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Multifunctionality in U.S. Rice Production: a Logit Analysis in Farmers Participation

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ABSTRACT

Multifunctionality refers to the multiple outputs of the agricultural activity in addition of its role of producing food and fibre, such as maintaining the viability of rural communities and environmental protection. Although, multifunctionality per se is not widely accepted U.S. agricultural policy its principles are fundamental to some policies that support functions beyond commodity production for the agricultural landscapes.

The first part of this study aims to explore the different paths that the concept of multifunctionality can follow in the U.S. based on the EU experiences, exploring different arguments, current policy instruments and agricultural practices. Following, a logit analysis t is selected in order to examine and explain the factors involved in the participation of rice operators in multifunctional initiatives, through conservation programs or the provision of recreational activities and agritourism services.

The model suggest that factors affecting the likelihood that a farmer adopts multifunctional activities are the level of education, years of experience, level Income from off farm and percentage of ownership, yield, intensity level of the rice, location, access to technical information and the implementation of other conservation plans .

Key words: Multifunctionality, agricultural policy, logit analysis, U.S rice.

This thesis is approved for recommendation
to the Graduate Council.

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Table of contents

Table of figures

1. Introduction

The concept of multifunctionality in agriculture has become an important part of the agriculture policy debates in the last decades. In general terms, multifunctionality refers to the multiple outputs of the agricultural activity in addition to its role of producing food and fibre, such as maintaining the viability of rural communities and environmental protection. While the definition is very broad it is at the same time related to other concepts such as public goods, externalities or 'jointness' of products. Thus, the scientific community has explored different interpretations and some countries have developed policy agendas with a particular focus on the multiple functions of agricultural activities. The emphasis for other functions of agriculture has been the reason to sometimes refer to multifunctionality as the post-production model, defining it as the new paradigm in the context of agriculture (Wilson, 2008).

In the traditional view, agriculture systems have been regarded as production units of marketable goods or commodities. Thus, policy and technology were focus on help farmers to increase the supply of goods in the market. However, this is no longer the only prevailing perception toward agriculture based systems. There is increasing concerns not only in negative externalities, but also on the positive externalities that agriculture can provide. Farmers are no longer regarded as simply a producer of marketable goods; they are as well producers of environmental and cultural services.

The adoption of policies to support multifunctionality has been especially important and dominant in Europe and Asian countries, sometimes as an effort to maintain flexibility in their farm policies. While the U.S. does not have an official position on the multifunctionality of agriculture, there is an existing debate with regard to this new model (Bohman et al. 1999). The U.S. agricultural sector has been able to develop a very competitive agriculture value chain structure and avoid the public restructuring problems, (such as diseconomies of farm size, peri-urban preasure on the land use, market acces, etc.,) of other industrialized countries. However the increase of international pressure to reduce traditional domestic support and trade protectionism raises the question regarding the future of existing price and direct income support policies. Although, multifunctionality *per se* is not widely accepted in U.S. agricultural policy, its principles are fundamental to some conservation policies and programs, such as the Environmental Quality Incentive Program (EQIP) or Conservation Security Program (CSP). The use of other similar terms such as multi-output and the adoption of policies that support functions beyond commodity production for the agricultural landscapes have been interpreted by some authors as an approach to this new paradigm (Lovell et al. 2010).

Currently it is well accepted in the international arena that the agriculture sector in developed countries is strongly determined by national policies. The U.S. periodically (approximately every 5 years) updates its Farm Bill to authorize different policies addressing agricultural sector intervention. Each periodic legislation introduces changes to suit the evolving needs of this sector, while responding to the long-term relative decline of its economic importance to the national economies. Consequently, adjustments in policies reflect the evolution of the sector and provide a reference to understand the potential challenges for the future.

This M.Sc. thesis aims to explore the different paths that the concept of multifunctionality can follow in the U.S. based on the EU experiences, exploring different arguments, current policy instruments and agricultural practices. With this purpose, the analysis will ultimately focus on rice production, using a logit analysis to understand the factors that influence the participation of U.S. rice operators in multifunctional activities.

The use of rice as a reference crop is based on two reasons. First, because rice is a staple crop with a very wide distribution on the planet it has always been the recipient of high domestic support in the national policies, even in the case of North America where consumption levels are relatively low compared to other regions. Second, rice production receives considerable attention as a multifunctional crop in different regions, as for example in the European Common Agricultural Policy or in Japan and other Asian countries (Cooper et al, 2009; Matsuno et al., 2006).

Rice production in the United States has some particularities compared to Asian and European productions. On the one hand, its production accounts for barely 2% of the world's production, however the U.S. is among the 5 biggest exporters accounting for 10% of the annual volume of global rice trade. The reasons behind this situation are that domestic consumption in the U.S. is relatively low by global standards and therefore the U.S. exports around 50 % of its production. Also in recent years U.S. rice farms have obtained very high yields under controlled irrigation and achieved high levels of technical efficiency, obtaining high levels of profitability for this crop.

This paper is organized as follows. The next chapter introduces the objectives and research questions. Chapter 3 provides a literature review on the concept of multifunctionality, with a first section mainly based on the EU research on the topic and, a second section on the U.S.'s initial scepticism, which has been followed by a slow but growing appreciation of the concept. In chapter 3, I present the conceptual framework to estimate a binary logit regression to understand the factors that determine the participation of U.S. rice operators in any activities related to multifunctionality. Chapters 4 and 5 contain a description of the data used and the methods. Chapter 6 presents the results and the discussion of the results. Finally chapter 7 introduces conclusions on the model observations and of the use of multifunctionality as a framework in the U.S. agricultural sector.

2. Objectives and research questions

The concept of multifunctionality is relatively new in research applications regarding the U.S. agricultural sector. As will be discussed, there are different interpretations of multifunctionality and sometimes they have been associated with political arguments and linked or appropriated to national or regional realities.

On the other hand, the United States has succeeded in adapting to free market conditions maintaining its global competitiveness and therefore there is this reason, among others, why the argument of multifunctionality in agriculture has not enjoyed much attention until now. Despite its competitiveness, there is growing concern that agricultural subsidies for U.S. farm producers cannot be justified on the basis of traditional arguments of price and income instability and inferior terms of trade relative to the non-farm economy. As the production sectors in Europe and developed Asian agricultural economies have found, appealing to the multifunctionality of the sector as a rationale for public support and subsidies has supplanted the traditional rationales for public intervention.

