sitting on the board of directors for the Louisiana Rice Growers Association and the USA Rice Council and on the USA Rice Producers Group Conservation Committee and the USA Rice Federation Environmental Regulatory Subcommittee; Edward David, rice sector technician for the coastal subsecretary of the ministry of agriculture in Ecuador; and Miguel Guzmán, Director of the Agricultural Service in Santa Cruz, Bolivia. In addition, Johnny Broussard, Director of Legislative Affairs and Communications at the USA Rice Federation, is another important contact with whom we have not yet spoken. These individuals' knowledge about the rice industry in their respective locations and their strategic positions within their organizations make them excellent contacts that the RWWG could utilize to further develop relationships with the rice industry and to understand the factors that are of concern to farmers. Additionally, organizations like CIAT and FLAR that operate throughout Latin America could be key for disseminating information and connecting with a large number of producers in many countries.

The RWWG could also reach out to conservation organizations and individuals in the hemisphere who are involved in rice and waterbird projects. For example, Aves Argentinas, a non-profit based in Buenos Aires, is also investigating the relationship between waterbirds and rice fields in Argentina and looking into the possibility of collaborating with rice producers on the implementation of bird-friendly agricultural management practices, moderate use of agrochemicals, bird surveys, and use of rice paddies as waterbird habitat (G. Stamatti, pers. comm., November 6, 2007). By discussing lessons learned, best practices, and ideas, rice-waterbird conservation projects could be implemented throughout the hemisphere and tailored to fit the needs of waterbirds and the rice industry in each region.

5.2 EDUCATION

After establishing ties between the rice industry and conservation practitioners, an exchange of ideas between the two groups could prove valuable for both parties. For example, industry knowledge on the current value of rice agriculture as wildlife habitat could be disseminated to people and organizations in the conservation community who are currently unaware of the rich biodiversity that is already supported in many rice fields. Rice growers could share information on the diversity and abundance of wildlife that use their land, especially in areas where little scientific investigation has occurred. Industry representatives could educate conservationists on the different management practices available and whether adopting new practices or modifying existing ones for conservation benefits would be acceptable to the industry. Industry could also communicate when conferences and growers association meetings occur, so that scientists and conservationists have a proper forum to discuss their ideas, research, and projects with people involved in the rice industry.

After the rice industry shares their knowledge with the conservation community, conservationists could reciprocate in turn. While taking into consideration the economic and social concerns of rice farmers that have been outlined in this paper, the RWWG could educate industry members on the needs of waterbirds and the benefits that rice fields provide wildlife across the hemisphere. Furthermore, an open dialogue between the RWWG and the rice industry could increase farmers' awareness of land use options, such as conservation easements and programs that aim to conserve habitat like the Wetlands Reserve Program and the Conservation Reserve Program in the US. Extending invitations to members of the rice industry to attend meetings, conferences, and seminars regarding waterbird conservation could allow for positive discussions and aid in the maintenance of already established relationships.

During this educational exchange, it will be important to identify areas of common ground between the rice industry and waterbird conservationists. By identifying shared interests, the rice industry and conservation practitioners can better collaborate on initiatives that will further each of their goals. For example, both parties have vested interests in the availability of water for rice fields and the persistence of rice fields over time, whether for maintenance of rice productivity or for bird habitat. It will be necessary for any rice-waterbird conservation activities to provide benefits for rice farmers, as well as for waterbirds, in order to ensure the continued participation of industry. These shared benefits could come in multiple forms, which will be explored in the subsequent section.

5.3 OPPORTUNITIES FOR COLLABORATION

David Brower, founder of Friends of the Earth coined the phrase "think globally, act locally." This is good advice with regard to waterbird conservation in rice-scapes and in planning collaborations between the rice industry and conservationists. While large-scale, eclipsing forces such as international rice prices, free trade agreements, and government support to agriculture have real and significant impacts on rice cultivation, there are still many valuable opportunities for conservation action at the local level. In particular, programs that help to offset high rice production costs could provide incentives to farmers to participate in and contribute toward waterbird conservation.

5.3.1 Management Practices

One possibility is to collaborate on the development of management techniques that are mutually beneficial to farmers and waterbirds. Information on the economic and environmental costs and benefits of different management practices would be helpful in assessing possible effects on waterbird populations that visit or reside near rice fields. Any alternative techniques promoted by conservationists will need to take the high production costs of fuel, fertilizer, and pesticides into consideration, as they are a concern for rice farmers. Applying aspects of lessons learned from other areas in the hemisphere, such as Cuba's success in significantly reducing pesticide use (R. Rice, pers. comm., October 24, 2007), may provide insights into potential sustainable agriculture practices. Sharing information about new rice research would also be mutually beneficial.

Rice-crawfish systems present an opportunity to maintain rice fields flooded for an extended period of time and allow farmers to generate income from the sale of the crawfish. This system requires reduced levels of pesticides and fertilizers, as crawfish are sensitive to these inputs. (Even though crawfish are typically raised in rice-fields when rice is not being grown, they are still sensitive to levels of agrochemicals that have been previously applied to the land.) Rice-crawfish systems have proven valuable to local, regional, and hemispheric populations of waterbirds, as this system provides a diversity of prey in the shallow waters (Huner, 2006). Jeff Durand, from southern Louisiana who is equal parts rice and crawfish farmer, has found that a combination of flooding and crawfish cultivation effectively breaks down rice stubble and may provide a potential alternative to rice straw burning (J. Durand, pers. comm., November 14, 2007). In some areas, incorporation of deteriorated crop residue–such as stubble–into the soil is used by farmers to increase levels of organic matter in their land (P. Rauser, pers. comm., November 16, 2007). Like rice, the profits obtained from crawfish production are dependent upon market prices and fluctuate throughout the year.

5.3.2 Payments

The rice industry and conservationists could also come together and develop innovative ways to provide financial support for environmentally responsible rice production. For example, conservation dollars and industry knowledge could contribute to finding an alternative pesticide to monocrotophos in Bolivia that is less harmful to wildlife yet still controls pests. Collaboration between industry and conservationists could produce conservation easement programs that support rice farming where the land is under threat from urbanization or other less wildlife-compatible land uses. In areas where water scarcity or the draining of natural wetlands is not an issue, payments could be made to farmers to flood their fields in cases where farmers could not otherwise afford to flood. Such a program could focus on areas where the timing of rice cultivation and the passage of wildlife make flooding optimal or on places where flooding rice fields to support wildlife is not a common practice. These and other financial support programs could support rice industries and help achieve conservation goals at the same time.

5.3.3 Duck-Hunting

Duck hunting in the rice off-season represents an opportunity for collaborative efforts between conservationists and rice producers. In California and Louisiana, rice producers flood their fields after rice has been harvested and rent out duck blinds to hunters (K. Berken, pers. comm., October 22, 2007; P. Buttner, pers. comm., October 15, 2007). The flooded fields provide habitat for waterbirds, income for producers, and food and recreation for hunters, which may explain why hunting is the most common incentive in the hemisphere for conservation of waterbirds. Operation Quackback in Louisiana was established to provide habitat for waterfowl, reduce the incidence of red rice by taking advantage of the foraging behavior of waterfowl, and demonstrate the environmental awareness of farmers, by flooding fields in the winter. Farmers do not receive any monetary compensation for participating in the program, but do gain the knowledge that they are providing a valuable environmental service (Richard & Cormier, 1996).

5.3.4 Ecotourism

Another potential for collaboration with the rice industry on waterbird conservation is ecotourism. Bird-watchers could pay for access to rice fields in order to observe waterbirds either during the rice cultivation season or during winter flooding. While it might seem counter-intuitive that birders would pay for access to fields when they can also go to many areas of natural bird habitat for free, there is often a higher density of waterbirds in rice fields than in natural habitat, which might also mean increased chances of sighting rare species. For example, farmers in Louisiana who raise crawfish in rice fields during the winter season inadvertently provide a food source that attracts great numbers of waterbirds. One farmer noted that there are more waterbirds in his rice fields when he is raising crawfish than there are in neighboring swamplands (J. Durand, pers. comm., November 14, 2007). While these birds also cause damage to crawfish yields, funds from ecotourism could be used to offset some of the farmers' losses and encourage them to continue raising crawfish. Ecotourism has already been adopted in some parts of Asia. For example, a birding trip through EarthFoot Ecotours in Indonesia includes stops at rice paddies to spot waterbirds (Tindige, n.d.).

The aforementioned Edward David, who advises the rice-growing sector in Ecuador, is very interested in collaborating with the RWWG on waterbird conservation. He believes that the vernal pools where rice is seeded in the summer provide optimal habitat for migratory bird species, especially because no agrochemicals are used in the pools and water remains in them for a long period of time (E. David, pers. comm., November 8, 2007). Because Edward is working on the rice section of the ministry's agricultural development plan, he would be in a special position to coordinate with the RWWG on an ecotourism effort in Ecuadorian rice paddies.

5.3.5 Bird-Friendly Rice

The rice industry and conservation community may also be able to collaborate on the creation and marketing of a bird-friendly rice label, similar to what exists for bird-friendly coffee. Coffee producers in many countries in Latin America have been able to increase their income by obtaining bird-friendly certification. This process requires farms to follow certain sets of environmental criteria, such as organic practices and shade-grown coffee cultivation, to provide valuable habitat for wildlife in exchange for certification (R. Rice, pers. comm., October 24, 2007). Perhaps a similar certification system could be developed for rice farms. Scientists and conservationists could provide input on what management practices would be required for such a certification and lend the credibility of their institutions to certified rice brands. The rice industry could provide information on what practices would be necessary to ensure adequate rice production, how to market certified rice, and how the rice could be processed and packaged so that it remains separated from non-certified, conventional rice. Such an arrangement already exists in the Delta Del Ebro, Spain, where the RietVell company produces ecological, bird-friendly rice endorsed by conservation organizations like the Ornithological Society of Spain (J. C. Cirera, pers. comm., October 26, 2007).

It would be important to tailor such a program to the characteristics of the rice industry and not simply use the same criteria for rice that is used for coffee. For example, despite the widespread use of fertilizers, most rice agriculture already provides important habitat for wildlife. Perhaps a two-tier, “bird-compatible” label for cultivation with fertilizer could be developed and a “bird-friendly” certification could be made for organic production. A point to note is that while “bird-friendly” coffee is grown in Latin America for the US market, most of the rice produced in the Western Hemisphere is for domestic consumption or exported from the US to other countries, many in Latin America. This is the opposite of the trade flow for bird-friendly coffee, and it would have to be determined whether consumers in Latin American countries and the US would be willing to pay more for “bird-friendly” rice. Thus, a good understanding the world rice market, including import and export trends and market volatility, is necessary to determine if trade partners will be receptive and if a stable market could exist for this specialty rice.

5.3.6 Green Marketing

Consumer education could increase demand for rice from farms that provide bird habitat. The rice industry could sponsor an awareness campaign about the services that rice farmers provide to waterbirds, modeled after awareness campaigns by the beef and dairy industries. It is likely a little known fact among average consumers that rice fields in California provide the bulk of bird habitat for the Pacific Flyway (P. Buttner, pers. comm., October 15, 2007) (Figure 13). This sort of information could be leveraged to increase rice sales and help maintain rice farms and waterbird habitat. It may also be necessary to provide a prompt to consumers at the place of purchase, for example a graphic on bags of rice identifying farms that provide habitat for a certain number of bird species.

The success of consumer education campaigns may vary among countries due to cultural differences. While such campaigns are relatively common in the US, their potential effectiveness in countries like Mexico and Brazil would need to be determined. However, in the case of rice exports from California to Japan, the cultivation of bird-friendly rice in Japan (R. Rice, pers. comm., October 24, 2007) may indicate that

Japanese consumers would be receptive to a rice product from California that was marketed as bird-friendly.