Rice farmers in the U.S. have enjoyed in recent years very profitable conditions in the cultivation of rice. Despite favorable conditions, the scope of the farmers has expanded by adapting to more efficient practices and engaging in other activities that provide farm income diversification. Participation in conservation programs by introducing and encouraging environmental considerations in agricultural operations can be and is identified with an approximation of U.S. agriculture to a multifunctional approach in this study. This approach is also reflected in the engagement in on-farm income diversification through the provision of recreational activities and agritourism services.

To understand the factors that affect farmer participation in initiatives considered more multifunctional in rice production a logit model is estimated. This empirical modeling framework is selected in order to examine and explain the factors involved in the participation of rice operators in multifunctional initiatives.

3. Literature review

a. Multifuntionality in Agriculture

i. Definition

The concept of multifunctionality in agriculture refers to the multiple outputs of the agricultural activity in addition to its role of producing food and fibre. This is an activity and outcome oriented notion, describing the results of the interrelationship of the different farm activities and the role of these activities within their territorial situation.

Under this general notion, multiple international organizations have produced research and developed different definitions for multifunctionality in agriculture. Thus, for example, the United Nations Food and Agriculture Organization (FAO) focused on the multiple roles of agriculture (Bresciani et. al., 2004) and its contributions to the different livelihood strategies of households in rural areas, especially in developing countries. Another interpretation is associated with the reform of the Common Agricultural Policy (CAP) of the European Union, which conceives the multifunctionality approach to be a key reason to maintain the economic vitality of rural areas along with other activities such as tourism and services. Under this viewpoint, maintaining the farm population is a basic constituent of a vital rural social structure and traditions associated with these rural landscapes.

The definition offered by the Organization for Economic Co-operation and Development (Maier & Shobayashi, 2001) receives considerable attention in the literature, and offers a more suitable definition for the current thesis, in part due its neo-classical economic approach and also for the ideological orientation of the Organization for Economic Cooperation and Development (OECD). In the OECD publication by Maier and Shobayashi (pg. 10, 2001), multifunctionality is defined as: “Beyond its primary function of producing food and fibre, agricultural activity can also shape the landscape, provide environmental benefits such as land conservation, the sustainable management of renewable resources and the preservation of biodiversity, and contribute to the socio-economic viability of many rural areas. Agriculture is multifunctional when it has one of several functions in addition to its primary role of producing food and fibre. "

The OECD study (Maier & Shobayashi 2001), states that the non-market outputs of farm activities constitute potential sources of market failure and create theoretical arguments for public intervention. These potential sources of market failure are diverse but usually related to the concept of joint products, externalities or public goods.

The number of additional functions connected to agricultural activities may be large, with presence and relevance strongly dependent on a regional specificity. Van Huylenbroek et al. (2007) introduce a classification of the different potential functions of agriculture in five colour codes: the green function for the environmental aspects (as landscape, biodiversity, nutrient recycling and limitation of carbon sinks); blue services (water management); red (energy production); yellow services (social cohesion, and vitality, ambience and development, exploiting cultural and historical heritages, creating a regional identity and offering hunting, agro-tourism and agro-entertainment); and, white functions (food security and safety).

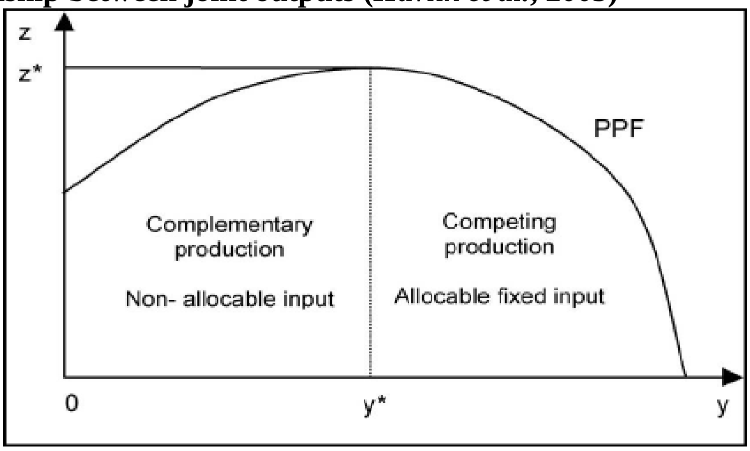
In the study of the multifunctionality, Aumand *et al*. (2006) distinguish two main approaches depending on the production side of their focus, describing the supply side (positive approach) and a demand side (normative approach). In addition to these two main schools, a third more holistic approach is given by rural sociology and rural geography, that describes multifunctionality from a territorial perspective describing farm activities as users of local resources and the linkage with consumers and producers (Cairol *et al.*, 2008).

Supply vision

The supply side approach analyses multifunctionality in terms of joint outputs of agricultural activities or as a result of the combination of these activities with their environment. Multifunctionality described from the supply vision constitutes an attribute of the agricultural production rather than an objective for the society, more related to the demand vision.

The multiple outputs, that farms supply as a result of the use of traditional agricultural inputs, may produce complementary or competing joint outputs, often as a result of the level of production on the farms. Havlik et al. (2005), describes a situation where based on the decisions of production the outputs can be produced at the same time being complementary, or enter into competition while choosing to increase the production of one of the outputs and to decrease another output (Figure 1). Under this concept, farms with highly profitable crops y may choose to maintain high levels of production, resulting in the decline of other z non-commodity outputs.

Figure 1. Relationship between joint outputs (*Havlik et al.*, 2005)



In the study by the Maier and Shobayashi (2001) three reasons for the jointness of production are discussed. The first reason is due to the technical interdependencies in production of multiple outputs, whereas choosing a technique of production that increases the production of one of the outputs, may have an impact of increasing or decreasing the others, with the same amount of inputs. These are generally negative outputs and are typically related to environmental impacts, as for example the case of soil erosion, water pollution, etc; but can be also positive as the result of, for example, crop rotation.

A second reason is the jointness of production as a result of the non-allocable inputs. A classical example is landscapes that agricultural crops often form, where the existence of the landscape always exists, but the quality of it may be altered.

The last reason refers to the allocation of the fixed inputs at the farm level to different outputs in the production process. The more relevant fixed inputs are usually land and self-employed labour.