5.3.7 Hemisphere-wide Initiatives

There is also potential for large-scale, hemisphere-wide rice and waterbird conservation initiatives. Because many waterbirds are migratory, they may make use of rice fields in multiple countries. In one scenario, farmers in different countries could be subsidized to flood their rice fields in time with the migration of bird species across the hemisphere. However, this tactic is obviously limited by the expense of subsidies and the practicality of needing flooding techniques to be seasonally appropriate for rice production, not just for creating waterbird habitat. In another scenario, bird species that pass through rice paddy habitat in multiple countries could be identified and utilized for hemisphere-wide awareness campaigns. These could be designated as flagship species and would call attention to the health of waterbird populations and the ecosystem services that rice fields provide. This sort of spotlight on rice-waterbird conservation collaborations might lead to future funding that could be used to maintain rice paddy bird habitat.

6. CONCLUSION

The rice industry provides substantial habitat to waterbirds throughout the Western Hemisphere. Rice farmers and other agents of the rice industry are therefore integral components in achieving waterbird conservation goals. Understanding the economic, policy-related, and social factors and pressures that affect the rice industry will shape approaches to waterbird conservation and enable the RWWG to facilitate an open dialogue with members of the rice industry in the Western Hemisphere.

The pressures faced by the rice industry in the Western Hemisphere include foreign competition, market volatility, rising production costs, water scarcity, free trade policies, and lack of intergenerational recruitment. Each pressure is influential in determining levels of production and the management practices employed by farmers, which in turn affect the quality and quantity of rice habitat. Therefore, addressing the concerns of farmers is considerably important from a waterbird perspective. These concerns are well-captured by Phil Rauser, a rice grower in southern Louisiana, who stated, “Meanwhile, we will pray for favorable weather, bountiful yields, and good prices for our crops in hope that we can continue to do what we love to do” (P. Rauser, pers. comm., November 25, 2007).

Outreach to establish relationships between the RWWG and members of the rice industry and mutual exchanges of knowledge are important first steps toward achieving collaborative efforts that produce benefits for both conservation and industry. There exist numerous ways in which the RWWG and the rice industry could work together toward mutual goals. Collaborations at the local scale have particular potential, as the rice industry differs within and among countries. Furthermore, farmers’ associations and agricultural technical assistance organizations within countries could play significant roles in disseminating information, addressing concerns, and facilitating discussions between the RWWG and members of the rice industry. Ultimately, the success of waterbird conservation will be determined by good communication and the maintenance of a collaborative relationship by both parties, so that everyone involved can continue to do what they love to do.

FIGURES

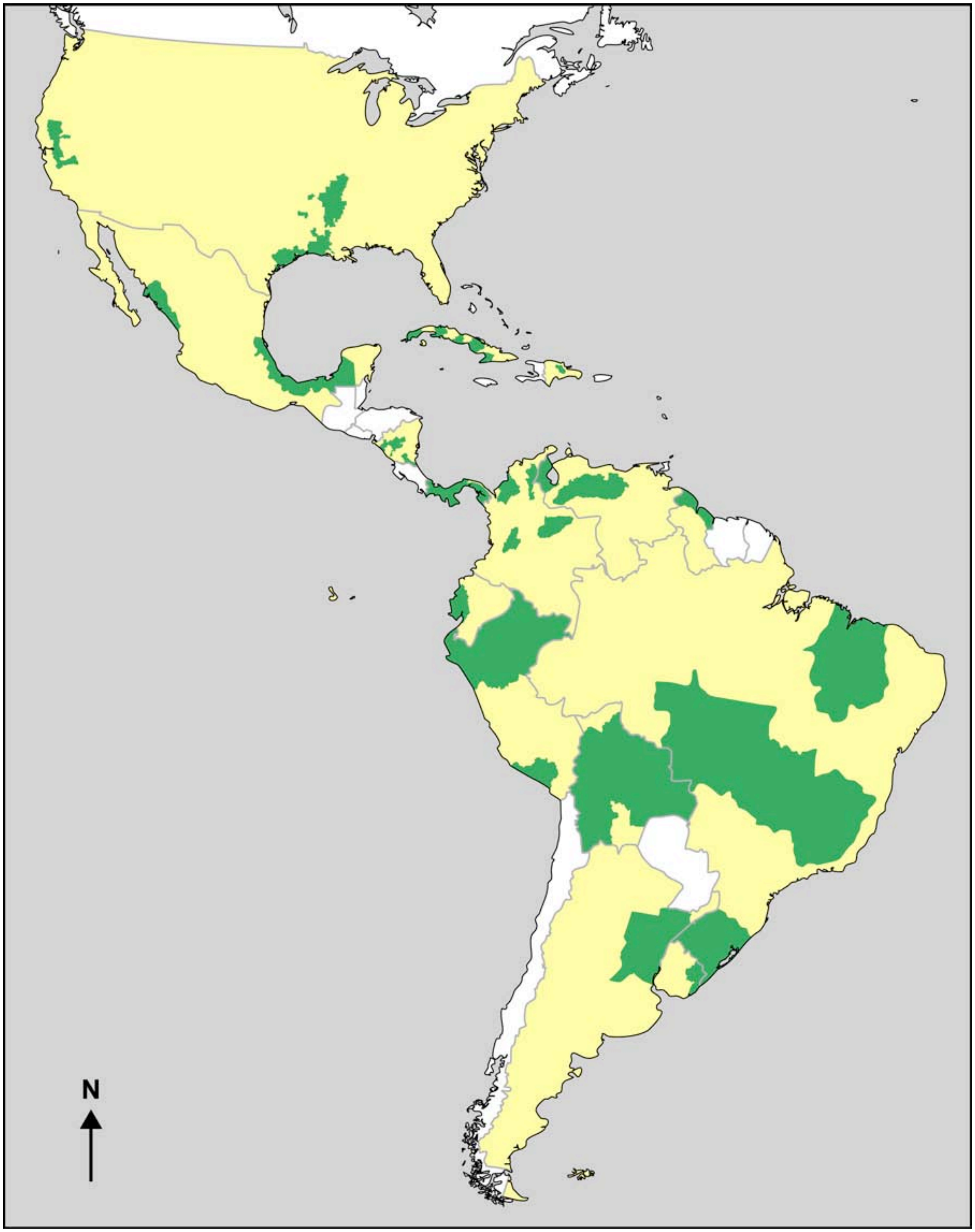

Figure 1. Regions of rice production in the Western Hemisphere. The green indicates political divisions–states, departments, provinces, and counties–in which rice is cultivated in the fifteen focus countries, *not* actual hectares of rice. Information from FAO (2002) and Childs and Livezey (2006).

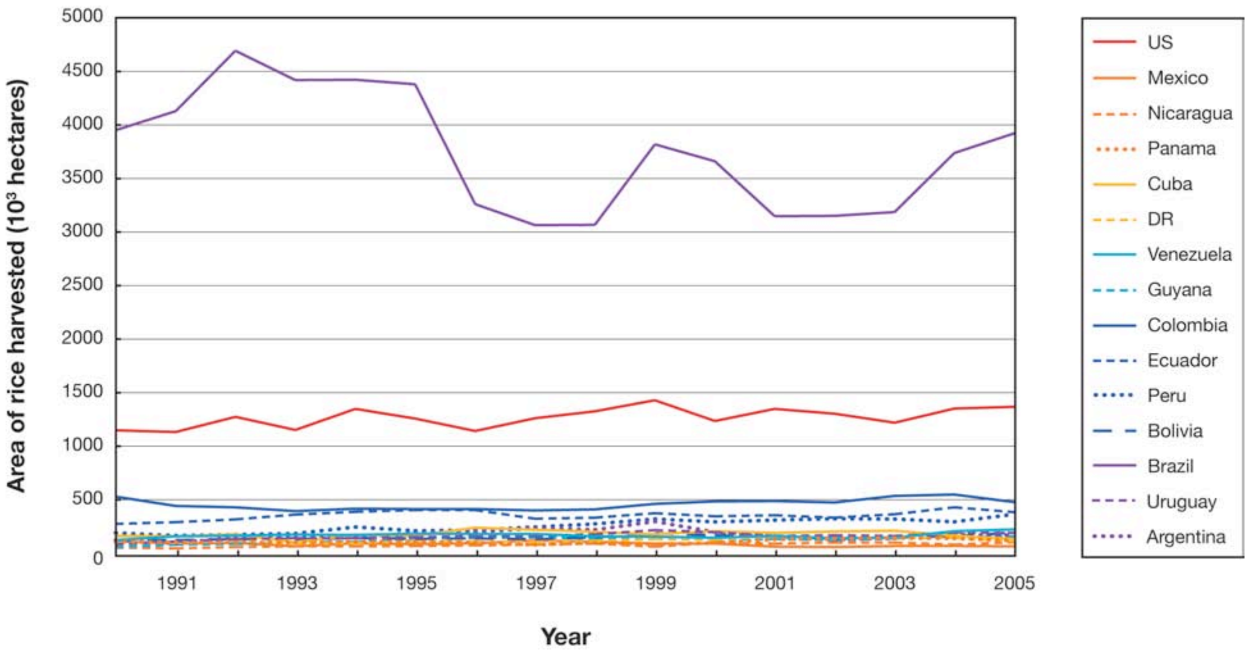

Figure 2. Area of rice harvested in each of the fifteen focus countries (10^3 hectares). Data from FAOSTAT database (2007). See Table 1 in Appendix 3.

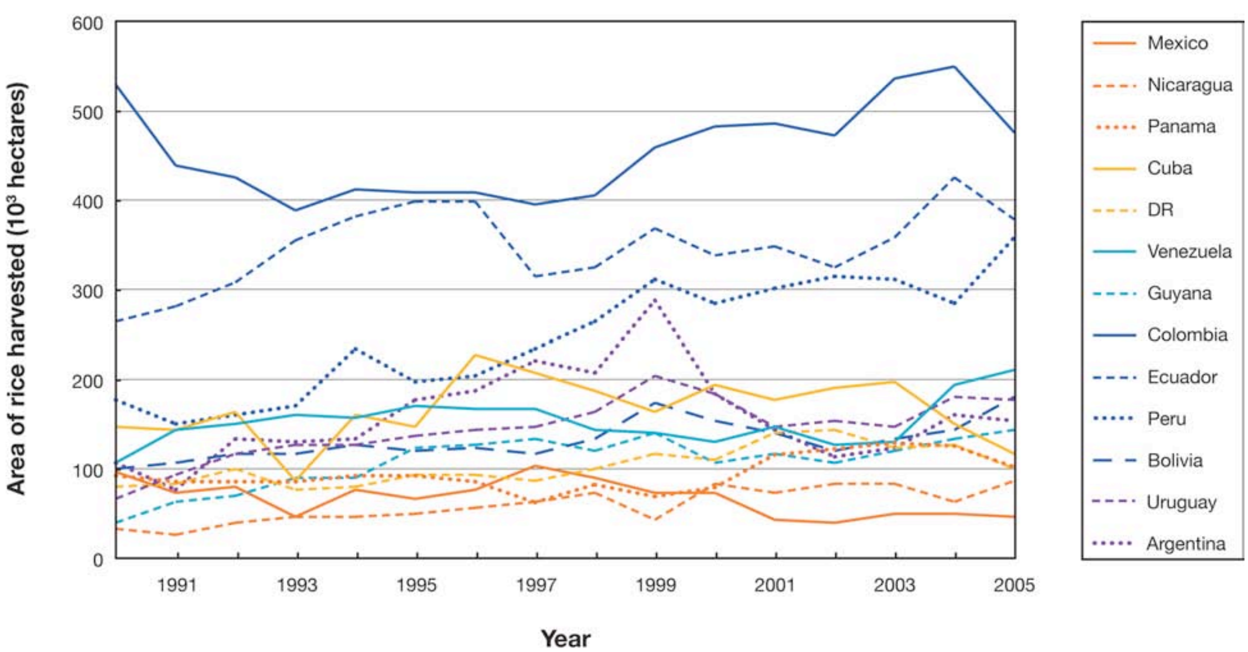

Figure 3. Area of rice harvested in each of the fifteen focus countries, excluding Brazil and the US (10^3 hectares). Data from FAOSTAT database (2007). See Table 1 in Appendix 3.

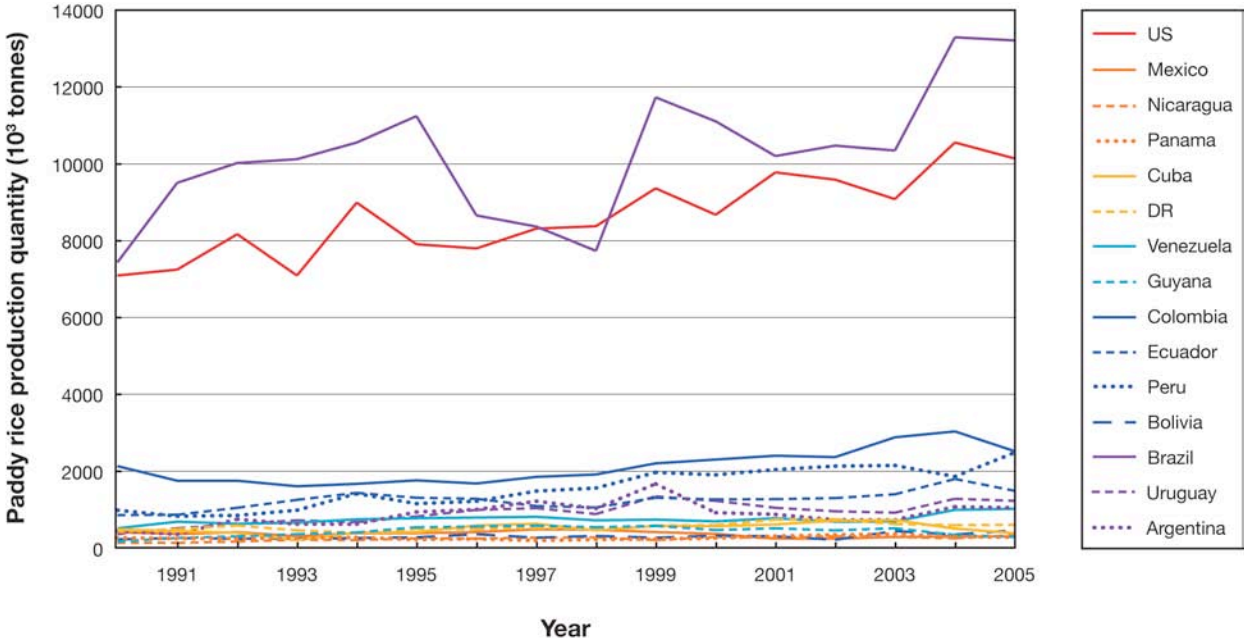

Figure 4. Paddy rice production quantities in each of the fifteen focus countries (10^3 tonnes). Data from FAOSTAT database (2007). See Table 2 in Appendix 3.

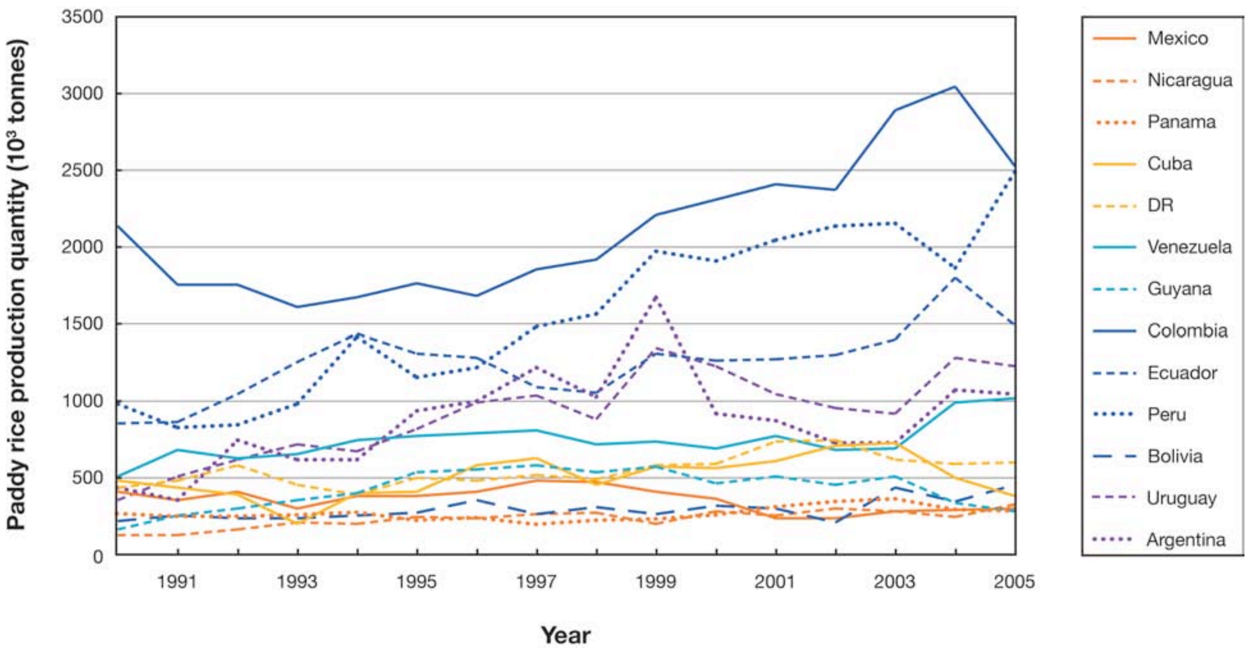

Figure 5. Paddy rice production quantities in each of the fifteen focus countries, excluding Brazil and the US (10^3 tonnes). Data from FAOSTAT database (2007). See Table 2 in Appendix 3.

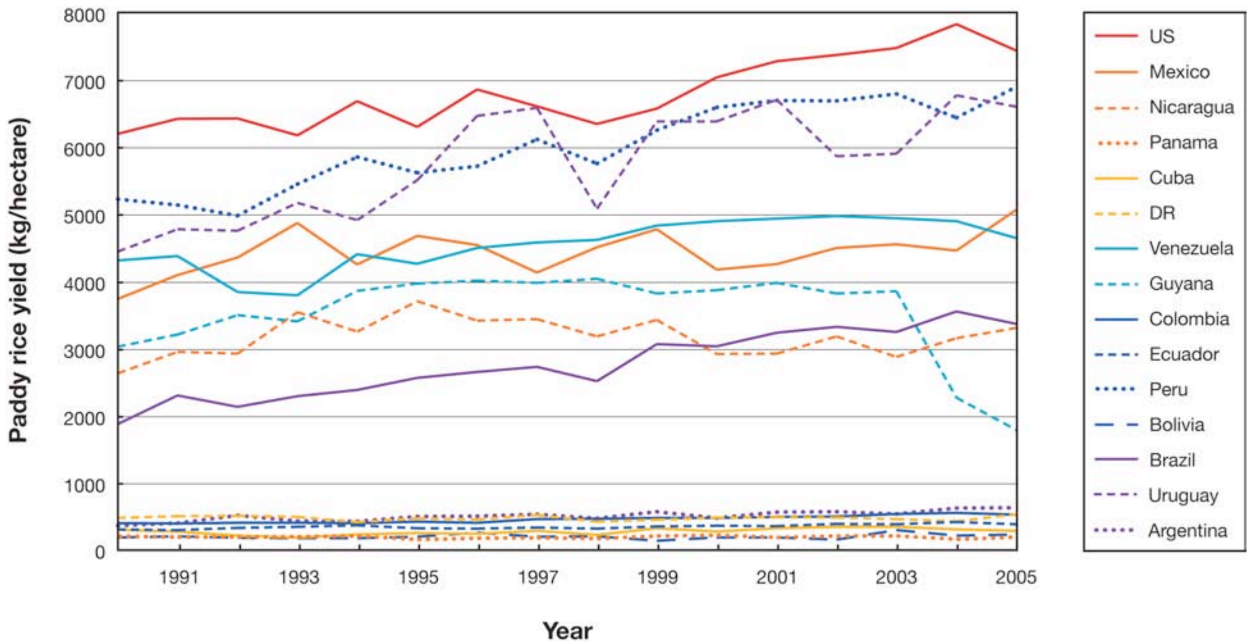

Figure 6. Paddy rice yields in each of the fifteen focus countries (kg/ha). Data from FAOSTAT database (2007). See Table 3 in Appendix 3.

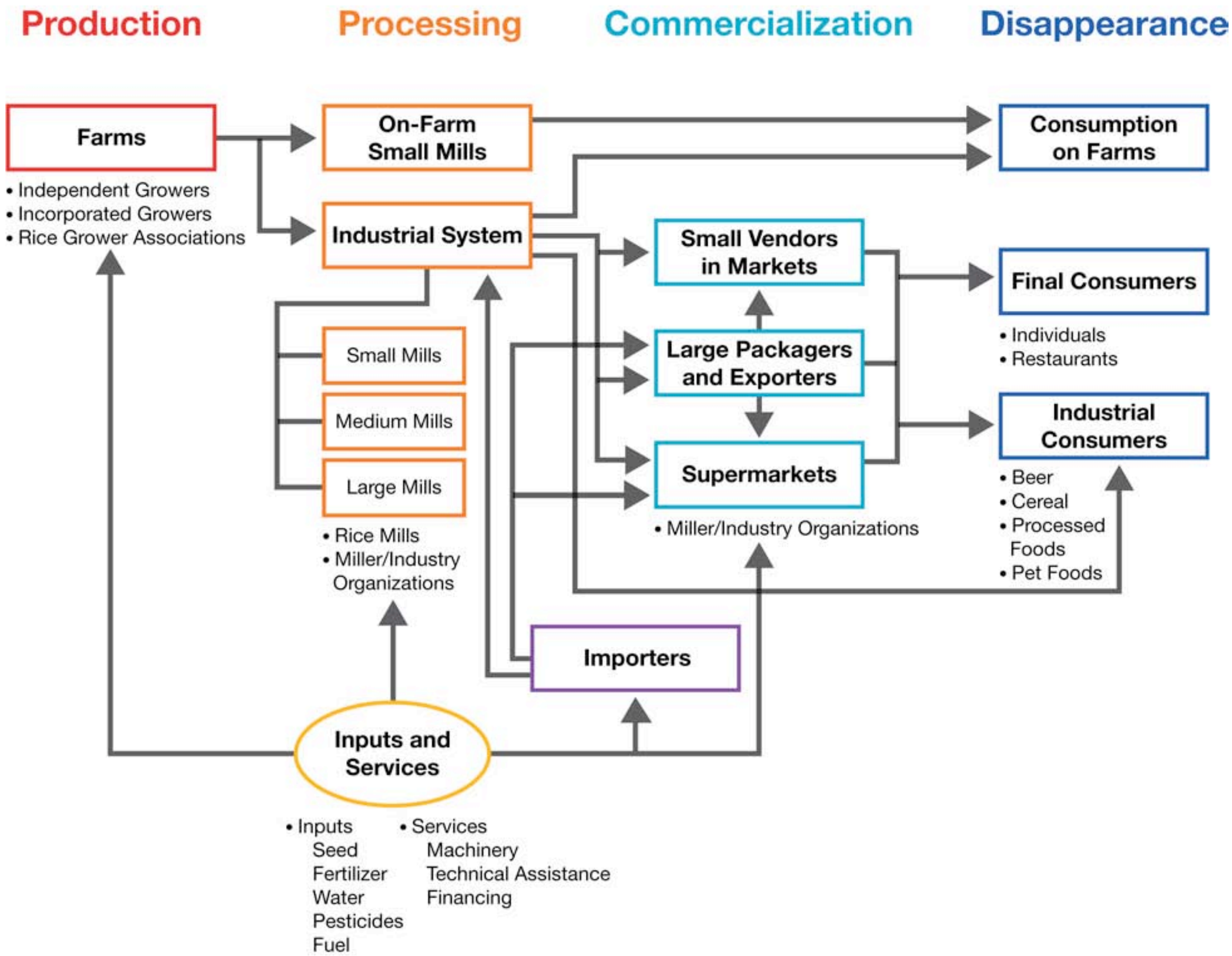

Figure 7. General rice supply chain for the Western Hemisphere.