Demand vision

The demand vision introduces the view of the society and the possible expectations or services that society may have on the agricultural activities, aside of the production of traditional products of food or fibre. According to Casini et al. (2004), the demand vision describes the potential production of material or immaterial goods and services that satisfy social expectations, meeting societal demand or needs. The additional outputs from agriculture may result from the structure of the agricultural sector, agricultural production processes and the spatial extent of agriculture.

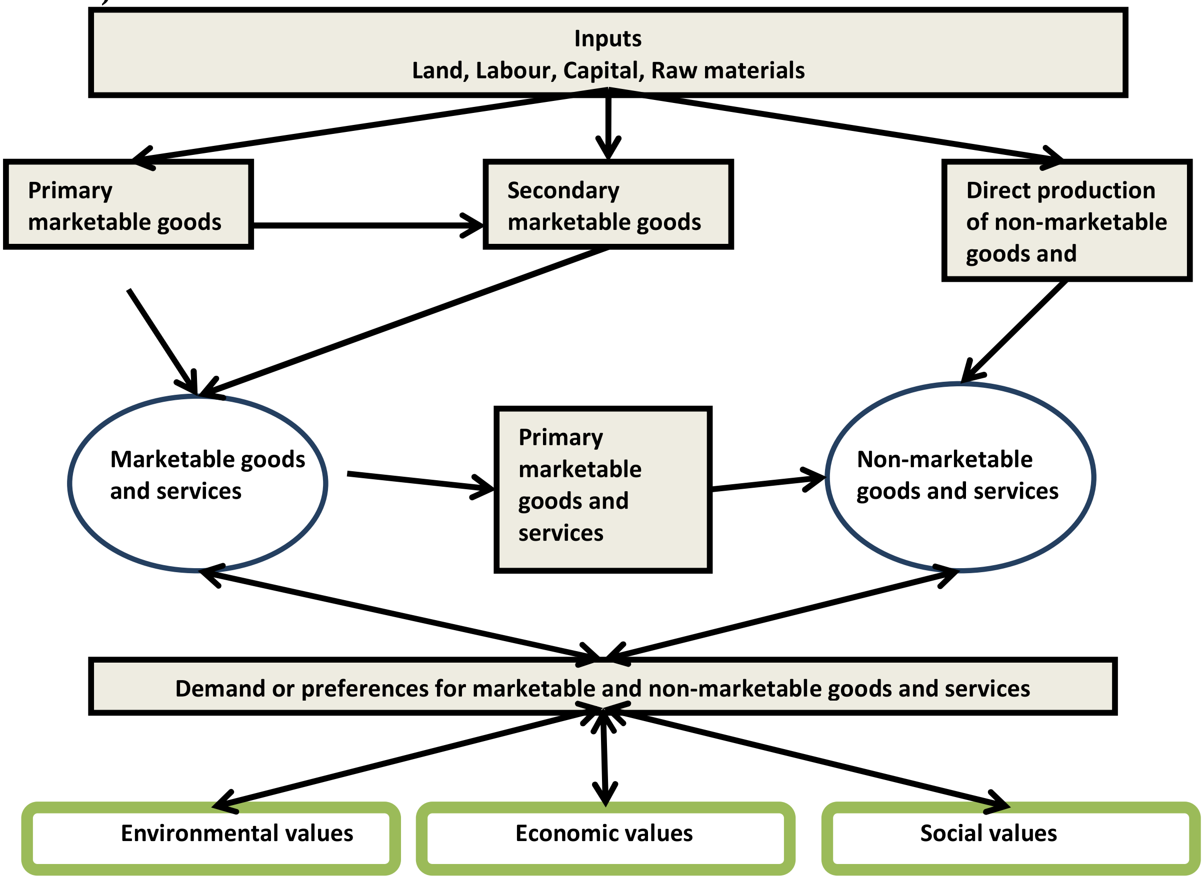
Under this vision agricultural land becomes also a consumptive space, where in addition to its production function it also may provide protection of wildlife habitats, biodiversity of landscape amenities, etc.

Within this vision three categories are often distinguished: ecological values (biodiversity, protection of habitats), social values (education, cultural diversity, and heritage) and economic values (rural employment, economic vitality, territorial valorisation).

Representing a multifunctional character of farm systems

The previous section explains two ways of approaching multifunctional agriculutre, from the perspective of supply and demand. Both approaches, have been combined to provide a general framework. Figure 2 represents an analytical framework that brings together the supply and demand side visions on multifunctionality, described in the previous section. Despite two sides of the multifunctionality vision it is rather clear that the core elements of multifunctionality are: (i) the existence of multiple commodity and non-commodity outputs that are jointly produced by agriculture; and (ii) the fact that some of the non-commodity outputs exhibit the characteristics of externalities or public goods, with the result that markets for these goods do not exist, are not well-defined or function poorly in generating market signals to produce.

Figure 2. Analytical framework to combine supply and demand vision (Van Huylebroek et al. 2007)



A farm as a multifunctional system becomes important to study by the nature of 'jointness' between non-commodity and commodity outputs and to define the relationships between the production factors within the agricultural production process which give rise to such linkages Ferrari (2004), Maier and Shobayashi (2001), Cahill (2001) and Vanslembrouck and Van Huylenbroeck (2005) provide some guidelines to analytically investigate the linkages. They suggest looking at the following issues:

• The extent to which the non-commodity outputs of agriculture are linked to or can be dissociated from commodity production;

• whether there are economies of scope in the joint provision of commodity and non-commodity outputs;

• whether and how the production linkages are influenced by site-and area-specific conditions (spatial dimension);

• the possibilities of alternative provisions of the non-commodity outputs. Even if there is jointness with agricultural production can other providers exist,

• finally, the mutual influence among the non-commodity outputs or the co-dependencies within the bundle of outputs.

ii. Clusters of research

The concept of multifunctionality has its origins in the early 1980s. Since then it has been the result of much debate, leading to different definitions, interpretations and different policy instruments. Scientific research reflects also this diversity of approaches in exploring the concept. Given the diversity of approaches, it becomes essential to develop an overview of the research on this topic. Caron et al. (2008) organized the scientific literature in four main categories of research, according to the level of analysis in the agricultural chain and to the main level of governance (market or public institutions) that organizes the distribution of goods and services (see also, Renting et al. 2009). The four main categories are: market regulation approaches, land-use approaches, actor-oriented approaches, and public regulation approaches.

Market regulation approaches

A first cluster examines the economic aspects of the non-commodity outputs and the policy mechanisms to introduce these new aspects into market mechanisms. According to Renting et al. (2009), this approach belongs to the disciplinary approaches of neoclassical economics and institutional economics; as a result the research in this area is very consistent with the traditional approach of the OECD.

Part of the research under this approach aims to set a theoretical background to establish the economic nature of multifunctionality. Under this aim, key economic concepts such as ‘public goods’, ‘externalities’ and ‘jointness’ have been explored. The definition of these concepts allows the study of the potential sources of market failure for the non-commodity outputs of the multifunctionality and introduces the potential arguments for the introduction of public intervention.

Another field of research under this approach has been the development of economic valuation techniques, to provide estimates of social and private costs and benefits in monetary units. The estimates in monetary value of the multifunctionality opened an important debate on how green prices can be considered as uniform or if they may differ according to the regions (Vatn, 2002).

A last group of studies explore the different governance structures that can be involved in providing public goods and services, and the transactional costs associated with provision (Romstad, 2004).

Land-use approaches

The land use approach introduces a focus on spatial issues associated with multifunctionality of agriculture and rural areas. This approach is mainly at a territorial level. It combines several approaches including landscaping, conservation ecology, geography, land-use distribution and regional economics. According to Groot et al. (2010) four different approaches can be described: descriptive/analytical, predictive or projective, explorative and design-oriented. All four approaches are affected by modelling to a different degree, being more relevant in predictive and exploratory studies.

The descriptive/analytical approaches look to the current and historical land-use patterns and combine with socio-economic information to provide an evaluation on the situation of the systems. The predictive approach, produces assumptions or possible future scenarios based on the descriptive/analytical methods of the current situation of the agricultural systems. On the other hand, the explorative approach describes possible developments of the systems based on the potentials of the natural systems, but they do not need to exist currently. The last type, the design-oriented approach explores different alternatives of future development and leads to decisions about which of those is the most desirable state.

Actor oriented approaches

The third approach adopts a perspective on the farm level or farm household to define and analyse the different rationales that affect actors involved in the construction and development of multifunctionality in agriculture. With an approach more in line with rural sociology and agricultural economics, the multifunctionality of agriculture is considered as a result of an evolving understanding of the rural space to accommodate new services and functions, beyond the productive idea (Knickel & Kröger, 2008). Under this scope a large set of goods are considered, including environmental aspects, energy production, food security, social cohesion and social services. This larger scope corresponds with a new paradigm of rural development, that according to some authors (Van der Ploeg & Roep, 2003), has its particularities on 'broadening', 'deepening' and 're-grounding' the relations between agriculture and society.

The traditional actor oriented research gave particular attention to the agricultural practices as a mainly profit-seeking activity, but this approach explores other non-commercial reasons for the maintenance of rural households and communities, as for example maintenance of cultural heritage or lifestyle preferences (Van der Ploeg & Roep, 2003).

In the last decade, the actor-oriented approaches have received much attention in countries where multifunctionality approach plays a key role in the agricultural policy. This approach has been a key element to identify empirical expressions of multifunctionality and to understand how the traditional sector of agriculture can contribute to a larger number of functions and services to the social communities.

Public regulation approaches

The last category of approaches analyses the institutional arrangements and the diversity of policies referring to multifunctionality and its different impacts. The discussion on how to introduce multifunctionality has raised considerable debate and discussion in recent years, both in countries that have chosen to incorporate these concepts, and in others who have analyzed the implications of such policies on international trade and therefore as this affects their production and competitiveness. Despite the concern on their implications for other countries, this approach tries to analyse how countries are integrating these policies efficiently.

Thus, some studies address the degree of recognition of multifunctionality in their governmental institutions. In this line, there are also studies that discuss to what extent multifunctionality has been interpreted or integrated in different regions under a common regulatory framework. The existence of specific challenges at a local context (Dufour et al. 2007), the different conceptions of rural development (Marsden and Sonnino, 2008) and the distinctive environmental management strategies have been viewed to be the key to determine how multifunctionality has been framed differently.

Other studies seek to determine whether existing national contexts have encouraged and initiated the adoption of policies for multifunctionality (Vandermeulen et al. 2006), or if on the other hand, policies designed with the goal of having a multifunctional agricultural sector have been the drivers of innovative practices at a regional level (Clark 2006). Apart from stressing the importance of both courses of action, further studies address how this cycle may be reinforced. Van Hulenbroeck et al. (2007), stress the idea of incorporating other partnerships between the private and public sectors as an important factor in the establishment of a more multifunctional agriculture.

The last subcategory in this approach concerns the evaluation of policies related to multifunctionality. In this context, the greatest contribution to the literature comes from the European Union, as a direct result of policy that is oriented towards enhancing the multifunctionality of the agriculture and the rural areas. Knickel and Kröger (2008), point in a review of policy evaluation in the EU that some aspects of multifunctionality such as environmental quality, biodiversity and landscape impacts have received more importance, and others such as recreational uses have been neglected or underexposed. This review also exposes the difficulties of addressing a broad policy issue and the need to apply the evaluation to the entire policy process.

Other studies point out the need to bring a policy evaluation that combines quantitative, qualitative and consultative methods (Knickel and Kröger, 2008; Zander et al., 2008), as a better way to understand the multiple impacts of multifunctionality.

iii. Sustainable development and Multifunctionality

Initially, the concept of multifunctionality appeared closely linked to the idea of sustainability, with its first appearance official documents of the Sustainability Conference in Rio 1992[1].