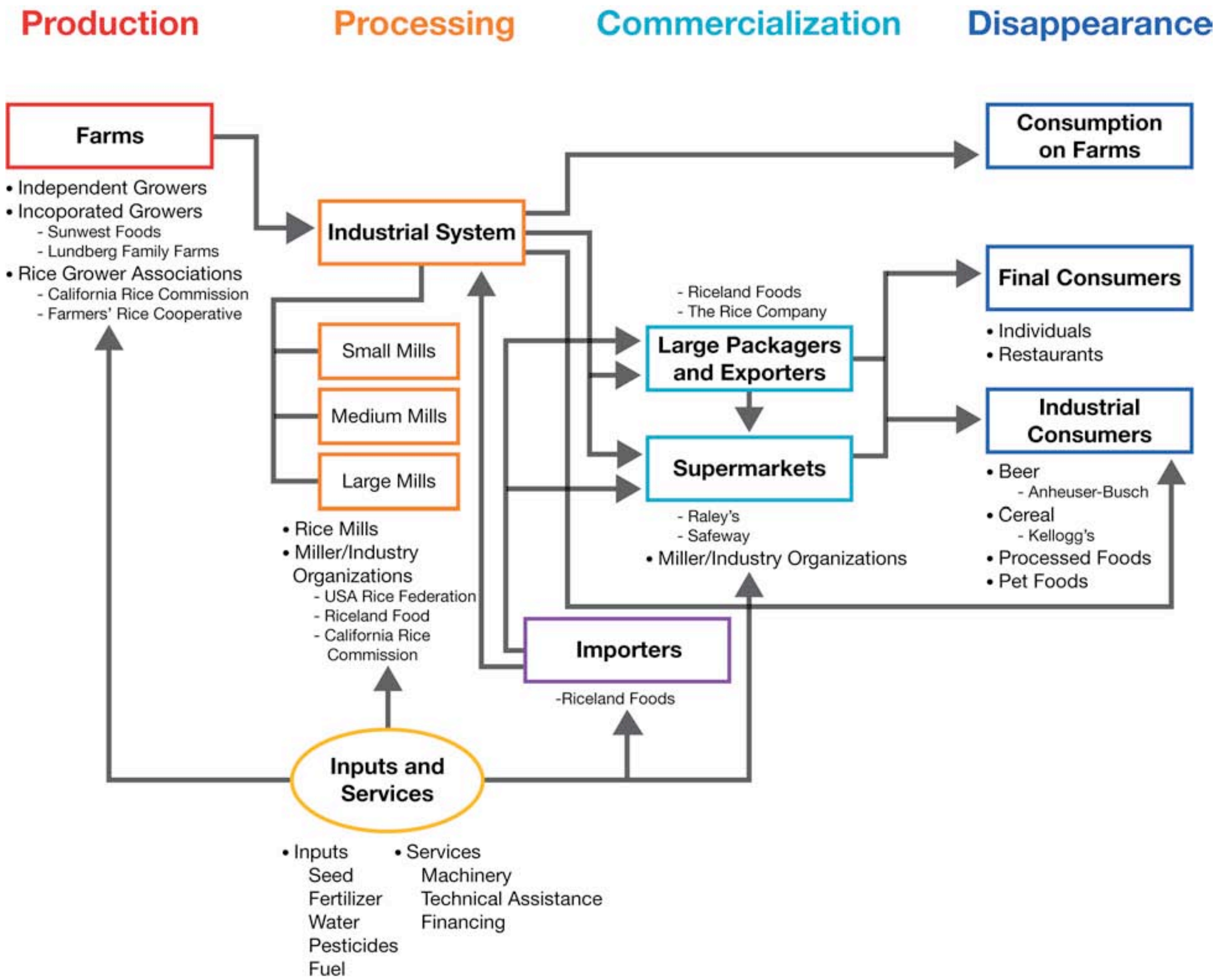

Figure 8. Rice supply chain for California.

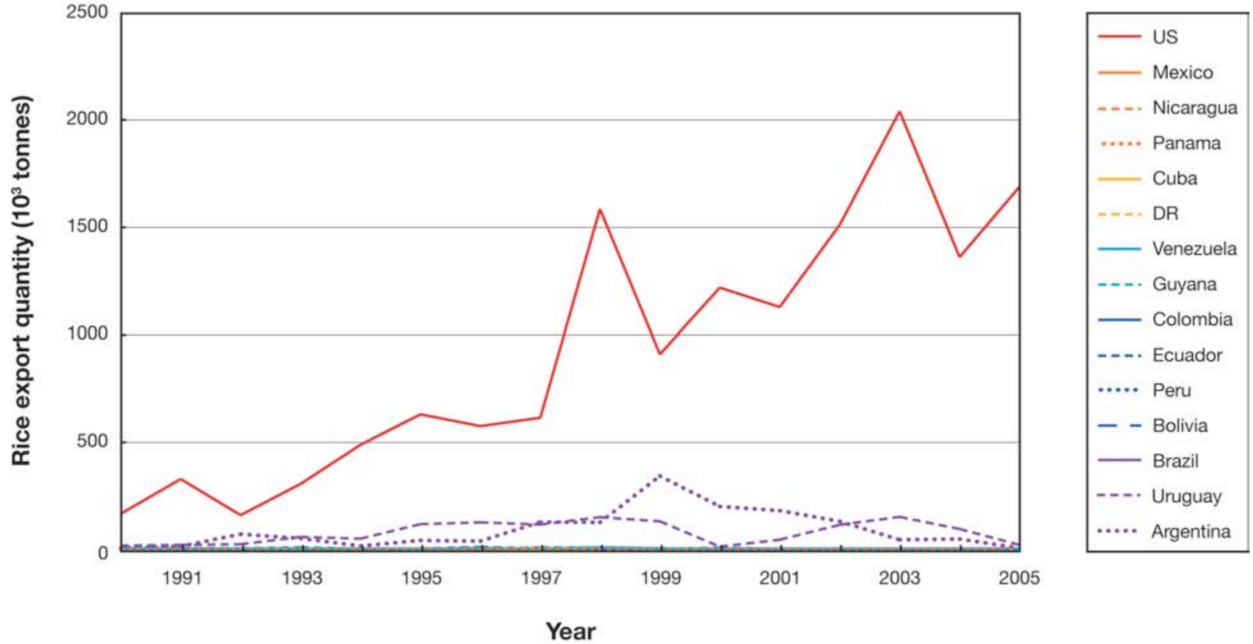

Figure 9. Rice export quantities in each of the fifteen focus countries (10^3 tonnes). Data from FAOSTAT database (2007). See Table 4 in Appendix 3.

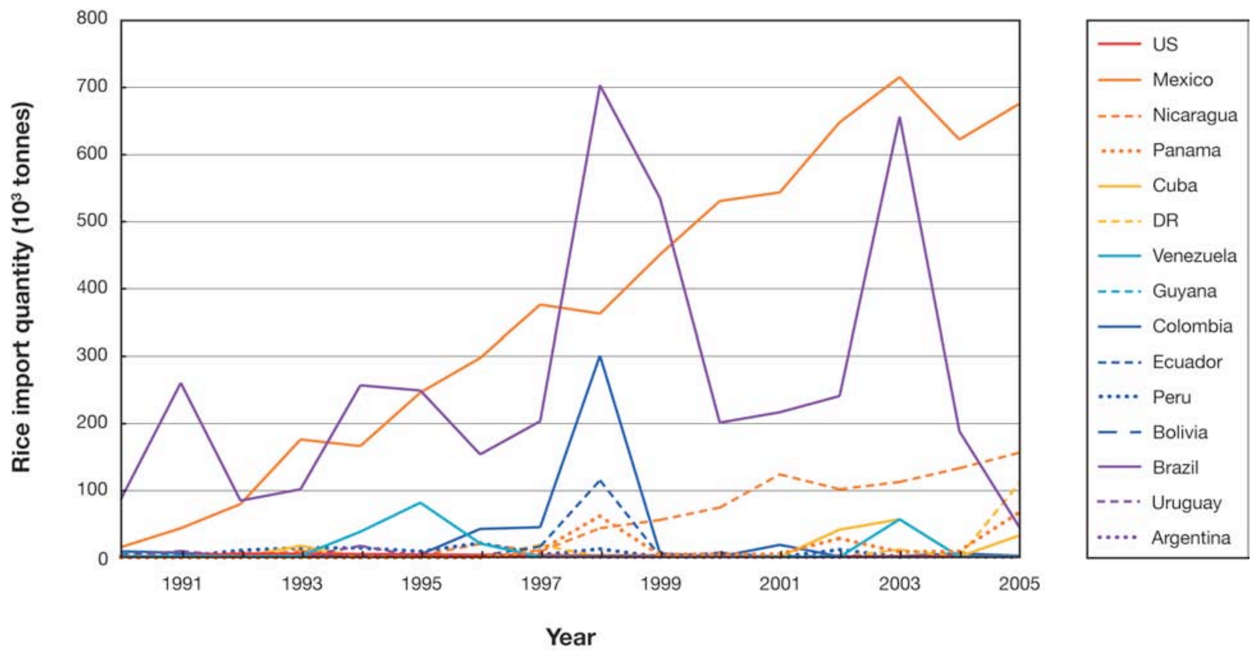

Figure 10. Rice import quantities in each of the fifteen focus countries (10^3 tonnes). Data from FAOSTAT database (2007). See Table 5 in Appendix 3.

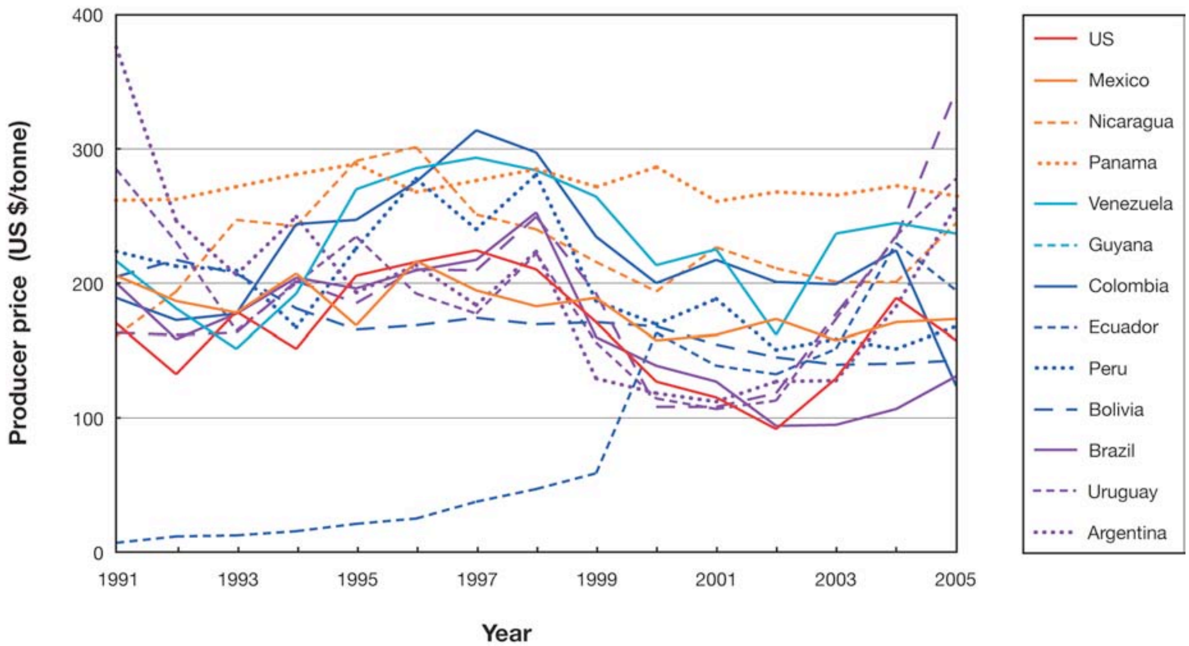

Figure 11. Paddy rice producer prices in each of the fifteen focus countries, excluding Cuba and the DR (US $/tonne). Data from FAOSTAT database (2007). See Table 6 in Appendix 3.

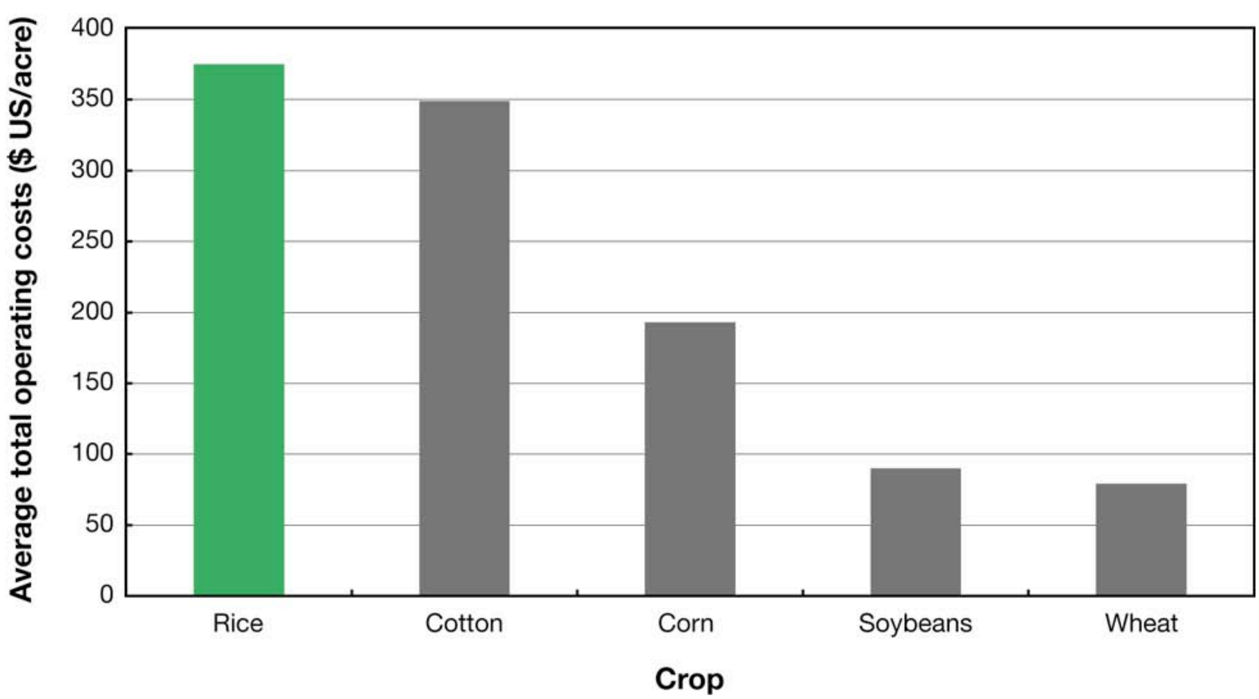

Figure 12. Operating costs in the US for agricultural crops (US $/acre). Data from Childs and Livezey (2006).

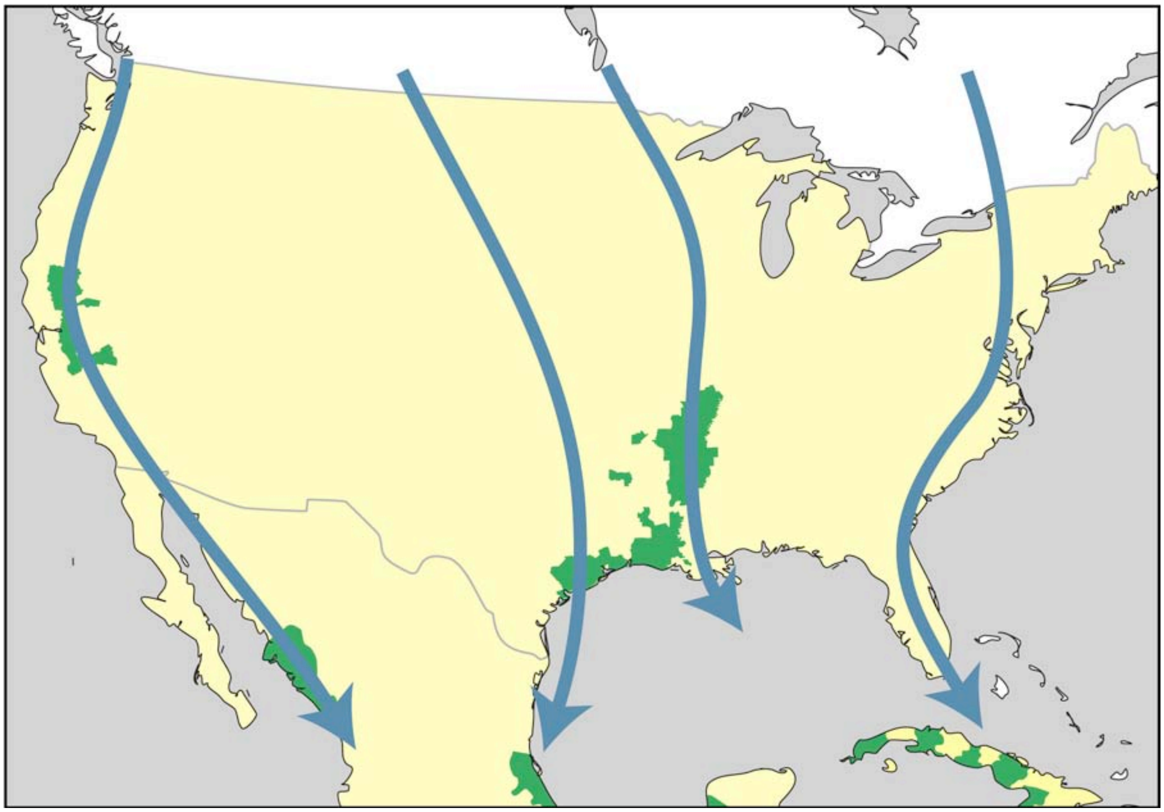

Figure 13. Rice areas harvested in North America (in green) overlaid by the Pacific, Central, Mississippi, and Atlantic flyways. Area harvested information from Childs and Livezey (2006) and FAO (2002).

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APPENDIX 1 – INTERVIEWEE LIST

Name: Daniel Blanco
Date: Oct. 1 2007
Affiliation: Wetlands International
Position: Biologist
Location: Argentina

Name: Paul Buttner
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Affiliation: California Rice Commission
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Location: US - California

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Position: Independent Louisiana (LA) Rice Farmer
Location: US - Louisiana

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Date: Oct. 24 2007
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Position: Policy Director
Location: US – Washington DC

Name: Juan Carlos Cirera
Date: Oct. 26 2007
Affiliation: RietVell
Position: General Manager
Location: Spain

Name: Greg Yielding
Date: Oct. 29 2007
Affiliation: Arkansas Rice Growers
Position: Executive Director
Location: Arkansas

Name: Rosalind Renfrew
Date: Oct. 30 2007
Affiliation: Vermont Institute of Natural Science
Position: Biologist
Location: US - Vermont

Name: Miguel Guzmán
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Position: Director
Location: Bolivia – Santa Cruz

Name: Edward David Álvarez
Date: Nov. 8 2007
Affiliation: Ministerio de Agricultura
Position: Agent
Location: Ecuador - Guayaquil

Name: Jeff Durand
Date: Nov. 14 2007
Affiliation: Rice and Crawfish Farmer, Louisiana Rice Growers Association, Louisiana Rice Council, USA Rice Council
Position: Member of Board of Directors for each of the three organizations
Location: US - Louisiana

Name: Ken Cox
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Location: US - California

Name: John Hasbrook
Date: Nov. 16 2007
Affiliation: SunWest Foods Inc.
Position: Vice President
Location: California

Name: Kevin McTitton
Date: Nov. 16 2007
Affiliation: Riceland Foods
Position: na
Location: Arkansas

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Affiliation: na
Position: Independent Louisiana (LA) Rice Farmer
Location: US - Louisiana

Name: Demetrio Guadagnin
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Affiliation: Laboratório de Ecologia e Conservação de Ecossistemas Aquáticos
Position: Professor
Location: Brazil

Name: Óscar Rodríguez
Date: Nov. 19 2007
Affiliation: Grupo Schettino
Position: Biologist/Commodity Buyer
Location: Mexico

Name: Reece Langley
Date: Nov. 27 2007
Affiliation: USA Rice Federation
Position: Senior Director of Government Affairs
Location: US – Washington DC

APPENDIX 2 – INTERVIEW QUESTIONS

A. Rice Farms

- Where are you located?
- What is the total number of rice growers and hectares of rice cultivated in the area?
- What is the size of a typical rice farm (in hectares) in the area?
- What is the number of employees at a typical farm?
- Are most farms rented or owned? If owned, are they corporate- or family-owned?

B. Rice Industry Structure

- What is the structure of the rice supply chain from grower to consumer in the area?
- What is the rice grower-miller relationship in the area?
- What is the final destination of rice cultivated in the area (geographic location and use)?
- How many companies distribute rice to the consumer? Who are the big players?
- How are rice producers organized (independent farms, cooperatives, etc.)?
- Is there an association of rice growers and handlers?
- If so, how many growers and other handlers are represented in the organization?

C. Economics/Finances

- What are the primary costs of production for rice growers in the area?
- What sort of financial and economic issues most impact rice growers (e.g. price of foreign rice, stability of domestic or international markets, trade agreements, etc.)?
- Does the cost of land in the area create a significant opportunity cost to rice production?

D. Management Practices

- What are the harvest times in the region?
- What rice varieties are cultivated and are hybrid and/or genetically modified varieties used?
- Who or what dictates management practices and policies in effect (e.g. regulations, market pressures, or some combination of factors)?
- What are typical management practices with regards to crop rotation?
- What are typical management practices with regards to mechanization vs. human labor?
- What are typical management practices for disposing of rice stubble and straw (e.g. flooding, rolling, burning)?
- If growers flood, when, how often, and for how long do they flood fields?
- If growers flood, how deeply are rice fields flooded?
- Are there any trends in green/sustainable/organic management practices in the area?
- Would growers consider switching to organic practices or integrated pest management if these lowered production costs?

- Are any other species produced or raised in addition to rice in the fields (e.g. crawfish or ducks)?
- Do pesticides cause any visible effect on wildlife other than pests in rice fields?
- Could rice fields be simultaneously used as habitat for animal species?
- Are waterbirds considered pests?
- Are there any specific management practices regarding waterbirds?
- Are waterbirds considered pests?
- Are there any specific management practices regarding waterbirds?

E. Policy

- What primary laws regulate rice production in the area?
- Are there any laws that specifically address waterbirds in areas of rice cultivation?
- What is the general perspective on US rice subsidies in relation to their effect on markets in other countries?
- Are there any import/export quotas on rice that impact rice production?

F. Social Aspects

- How networked is the rice industry? Is there a formal network or a more informal social network of rice producers?
- Do rice growers farm year-round and/or do they have additional sources of employment?
- Does the younger generation in the area have interest in the rural lifestyle and continuing rice production, especially on family farms?
- Is rice farming still considered a viable long-term practice in the area, or is there a trend toward switching to other crops or leaving rural areas?