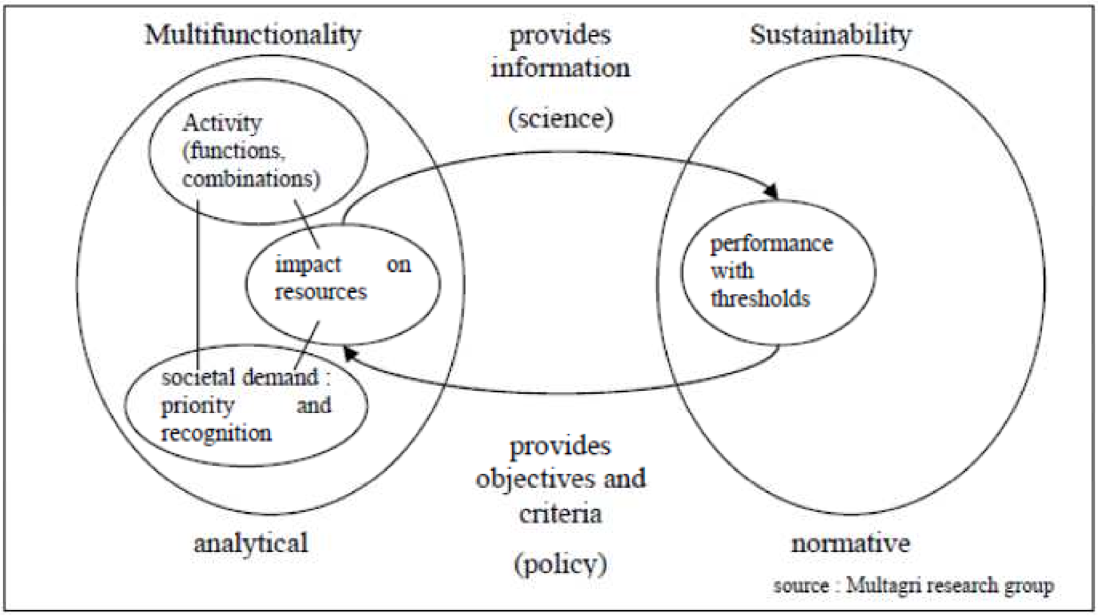
[1] The United Nations Conference on Environment and Development (UNED) also known as the Rio Summit or Earth Summit was a major UN conference held in Rio de Janeiro 3-14 June 1992. http://www.un.org/esa/dsd/resources/res_docukeyconf_eartsumm.shtml

Similarly, the European Union based its model on the hypothesis that to make agriculture more sustainable, the dimension of multifunctional agriculture should be enhanced. This hypothesis evolves with the adoption of multifunctionality as an analytical framework and the assumption of an existing linkage between sustainability and multifunctionality becomes unclear.

Multifunctionality as an analytical framework is an activity or outcome oriented view that describes characteristics of farm production and joint outputs of agricultural activities. The translation in policies in the normative approach of multifunctionality has been directed to the same goals and dimensions that concern sustainable development. Therefore, the use and understanding of multifunctionality as a framework becomes a possible way to address sustainable development (Cairol et al., 2006). Figure 3 illustrates how the impact of agricultural activities on resources relates to the concept of sustainability. Since the conception of multifunctionality is based on activities and functions it is possible to establish a link with sustainability, providing objectives and criteria to regulate the impacts that agriculture can have on the natural resources that employ in the production process.

Figure 3 also shows the importance and the analytical concern that multifunctionality places among the relations of the activity, the demands of the society and the impacts on the society and resources. According to this, changes in demands of the society should change activities as well as resource impacts which may in turn raise social concerns. The role of science is to provide information on the state of the impact and to analyse the performance in meeting societal sustainability standard (Kroger, 2008). Finally, policy may translate the set of rules to provide the thresholds that limits the impact on the resources.

Figure 3. Formalisation of links between multifunctionality and sustainability (Cairon et al., 2006)



In most of the research the relationship between multifunctionality and sustainability have been considered implicit and is rarely mentioned explicitly.

According to the figure, we can make a last remark to understand that multifunctionality does not assure sustainability; the combination of functions can be unsustainable if their impact on resources is negative in regard of criteria defined by society.

b. Multifunctionality in the U.S.

i. Main arguments

The appearance of the concept of multifunctionality as a new analytic framework for U.S. agriculture raised two issues for national farm policies in the United States. On one hand, it was argued that the concept was a new device to create trade barriers (Bohman et al. 1999), negatively affecting the large volume of exports U.S. traditionally recorded. On the other hand, if multifunctionality is accepted, the implementation of this approach in U.S farm policies will present some challenges altering the way agricultural policies are implemented in the farm sector relative to the past (Freshwater 2002, Blandford et al. 2002).

The first references in official documents to the multifunctional character of agriculture appeared in the Rio Conference in 1992. However, the importance of the international debate emerged years later in 1999 as a result of negotiations on international trade when the EU, Japan and South Korea proposed to include specifically the term "multifunctionality" of agriculture in the review of the Uruguay Round Agreement on Agriculture (AoA) to address considerations on biodiversity, landscape, cultural heritage, food security and rural development. In opposition to this proposal, were the food exporting countries organized in the Cairns group[2] and the United States, arguing that under this concept were grouped policies and instruments aimed to maintain the protection of national agricultural markets and distortions in international trade.

The concerns associated with multifunctionality from the U.S. were described on the report by the Economic Research Service of the USDA, authored by Bohman et al. (1999). It was argued

[2] The Cairns Group is a coalition of 19 agricultural exporting countries which account for over 25 per cent of the world's agricultural exports, organised to push for the liberalisation of trade in agricultural exports. Members of the Group are: Argentina, Australia, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Guatemala, Indonesia, Malaysia, New Zealand, Pakistan, Paraguay, Peru, the Philippines, South Africa, Thailand and Uruguay.

that the idea behind multifunctionality was being misused in the international trade negotiations to maintain trade-distorting domestic policies, the designated amber box. The major proponents of the multifunctionality were in fact the countries that had higher levels of the designated trade-distorting domestic policies.

Also questioned was the need for subsidies linked to production under the economic argument of joint production, arguing that some of the measures in the “green box” provided tools to address the non-commodity products. This last argument belongs to the tradition of the U.S. to address environmental problems removing crop land from production to achieve goals related to non-food outputs.

The United States was clearly in opposition to the multifunctionality character in the international negotiations. But there have been some U.S. references to this approach, especially in the last decade. For example, on the eve of the WTO negotiations in Seattle in 1999 Secretary of Agriculture Glickman gave a speech to the International Federation of Agricultural Producers which alluded to the multifunctional policies "to support the right of any nation to give farmers the tools they need to prosper."

The updates of the U.S. farm bills since beginning in 2002 has been considered by many as a shift in the approach to conservation policies introducing new mechanisms such as “working lands” conservation, as well as an approach to a more multifunctional agricultural production (Claassen 2003, 2006).

ii. Reasons behind the U.S. Skepticism

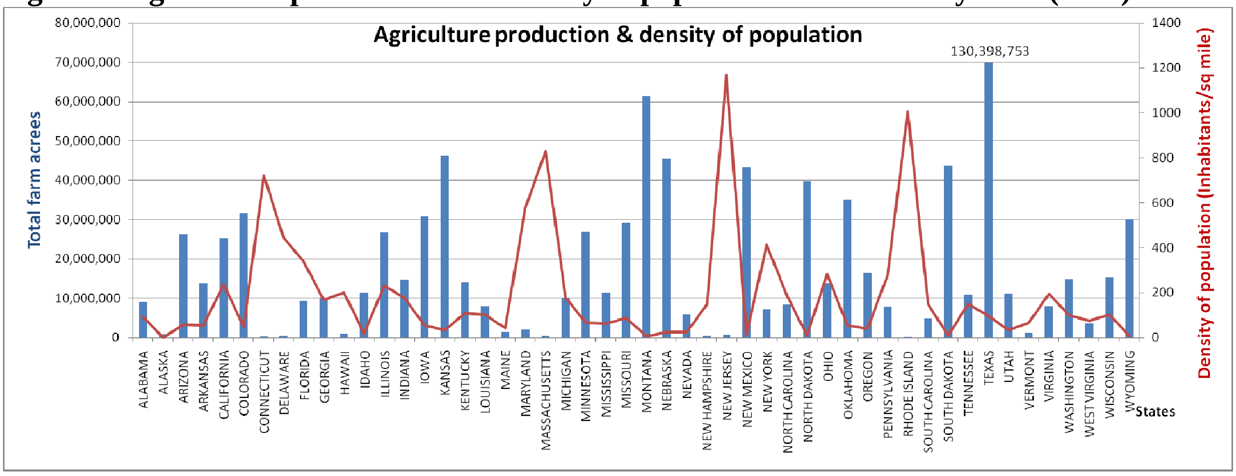
The concept of multifunctionality has been extensively related to sustainability in the European reform of the agricultural sector. The multifunctionality approach reflects efforts to introduce the ideas of sustainability in the context of agricultural practices, introducing other considerations besides the purely production of commodities. Also, in the United States some consider multifunctionality an innovative approach to solve problems especially related to negative externalities in the agricultural sector (Freshwater 2002). At the same time, there are differences in the perception of agriculture and political mechanisms that differentiate the extent to which this new approach differs in the United States.

First, the necessary policy instruments to implement this approach require intervention at different levels of political responsibility (Freshwater, 2005). For example, land-use management has traditionally been a local issue, so it is difficult to promote national measures to address the issue. It is consequently possible to find more tools at the local level to implement the multifunctional character of agriculture. At the same time, this local responsibility is appropriate to the spatial location of most public goods and externalities linked to agricultural practices (Gundersen, Kuhn, Offutt, & Morehart, 2004).

Second, U.S. policy historically addressed the environmental negative externalities of agricultural practices on an issue by issue basis and, sometimes, provided incentives to remove the environmental sensitive land from the production.

Third, there exists a disconnection between most agricultural activities and where people live. Multifunctional strategies have been especially linked to peri-urban environments, where farmers have innovated to respond the socioeconomic pressures and land use changes adapting to diversify their production to the new demands of the population (Zasada, 2011). In the U.S., the majority of the population is concentrated on the coasts and most agricultural activities take place in the central region of the country. Thus, the agricultural areas have been established as vast areas of agricultural production, with which the majority of the population have nowadays little contact. In figure 4, we observe that states with low density of population usually have large amounts of farm land.

Figure 4. Agriculture production and density of population in the U.S. by state (2007).



Source: U.S. Census Bureau.

Another reason that complicates the implementation of multifunctionality in the U.S. is the opinion of the population on current agricultural activities. Despite the continued existence of small-scale agricultural activities, currently many people look at the agricultural sector mainly as a commercial enterprise. This implies that agriculture is no longer part of the popular culture of the U.S. population, as it was in the past. Thus, one of the goals of the multifunctional approach, to preserve the rural areas, has lost acceptance in American society (Bales and Grady, 2005). However, some efforts have been made in recent years to reconnect the urban population with agricultural activities. For example there has been a 16% increase in the number of farmers markets between 2009 and 2010, or initiatives such as the First Lady Michele Obama planting a White House food garden.

This view on agricultural activities at the same time makes the implementation of policy instruments to promote practices that are more multifunctional more difficult. Agricultural activities have received significant financial funds in recent years and have also benefited to a greater extent the large commercial farms with little impact on small scale farms (Bailey 2007). As a result, public opinion has a poor perception of financial support of agriculture and has moved to adopt a position for the reduction of agricultural subsidies.

Finally, the approach of multifunctionality requires a rethinking of U.S. agricultural policy. Over the last decades, the agrarian policy of the United States has been based on maintaining their competitiveness in international markets as a model of development (table 1). This, together with the organization of policies on a commodity basis and the distribution of influence in the agrarian policy negotiations, involves difficulties to implement other development models. However, in recent years the increasing presence of environmental groups and small farmers, has opened up new tools and considerations in the agrarian model. Some authors consider possible transformation or integration of practices that are more multifunctional farming systems in the U. S. (Jordan et al., 2010).

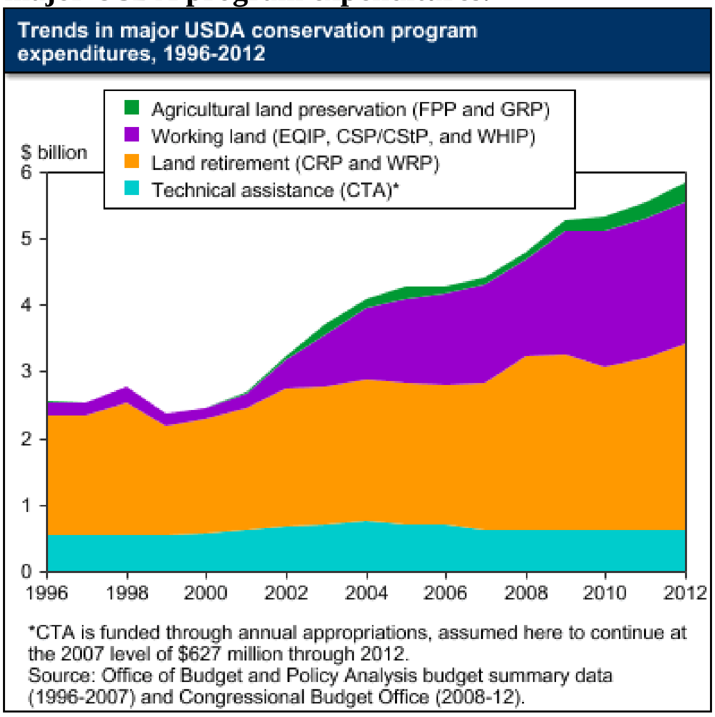
Table 1. Development models under competitive paradigm and multifunctional paradigm (Allert et al., adapted for Van Huylenbroek et al. 2007)