G. Additional Pressures

- Does water scarcity or the price of water pose threats to the rice industry in the area?
- Are pests and disease significant threats to rice in the area?
- What impact, if any, has the biofuel boom had on rice production (e.g. using rice for fuel, switching to soy, price of rice)?
- Is climate change affecting rice production and has this issue been considered by producers?

APPENDIX 3 – TABLES

Table 1. Area harvested data (10^3 hectares) from the FAOSTAT database (2007). The Western Hemisphere column is total area harvested in the hemisphere. The area harvested is defined as the area from which a crop was gathered and excludes the area from which there was no harvest due to damage, failure, etc. (FAOSTAT glossary, 2007). [*Years 2003-2005 of columns Other – North America (NA) & Central America (CA) and Other – South America (SA) are unconfirmed figures from the IRRI (2007).]

YEAR	Western Hemisphere	Argentina	Bolivia	Brazil	Chile	Colombia	Costa Rica	Cuba	DR	Ecuador	Guyana	Haiti	Mexico	Nicaragua	Panama	Paraguay	Peru	Suriname	Uruguay	US	Venezuela	Other - NA & CA*	Other - SA*
1990	7449.70	116.62	109.38	3946.69	32.59	521.10	50.82	154.90	89.36	269.19	51.35	61.50	105.40	45.92	98.36	34.00	184.76	52.01	78.09	1142.40	114.76	168.85	21.65
1991	7563.60	86.27	114.56	4121.60	29.75	435.10	48.43	152.15	92.09	283.90	75.19	60.00	84.79	40.32	94.09	33.40	158.35	60.09	103.13	1125.40	151.76	184.73	28.50
1992	8452.78	140.70	125.01	4687.02	31.76	423.57	52.72	171.82	110.25	309.60	81.47	58.13	90.42	52.64	93.14	33.00	166.50	68.75	127.30	1267.50	158.83	178.33	24.32
1993	7978.98	139.65	125.24	4411.32	29.08	385.92	41.87	97.11	88.66	356.21	101.36	55.00	58.94	56.76	93.50	45.00	177.53	58.64	135.70	1146.50	168.46	178.98	27.55
1994	8382.42	141.34	136.39	4414.80	30.36	408.28	44.78	166.73	89.94	379.96	101.38	53.00	87.80	58.12	97.67	47.00	239.45	55.00	134.20	1341.95	165.15	163.93	25.19
1995	8292.91	184.12	129.99	4373.54	33.93	406.76	41.15	154.70	101.99	395.60	132.90	50.00	78.44	62.68	98.95	48.00	203.20	60.00	146.30	1251.70	177.43	136.25	25.28
1996	7191.07	193.22	130.97	3253.77	32.03	407.25	57.55	233.13	102.87	396.00	135.38	48.20	86.78	67.36	93.41	44.00	210.35	61.76	150.50	1134.75	173.31	147.50	30.98
1997	7091.97	224.41	126.18	3058.13	24.10	394.08	56.93	213.40	97.40	316.43	142.73	70.00	113.49	74.61	69.62	40.50	238.71	53.50	155.50	1255.75	172.95	162.31	31.24
1998	7117.05	211.71	142.06	3062.20	26.70	402.78	56.01	193.92	111.12	325.33	129.42	51.17	101.56	83.57	88.23	20.86	269.08	50.14	169.90	1318.08	151.85	126.46	24.90
1999	8229.11	289.20	181.23	3813.27	14.70	455.18	64.67	171.09	124.98	366.13	147.01	60.00	82.58	56.23	77.96	27.77	312.74	48.46	208.09	1421.27	148.97	137.70	19.88
2000	7714.12	189.05	161.18	3655.29	25.77	475.91	68.36	200.11	120.07	338.65	116.02	52.00	84.07	92.82	85.61	26.25	287.11	42.00	189.40	1230.36	138.20	116.27	19.61
2001	7295.69	150.77	149.25	3142.64	28.55	481.29	56.97	183.86	147.43	348.89	124.52	51.20	53.23	84.08	122.45	26.68	302.80	50.78	153.68	1341.70	154.20	109.17	31.54
2002	7149.11	124.17	129.63	3145.87	27.98	468.91	47.89	197.95	150.37	326.67	116.00	52.00	50.46	92.13	127.56	27.03	316.81	40.05	160.23	1297.84	134.29	92.86	22.41
2003	7321.74	133.00	141.18	3180.86	28.23	528.03	54.04	204.60	131.35	357.56	130.00	52.50	60.00	92.97	133.88	30.30	313.86	52.43	153.40	1212.86	137.40	169.83	23.46
2004	8166.58	169.20	152.19	3733.15	24.90	543.52	62.12	157.83	134.19	421.55	143.20	51.54	62.40	73.64	130.10	31.00	286.47	45.69	186.47	1345.59	198.78	189.55	23.50
2005	8206.93	162.00	188.38	3915.86	25.03	469.95	55.25	127.20	110.39	377.30	152.78	51.12	57.48	95.67	109.50	33.50	357.88	43.88	184.00	1361.38	216.50	88.38	23.50
AVERAGE	**7725.23**	**165.96**	**140.18**	**3744.75**	**27.84**	**450.48**	**53.72**	**173.78**	**112.65**	**348.06**	**117.54**	**54.84**	**78.62**	**70.60**	**100.88**	**34.27**	**251.60**	**52.70**	**152.24**	**1262.19**	**160.18**	**146.94**	**25.22**
% OF TOTAL	**100.0**	**2.1**	**1.8**	**48.5**	**0.4**	**5.8**	**0.7**	**2.2**	**1.5**	**4.5**	**1.5**	**0.7**	**1.0**	**0.9**	**1.3**	**0.4**	**3.3**	**0.7**	**2.0**	**16.3**	**2.1**	**1.9**	**0.3**

Table 2. Paddy rice production quantity data (10^3 tonnes) from the FAOSTAT database (2007). The Western Hemisphere column is total paddy rice production quantity in the hemisphere. Production quantity figures encompass total domestic production, which includes non-commercial production and production from kitchen gardens. Paddy rice is unprocessed rough rice (FAOSTAT glossary, 2007). [*Years 2003-2005 of columns Other – North America (NA) & Central America (CA) and Other – South America (SA) are unconfirmed figures from the IRRI (2007).]

YEAR	Western Hemisphere	Argentina	Bolivia	Brazil	Chile	Colombia	Costa Rica	Cuba	DR	Ecuador	Guyana	Haiti	Mexico	Nicaragua	Panama	Paraguay	Peru	Suriname	Uruguay	US	Venezuela	Other - NA & CA*	Other - SA*
1990	22655.99	428.10	211.26	7420.93	136.01	2116.60	217.64	473.67	427.60	840.36	155.74	129.90	394.39	120.89	222.29	85.70	966.10	196.01	347.30	7080.00	495.00	168.85	21.65
1991	24649.12	347.60	240.77	9488.01	117.12	1738.60	213.18	427.62	466.17	848.18	241.32	120.00	347.25	119.03	203.24	86.92	814.17	229.26	492.60	7230.00	664.85	184.73	28.50
1992	26917.32	732.70	229.29	10006.29	133.53	1734.95	202.52	376.33	565.65	1029.56	284.96	125.48	394.02	154.00	204.75	85.37	829.37	261.08	605.40	8149.00	610.42	178.33	24.32
1993	25783.01	608.30	222.59	10107.31	130.63	1590.06	172.77	185.60	442.53	1239.76	345.64	110.00	287.18	201.20	210.00	116.60	967.63	216.89	701.80	7081.00	638.99	178.98	27.55
1994	29150.74	607.60	247.33	10540.79	133.08	1657.21	205.44	387.60	375.81	1420.47	391.25	105.00	373.62	189.06	227.02	122.10	1401.39	218.00	659.70	8971.10	728.05	163.93	25.19
1995	29196.95	926.20	264.61	11226.06	145.90	1742.55	183.18	396.10	486.74	1290.52	527.98	100.00	367.03	232.46	176.23	136.26	1141.55	242.00	806.10	7887.00	756.95	136.25	25.28
1996	27098.19	986.00	343.52	8643.80	152.80	1661.34	236.53	572.90	474.22	1269.66	543.50	120.00	394.08	230.32	189.75	132.46	1203.17	228.65	973.50	7783.60	779.91	147.50	30.98
1997	27896.40	1205.14	255.59	8351.67	87.55	1830.29	248.53	614.20	508.54	1071.54	568.19	160.00	469.46	256.59	144.36	141.58	1459.83	213.05	1023.80	8300.70	792.24	162.31	31.24
1998	26642.34	1011.14	296.25	7716.09	104.38	1897.74	239.00	441.60	474.60	1042.99	522.91	101.32	458.11	265.93	171.28	80.92	1548.78	188.41	864.16	8364.20	701.17	126.46	24.90
1999	33820.72	1658.20	256.79	11709.70	61.00	2185.23	264.32	559.00	566.50	1289.68	562.26	125.00	394.43	192.96	182.29	128.09	1955.03	180.30	1328.22	9343.95	720.19	137.70	19.88
2000	31617.21	903.63	310.10	11089.80	135.06	2285.72	266.42	552.80	581.41	1246.63	449.18	130.00	351.45	271.15	207.43	101.05	1892.10	163.66	1209.14	8657.82	676.78	116.27	19.61
2001	32007.80	859.14	287.13	10184.00	143.26	2385.01	216.70	601.00	721.67	1255.99	495.86	103.00	226.64	246.20	261.21	106.18	2026.97	191.37	1030.20	9764.50	761.06	109.17	31.54
2002	31796.73	713.45	202.01	10457.10	141.93	2347.92	189.77	692.00	730.71	1284.50	443.70	104.00	227.19	293.46	295.38	104.97	2118.61	157.11	939.49	9570.00	668.16	92.86	22.41
2003	32115.29	717.60	423.28	10334.60	140.85	2860.87	183.64	715.80	608.33	1384.72	501.50	105.00	273.30	267.61	315.96	110.25	2132.41	193.69	905.70	9068.00	678.89	169.83	23.46
2004	37164.86	1060.00	331.34	13277.01	119.27	3016.24	197.21	488.90	576.62	1778.38	325.59	107.48	278.50	232.62	243.38	125.00	1844.90	172.92	1262.60	10539.76	974.09	189.55	23.50
2005	36318.43	1027.00	445.70	13192.86	116.83	2502.28	183.25	367.60	591.97	1471.08	273.33	108.54	291.15	316.71	235.16	102.00	2468.36	166.56	1214.50	10125.00	1006.67	88.38	23.50
AVERAGE	**29676.94**	**861.99**	**285.47**	**10234.13**	**124.95**	**2097.04**	**213.76**	**490.80**	**537.44**	**1235.25**	**414.56**	**115.92**	**345.49**	**224.39**	**218.11**	**110.34**	**1548.15**	**201.19**	**897.76**	**8619.73**	**728.34**	**146.94**	**25.22**
% OF TOTAL	**100.0**	**2.9**	**1.0**	**34.5**	**0.4**	**7.1**	**0.7**	**1.7**	**1.8**	**4.2**	**1.4**	**0.4**	**1.2**	**0.8**	**0.7**	**0.4**	**5.2**	**0.7**	**3.0**	**29.0**	**2.5**	**0.5**	**0.1**

Table 3. Paddy rice yield data (kg/hectare) from the FAOSTAT database (2007). The Western Hemisphere column is average yield for the hemisphere. The FAO generally obtains yield figures by dividing the production data by the data on area harvested, as yield data are often not recorded (FAOSTAT glossary, 2007). [*Years 2003-2005 of columns Other – North America (NA) & Central America (CA) and Other – South America (SA) are unconfirmed figures from the IRRI (2007).]