Development models	**1**	**2**	**3**	**4**
Policy paradigm	**Competitive**	**Multifunctional**		
Planning discourse	Production space	Network of activities	Network of localities	Ecosystem
Main agricultural model	Industrialised, large scale commodity producing agriculture	Agri-business complex exploiting local comparative advantages	Local food systems with diversification	Ecological farming systems
Main market for products	World commodity market	Identified world markets for value chains	Local food market	Specific markets for integrated and organic produce
Regional approach	Not, individual producers organised per sector	Regional agribusiness complex with contractual linkages	Regional identity with regional labelling	Local agro-ecological system
Possible constraints	Competitiveness at world market (competition with low cost producers)	Competitiveness at world market of value chain (relocation of industry)	Territorial competitiveness (saturated markets)	Competitiveness in niche markets (small markets)
Sustainability stakes	Economic (employment)	Economic (employment and services)	Social	Ecologic
Policy to increase sustainability and multifunctionality	Strengthening of local networks and promoting higher value production	Strengthening of competitiveness on basis of territorial resources (product oriented rather than scale oriented)	Strengthening the regional identity and creating vertical markets	Creation of local food networks and non-commodity markets

iii. Approaching multifunctionality in the U.S farm policy

The passage of the 2002 Farm Security and Rural investment Act introduced changes in the program emphasis, increasing an emphasis on conservation funding (Claassen 2006). The 2002 Act, directed the largest share of new spending to programs for conservation on working lands and livestock related issues, partly because the amount of land eligible for land retirement were already enrolled. Thus, programs that affect agricultural practices increased their share of the budget from 9% between 1986 and 2001, to 25% in 2002 and 2006 (figure 5). The 2002 act also introduced an increase on the funding of the Wetland Reserve program and, also, in the decision process for the programs in an attempt to improve environmental cost effectiveness of the participants. In the 2008 Farm Act the efforts towards programs directed at working-lands conservation kept growing with a 17 percent increase in funding, mainly to two programs the Environmental Quality Incentives Program and the Conservation Stewardship Program.

Figure 5 Trends in major USDA program expenditures.



Source: USDA, ERS.

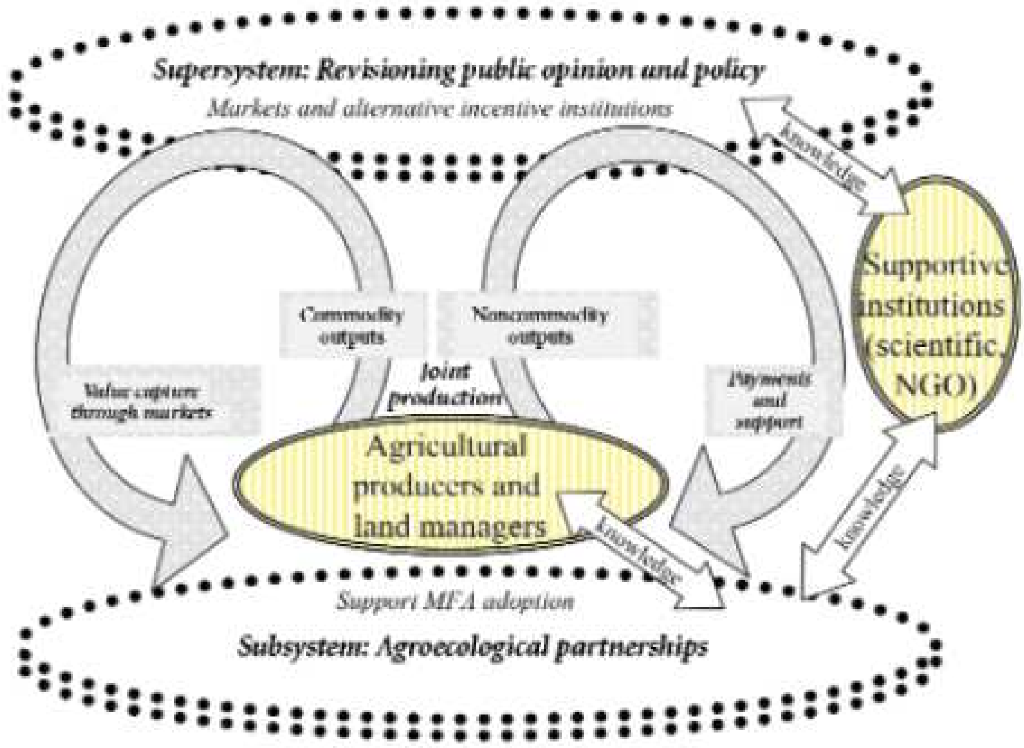
The increased importance of these working lands programs in recent years has been interpreted and related to an increase of the significance of the multifunctional character of agriculture in U.S. policy. Thus, the continued expansion of programs EQIP and CSP has been considered as the recognition of the services of ecosystems associated with agriculture (Dobbs and Pretty, 2004). Also evidence shows that other non-commodity products, like the demand for open space and rural amenities were among the reasons for the funding increase in conservation programs (Hellesterstein, 2002).

The perception of consumers on the issue has been also explored. A national survey of registered voters in the U.S indicates that a significant portion of the U.S. public is in favour of supporting farmers for the provision of various non-market outputs associated with agriculture (Moon, 2005). Further research ranked among several non-commodity outputs of agriculture food self-sufficiency as the most important, followed by ecosystem services (Moon, 2010).

The concept of multifunctionality was initially linked mostly to explore the types of non-commodity products associated with the agricultural production and the set of policies introduced for economic support of this production. Nowadays, the term has gained importance referring to a specific and complex set of demands and new challenges for the agricultural sector, such as providing environmental services, local food systems and energy production (Jordan, 2010).

Selman and Knight (2006), theorize the formation of positive feedbacks that integrate and enhance rural resources, referring to them as "virtuous circle" of rural development. The operation of this system (figure 6) is based in effective joint production of agricultural activities. In this situation, a variety of sectors will have incentives to capture value of the non-commodities outputs such as environmental amenities.