YEAR	Western Hemisphere	Argentina	Bolivia	Brazil	Chile	Colombia	Costa Rica	Cuba	DR	Ecuador	Guyana	Haiti	Mexico	Nicaragua	Panama	Paraguay	Peru	Suriname	Uruguay	US	Venezuela	Other - NA & CA*	Other - SA*
1990	1869.00	367.09	193.14	1880.30	417.34	406.18	428.23	305.80	478.51	312.18	3033.10	211.22	3741.80	2632.60	226.00	2520.60	5229.00	3769.10	4447.40	6197.50	4313.50	3.11	4.24
1991	1957.11	402.94	210.17	2302.00	393.66	399.59	440.19	281.05	506.19	298.76	3209.70	200.00	4095.40	2952.10	216.01	2602.40	5141.60	3815.60	4776.70	6424.40	4380.80	2.85	4.27
1992	1942.49	520.75	183.41	2134.90	420.44	409.60	384.18	219.02	513.06	332.54	3497.90	215.86	4357.70	2925.50	219.83	2586.80	4981.20	3797.50	4755.70	6429.20	3843.20	3.17	3.30
1993	2016.24	435.59	177.74	2291.20	449.21	412.02	412.64	191.13	499.16	348.04	3410.10	200.00	4872.50	3545.00	224.60	2591.20	5450.60	3698.70	5171.70	6176.20	3793.00	3.26	3.73
1994	2070.63	429.89	181.34	2387.60	438.34	405.90	458.75	232.47	417.85	373.85	3859.30	198.11	4255.50	3252.80	232.44	2597.90	5852.50	3963.60	4915.80	6685.10	4408.50	3.09	3.26
1995	2134.02	503.06	203.57	2566.80	430.00	428.40	445.18	256.04	477.25	326.22	3972.80	200.00	4679.20	3708.40	178.10	2838.70	5618.00	4033.30	5509.90	6301.00	4266.20	3.16	3.16
1996	2202.14	510.31	262.30	2656.60	477.04	407.94	411.02	245.74	460.97	320.62	4014.60	248.96	4541.20	3419.50	203.13	3010.50	5719.80	3702.50	6468.40	6859.30	4500.00	3.07	3.48
1997	2238.67	537.03	202.56	2731.00	363.36	464.45	436.52	287.81	522.11	338.64	3981.00	228.57	4136.50	3438.90	207.35	3495.80	6115.40	3982.60	6583.90	6610.10	4580.70	3.14	3.37
1998	2138.37	477.62	208.54	2519.80	390.89	471.16	426.68	227.72	427.09	320.60	4040.50	198.00	4510.80	3182.00	194.13	3879.20	5755.80	3758.10	5086.20	6345.80	4617.70	2.98	2.78
1999	2321.79	573.37	141.69	3070.80	415.08	480.09	408.75	326.73	453.26	352.25	3824.60	208.33	4776.20	3431.90	233.82	4612.60	6251.40	3720.50	6383.00	6574.40	4834.50	3.60	2.61
2000	2288.75	477.98	192.40	3033.90	524.14	480.28	389.75	276.25	484.22	368.12	3871.50	250.00	4180.50	2921.30	242.29	3849.20	6590.10	3897.00	6384.00	7036.80	4897.00	3.63	2.23
2001	2341.19	569.83	192.38	3240.60	501.79	495.54	380.39	326.89	489.50	360.00	3982.30	201.17	4257.60	2928.10	213.32	3979.70	6694.10	3768.60	6703.70	7277.70	4935.50	3.64	3.80
2002	2333.84	574.58	155.83	3324.10	507.24	500.72	396.23	349.59	485.93	393.21	3825.00	200.00	4502.70	3185.30	231.56	3884.10	6687.60	3922.70	5863.20	7373.80	4975.40	3.00	2.71
2003	2311.54	539.55	299.83	3249.00	498.93	541.80	339.79	349.85	463.14	387.26	3857.70	200.00	4555.00	2878.40	236.00	3638.30	6794.20	3694.50	5904.20	7476.50	4940.80	5.31	3.90
2004	2317.11	626.48	217.71	3556.50	478.98	554.94	317.49	309.77	429.71	421.87	2273.70	208.53	4463.10	3158.80	187.07	4032.30	6440.10	3784.40	6771.20	7832.80	4900.30	6.77	3.92
2005	2264.09	633.95	236.59	3369.10	466.77	532.45	331.69	289.00	536.24	389.90	1789.10	212.35	5065.30	3310.60	214.75	3044.80	6897.10	3795.70	6600.50	7437.30	4649.70	3.16	3.92
AVERAGE	**2171.69**	**511.25**	**203.70**	**2769.64**	**448.33**	**461.94**	**400.47**	**279.68**	**477.76**	**352.75**	**3527.68**	**211.32**	**4436.94**	**3179.45**	**216.28**	**3322.76**	**6013.66**	**3819.03**	**5770.34**	**6814.87**	**4552.30**	**3.56**	**3.42**

Table 4. Paddy rice export data (10^3 tonnes) from the FAOSTAT database (2007). The Western Hemisphere column is total export quantity in the hemisphere. Export quantities are given for the primary commodity (FAOSTAT glossary, 2007).

YEAR	Western Hemisphere	Argentina	Bolivia	Brazil	Chile	Colombia	Costa Rica	Cuba	DR	Ecuador	Guyana	Haiti	Mexico	Nicaragua	Panama	Paraguay	Peru	Suriname	Uruguay	US	Venezuela	Other - NA & CA	Other - SA
1990	198.63	3.81	0.51	1.02	0.00	0.64	0.20	0.00	na	3.66	5.19	na	0.01	0.51	0.62	0.00	0.00	na	15.67	164.65	2.14	na	na
1991	369.95	12.35	0.16	1.24	0.00	1.17	0.01	na	0.00	3.22	4.71	na	0.01	0.27	0.55	0.00	0.00	0.00	19.29	326.57	0.40	na	na
1992	256.02	68.62	0.01	1.19	0.03	0.70	0.02	na	0.00	0.06	2.84	na	0.01	0.23	0.00	0.00	0.00	na	22.49	158.17	1.65	na	na
1993	425.93	49.30	0.00	1.06	0.28	1.64	2.07	0.00	0.00	1.72	8.28	na	0.01	0.11	0.02	1.20	0.00	na	56.76	302.93	0.55	na	na
1994	557.09	14.65	0.09	1.48	0.00	0.15	0.08	na	na	1.97	1.87	na	0.00	0.16	0.01	0.45	0.00	na	49.04	486.14	1.00	na	na
1995	786.29	40.00	0.00	1.02	0.00	0.12	0.11	na	0.00	1.00	0.35	na	0.00	0.39	0.03	0.13	0.00	na	115.57	627.39	0.18	na	na
1996	758.36	36.93	0.00	1.07	0.00	0.10	0.02	na	na	9.27	1.21	na	0.02	0.27	0.09	7.88	0.01	0.00	123.82	572.80	4.87	na	na
1997	884.65	126.12	0.00	0.94	0.00	0.07	0.11	na	na	1.35	8.74	na	0.01	0.62	8.02	11.02	0.01	na	115.28	611.52	0.84	na	na
1998	1872.04	123.72	0.01	1.08	0.04	0.16	0.02	na	na	0.00	6.60	na	0.10	0.15	0.02	1.63	0.01	0.02	148.00	1581.84	8.64	na	na
1999	1386.18	341.20	0.00	2.68	0.00	0.07	0.14	na	na	1.05	0.21	na	0.00	0.01	0.03	1.60	0.01	0.02	129.88	906.85	2.43	na	na
2000	1456.91	197.88	0.01	1.01	0.00	0.09	0.30	na	na	0.01	6.14	na	0.00	0.02	na	24.34	0.00	na	11.37	1214.97	0.77	na	na
2001	1362.82	179.69	0.00	0.95	0.00	0.05	0.87	na	0.01	0.34	0.11	na	0.43	0.09	0.33	11.57	0.00	na	43.84	1124.22	0.32	na	na
2002	1757.28	128.45	0.00	1.04	0.00	0.31	0.34	na	na	0.02	0.09	na	0.00	0.24	0.15	6.88	0.07	na	112.72	1506.63	0.34	na	na
2003	2235.80	43.92	0.00	1.12	0.10	0.37	0.22	na	0.02	0.38	0.06	na	0.00	0.21	0.00	1.62	0.00	na	150.50	2037.23	0.05	na	na
2004	1513.29	47.46	0.01	1.00	0.00	0.81	0.40	na	0.01	0.01	0.04	na	0.04	0.06	0.45	11.60	0.00	0.12	93.22	1357.82	0.24	na	na
2005	1742.45	4.99	0.00	1.02	0.00	0.36	0.21	na	na	0.20	0.35	na	0.05	0.02	0.52	29.36	0.02	na	19.97	1684.89	0.49	na	na
AVERAGE	**1097.73**	**88.69**	**0.05**	**1.18**	**0.03**	**0.43**	**0.32**	**0.00**	**0.00**	**1.52**	**2.92**	**0.00**	**0.04**	**0.21**	**0.68**	**6.83**	**0.01**	**0.01**	**76.71**	**916.54**	**1.56**	**0.00**	**0.00**
% OF TOTAL	**100.0**	**8.1**	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.3**	**0.0**	**0.0**	**0.0**	**0.1**	**0.6**	**0.0**	**0.0**	**7.0**	**83.5**	**0.1**	**0.0**	**0.0**

Table 5. Paddy rice import data (10^3 tonnes) from the FAOSTAT database (2007). The Western Hemisphere column is total import quantity in the hemisphere. Import quantities are given for the primary commodity (FAOSTAT glossary, 2007).

YEAR	Western Hemisphere	Argentina	Bolivia	Brazil	Chile	Colombia	Costa Rica	Cuba	DR	Ecuador	Guyana	Haiti	Mexico	Nicaragua	Panama	Paraguay	Peru	Suriname	Uruguay	US	Venezuela	Other - SA	Other - NA & CA
1990	116.44	0.21	0.00	85.23	0.04	8.43	0.26	0.04	0.00	3.48	0.00	0.05	14.52	1.75	0.04	0.00	0.50	na	0.51	0.78	0.60	na	na
1991	324.57	0.63	0.21	259.46	0.03	6.05	0.28	0.04	0.00	3.27	0.00	0.49	42.77	0.09	0.16	0.00	0.60	na	8.56	0.85	1.08	na	na
1992	219.96	0.21	0.17	84.12	0.02	1.32	35.96	0.04	0.00	3.03	0.00	0.53	78.62	0.11	0.10	0.00	9.68	na	0.01	5.38	0.66	na	na
1993	344.68	0.36	0.09	100.76	0.02	3.14	16.82	16.47	0.00	2.67	0.00	0.25	175.08	9.44	0.19	0.19	13.19	na	0.00	4.42	1.59	na	na
1994	508.97	0.82	0.33	255.97	0.01	2.97	10.20	0.04	0.00	0.00	0.00	na	165.14	1.68	0.11	0.00	13.47	na	16.52	4.18	37.53	na	na
1995	654.11	0.56	0.15	248.06	5.23	3.62	55.27	0.04	0.00	0.13	0.00	0.10	244.86	1.95	0.11	1.27	8.12	na	0.05	3.66	80.93	na	na
1996	643.84	0.53	0.01	152.88	0.03	41.68	86.91	0.04	0.00	1.41	0.01	na	296.39	19.69	0.01	0.02	20.52	0.03	0.41	3.18	20.09	na	na
1997	771.77	0.28	0.02	202.09	0.12	44.25	90.65	0.04	18.23	15.55	0.00	0.02	375.21	8.35	10.07	0.06	3.20	na	0.95	2.64	0.04	na	na
1998	1710.88	0.18	0.15	702.34	0.00	299.93	112.94	0.04	0.00	114.08	0.00	0.02	361.90	42.65	61.50	0.47	11.82	na	0.58	2.22	0.06	na	na
1999	1131.29	0.06	0.03	533.98	0.00	5.26	79.30	0.06	0.03	1.01	0.00	0.02	449.77	54.95	4.63	0.24	0.02	na	0.11	1.82	0.00	na	na
2000	883.05	0.01	0.25	200.07	0.00	0.77	65.07	0.10	0.00	6.00	0.00	na	529.80	73.86	4.96	0.11	0.02	na	0.01	1.98	0.04	na	na
2001	1001.84	0.01	0.99	215.79	0.00	18.09	68.73	0.08	0.00	0.01	0.00	27.26	542.50	122.91	5.19	0.04	0.01	na	0.01	0.21	0.01	na	na
2002	1188.03	0.01	0.01	239.84	0.00	0.36	108.54	40.82	0.00	0.10	0.00	8.27	647.19	101.10	28.35	0.06	11.02	na	2.27	0.08	0.01	na	na
2003	1766.42	0.33	0.00	655.40	6.14	0.81	145.09	56.01	10.95	0.09	0.00	0.92	714.40	111.74	8.50	0.00	0.00	na	0.01	0.17	55.86	na	na
2004	1134.61	0.27	0.00	187.19	0.02	5.02	177.35	0.44	0.02	0.66	0.00	na	621.16	132.37	8.95	0.19	0.38	na	0.07	0.49	0.03	na	na
2005	1248.73	0.27	0.15	44.31	5.62	1.75	157.47	31.72	110.39	0.13	0.00	na	674.73	155.61	66.08	0.09	0.02	na	0.02	0.35	0.02	na	na
AVERAGE	**853.07**	**0.30**	**0.16**	**260.47**	**1.08**	**27.72**	**75.68**	**9.13**	**8.73**	**9.48**	**0.00**	**2.37**	**370.88**	**52.39**	**12.43**	**0.17**	**5.79**	**0.00**	**1.88**	**2.03**	**12.41**	**0.00**	**0.00**
% OF TOTAL	**100.0**	**0.0**	**0.0**	**30.5**	**0.1**	**3.2**	**8.9**	**1.1**	**1.0**	**1.1**	**0.0**	**0.3**	**43.5**	**6.1**	**1.5**	**0.0**	**0.7**	**0.0**	**0.2**	**0.2**	**1.5**	**0.0**	**0.0**

Table 6. Paddy rice producer price data ($ US/tonne) from the FAOSTAT database (2007). The Western Hemisphere column is average producer price for the hemisphere. Producer prices are calculated by multiplying producer prices in local currency times the exchange rate for the selected year (FAOSTAT glossary, 2007).

YEAR	Western Hemisphere	Argentina	Bolivia	Brazil	Chile	Colombia	Costa Rica	Cuba	DR	Ecuador	Guyana	Haiti	Mexico	Nicaragua	Panama	Paraguay	Peru	Suriname	Uruguay	US	Venezuela	Other - NA & CA	Other - SA
1991	194.14	369.70	201.36	196.84	228.61	185.61	260.21	na	767.62	6.35	na	na	202.42	157.82	257.00	279.96	220.07	397.76	160.09	167.00	212.58	na	na
1992	205.94	242.27	213.31	155.35	168.59	169.90	263.34	na	990.12	10.50	na	na	183.21	190.20	258.00	226.63	208.70	784.32	158.52	130.00	177.69	na	na
1993	161.78	203.21	203.28	173.98	156.05	173.97	266.31	na	832.77	11.38	na	na	174.60	243.40	267.00	161.67	206.20	na	160.62	176.00	148.64	na	na
1994	165.76	245.24	178.12	200.22	207.12	239.91	259.20	na	602.81	14.73	na	na	203.85	238.59	276.00	196.88	164.01	83.99	197.86	149.00	189.22	na	na
1995	176.29	190.05	162.49	192.88	210.59	242.80	260.86	na	590.34	19.81	na	na	166.06	286.26	284.00	230.77	221.89	169.60	182.08	202.00	265.89	na	na
1996	184.05	210.07	165.73	205.95	200.11	271.10	262.58	na	595.38	24.33	na	na	212.78	296.72	263.00	189.13	273.10	179.44	206.98	212.00	280.69	na	na
1997	182.41	180.09	171.29	213.36	210.67	309.27	279.47	na	625.89	36.10	na	na	191.45	247.25	272.00	174.02	236.47	149.63	206.10	221.00	289.03	na	na
1998	185.94	220.11	166.42	248.17	195.12	292.73	278.83	na	571.85	45.82	na	na	179.51	236.25	280.00	218.60	276.45	149.63	245.04	207.00	279.11	na	na
1999	162.89	127.06	168.26	157.05	196.95	230.99	269.54	na	588.51	57.27	na	na	185.77	212.29	267.00	153.57	183.25	168.72	188.81	168.00	260.50	na	na
2000	150.14	116.06	165.12	136.06	160.45	196.70	267.34	na	542.27	160.08	na	na	155.15	190.39	282.00	112.44	166.19	211.73	106.04	125.00	210.06	na	na
2001	143.14	110.06	151.36	124.70	133.87	213.53	257.80	na	522.51	136.00	na	na	158.53	223.30	256.00	104.73	185.35	130.82	106.01	113.00	221.51	na	na
2002	132.88	125.03	142.26	92.10	122.29	197.58	247.70	na	480.81	130.00	na	na	169.95	207.49	263.00	111.09	147.87	121.45	116.01	90.00	158.74	na	na
2003	133.67	125.49	137.21	92.62	132.27	196.05	241.41	na	296.87	149.00	na	na	154.79	197.49	261.00	170.29	155.24	96.87	173.95	127.00	233.17	na	na
2004	168.62	179.68	137.96	104.13	155.80	220.55	264.92	na	655.60	226.00	na	na	167.96	197.06	268.00	231.20	148.79	95.15	230.07	186.00	240.69	na	na
2005	179.57	253.04	139.92	128.15	176.07	121.58	279.00	na	728.25	191.00	na	na	170.19	240.70	260.00	273.11	165.23	98.22	338.35	155.00	232.77	na	na
AVERAGE	**157.95**	**181.07**	**156.51**	**151.35**	**165.91**	**203.89**	**247.41**	**0.00**	**586.98**	**76.15**	**0.00**	**0.00**	**167.26**	**210.33**	**250.88**	**177.13**	**184.93**	**177.33**	**173.53**	**151.75**	**212.52**	**0.00**	**0.00**

APPENDIX 4 – INDUSTRY AT A GLANCE

	Rice Industry Structure				Management Practices				
Country	Production Quantity[8] (1990-2005 Averages)	Area Harvested[8] (1990-2005 Averages)	Number of Producers	Relative Organization/ Connectivity of Rice Growers	Rice Growing Season		Percent of Irrigated Rice (as a percent of total rice area)	Stubble Disposal Practices	Source of Technical Advice
	(10^3) tonnes	(10^3) hectares			Planting[12]	Harvesting[12]			
Argentina	862	166			Oct-Nov	Mar-Apr			INTA, SAGPAyA
Bolivia	285	140			Oct-Dec	Feb-Mar			SEDAG
Brazil	10234	3745		Moderate	Nov-Dec (North) Mar-May (Northeast) Oct-Nov (South)	Apr-Jun Aug-Oct Mar-Apr	19[4]		EMBRAPA, IRGA
Colombia	2097	450	28000[9]		Aug-Oct (winter) Mar-Apr (summer)	Jan-Mar (winter) Jul-Aug (summer)	67[4]		Ministry of Agriculture and Rural Development
Cuba	491	174			Mar-Apr	Jul-Aug	100[4]		
Dominican Republic	537	113			Mar-Apr	Jul-Aug	93[4]		State Department of Agriculture
Ecuador	1235	348	70000[7]		Dec-Feb (winter) May-Jul (summer)	Apr-Jun (winter) Sep-Dec (summer)	54[4]		
Guyana	415	118	>12000[15]		Jan-Feb	May-Jun	71[4]	Burn[16]	Guyana Rice Development Board[17]
Mexico	345	79	5600[3]	Moderate	Mar-Apr	Aug-Sep	34[3]	Burn[14]	SAGARPA[3]
Nicaragua	224	71	17000[2]	Moderate	Apr-May Apr-May	Sep-Nov Sep-Oct	33[15]		MAG-FOR, CIAT
Panama	218	101							MIDA
Peru	1548	252	100000[7]	Low	Jan-Feb	May-Jun	80[4]		Ministry of Agriculture
Uruguay	898	152	600[1]	High	Oct-Dec	Mar-May	100[4]		
US	8620	1262		High	Apr-Jun (Gulf) Apr-Jun (CA)	Aug-Oct (Gulf) Sep-Nov (CA)	100[4]	Flood/Burn[18,19]	Cooperative Extension
Venezuela	728	160		High	Nov-Dec (dry) Jul-Aug (wet)	May-Jun (dry) Nov-Dec (wet)			INA, FUNDARROZ

[1]"Arroz en Uruguay," n.d.
[2]Cáceres, 2005
[3]Comite Sistema Producto Arroz, 2005
[4]"Distribution of rice crop by area," 2001
[5]D. Guadagnin, pers. comm., November 19, 2007
[6]E. David, pers. comm., November 8, 2007
[7]FAO, 2006
[8]FAOSTAT database, 2007
[9]FAOSTAT trade flows, 2007
[10]Goodman, April 26, 2006
[11]J. Hasbrook, pers. comm., November 16, 2007
[12]MacLean et al., 2003
[13]M. Guzmán, pers. comm., November 6, 2007
[14]O. Rodriguez, pers. comm., November 19, 2007
[15]"Participatory rice research," n.d.
[16]"Rice in Guyana," n.d.
[17]UNEP, 2002
[18]Hill et al., 1997
[19]G. Yielding, pers. comm., October 29, 2007

	Economics/Finances		Policy		Social/Culture	
Country	Role in Market (Net Importer, Net Exporter, National Consumer)[8]	Trade Partners[9]	Type of Subsidy	Existing Policy	View of Waterbirds	Intergenerational Recruitment
Argentina	Exporter	Brazil, Costa Rica, Paraguay, Uruguay, Sub-Saharan Africa		Mercosur		
Bolivia	Domestic Consumer				Neutral[13]	High[13]
Brazil	Importer	Paraguay, Uruguay, Argentina, US		Mercosur	Neutral[5]	High[5]
Colombia	Domestic Consumer					
Cuba	Importer					
Dominican Republic	Importer					
Ecuador	Domestic Consumer				Favorable[6]	Low[6]
Guyana	Domestic Consumer					
Mexico	Importer	US	Inputs, some direct		Neutral[14]	Low[14]
Nicaragua	Importer	Costa Rica, Guatemala, US	Inputs			
Panama	Domestic Consumer					
Peru	Domestic Consumer					
Uruguay	Exporter	Brazil, Argentina, Sub-Saharan Africa		Mercosur		
US	Exporter	Mexico, Asia, Middle East	Countercyclical, direct payments	Farm Bill/NAFTA, CAFTA-DR	Favorable[11]	Low[11]
Venezuela	Domestic Consumer					

[1]"Arroz en Uruguay," n.d.
[2]Cáceres, 2005
[3]Comite Sistema Producto Arroz, 2005
[4]"Distribution of rice crop by area," 2001
[5]D. Guadagnin, pers. comm., November 19, 2007
[6]E. David, pers. comm., November 8, 2007
[7]FAO, 2006
[8]FAOSTAT database, 2007
[9]FAOSTAT trade flows, 2007
[10]Goodman, April 26, 2006
[11]J. Hasbrook, pers. comm., November 16, 2007
[12]MacLean et al., 2003
[13]M. Guzmán, pers. comm., November 6, 2007
[14]O. Rodriguez, pers. comm., November 19, 2007
[15]"Participatory rice research," n.d.
[16]"Rice in Guyana," n.d.
[17]UNEP, 2002
[18]Hill et al., 1997
[19]G. Yielding, pers. comm., October 29, 2007

APPENDIX 5 – RICE INDUSTRY GUIDE

*See separate Appendix5 Excel file.