Figure 6. Virtues circle of rural development (Selman and Knight, 2006)

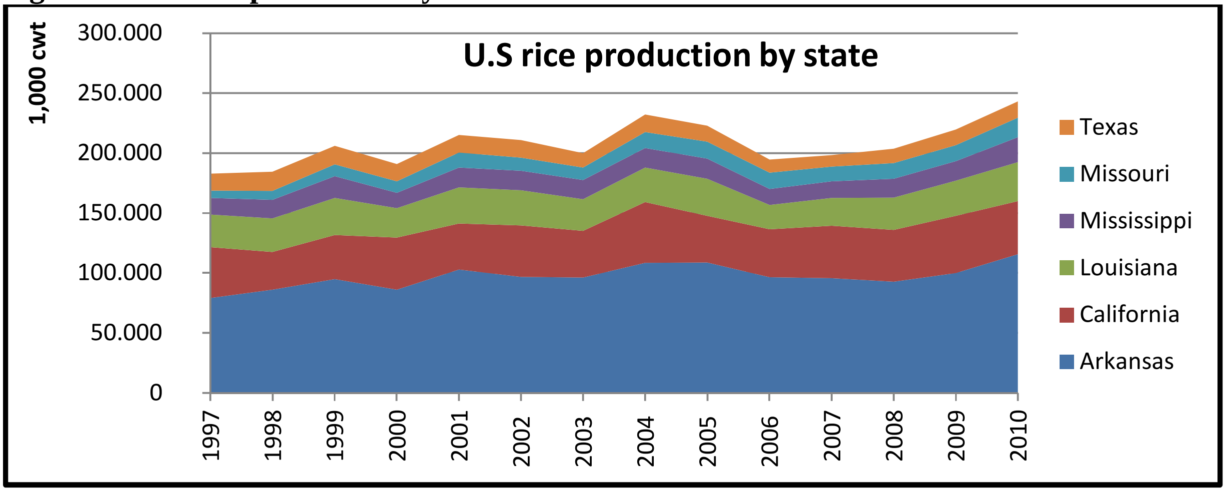


c. Rice and multifunctionality

i. U.S. Rice production

Rice production in the United States is concentrated in 6 States: Arkansas, Louisiana, Mississippi, Texas, Missouri and California. For 2010, Arkansas accounted for 48% of the U.S. production, followed for California with 18% and Louisiana with 13% (figure 7).

Figure 7. U.S. rice production by state.



Source: USDA, National Agricultural Statistics Service, Quick Stats.

Due to its geographical distribution, we can also talk about 4 areas of United States rice production: Arkansas Grand Prairie, Mississippi Delta, (parts of Arkansas, Mississippi, Missouri, and Louisiana); Gulf Coast (Texas and Southwest Louisiana); and Sacramento Valley of California. The Delta is the largest production region.

In the U.S. the type of rice is usually referred to by the length of grain, establishing a distinction among long, medium and short grain. The long grain accounts for 70% of the U.S. production and its produced mostly in the South. The medium grain is grown mainly in California and the south, mostly in Arkansas, and represents the 25% of the production. The remaining of the production in short grain is growth in California.

U.S produces less than the 2% of the world's production, however it is among the 5 biggest exporters accounting for 10% of the annual volume of global rice trade. This occurs because about half of the U.S. production of rice is exported. The major partners in the trade of rice are Mexico, Central America, Northeast Asia, the Caribbean, and the Middle East and, also smaller volumes to Canada, the European Union, and Sub-Saharan Africa. Despite the large volume of exports, the United States also imports a small amount of aromatic rice varieties that are not currently produced in the domestic production, mainly jasmine from Thailand, basmati from India and Pakistan and a small quantity of *Arborio* rice from Italy.

The other half of the production is sold in the domestic market, mainly for food consumption, beer, and pet food. The consumption of rice in the U.S. has been growing in the last years, usually attributed to demographic factors, the rise of healthy diets and introduction of rice- based products like rice mixes, cereal, and rice cakes. The aromatic varieties imported account about the 15% of the domestic food consumption.

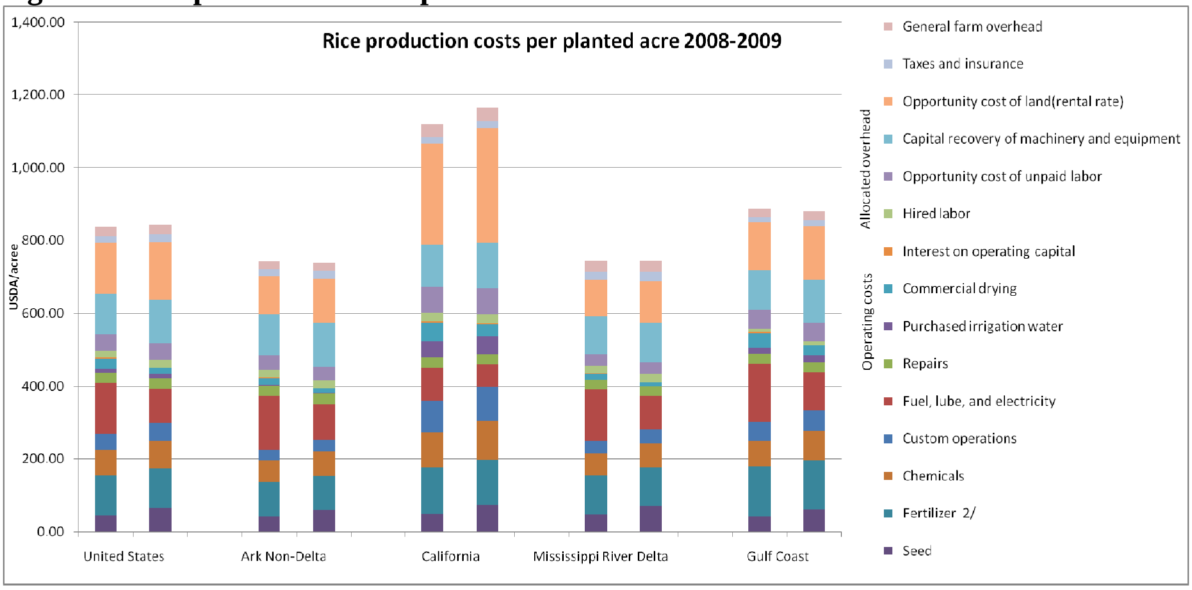
All production in the U.S. is on controlled irrigation fields resulting in a very high cost crop. Due to the high costs associated to the production of rice, the farm sizes and the production levels have to been growing in the last years. The average U.S. rice farm size in 2009 was estimated to be 511 planted acres (207 hectares), compared to 418 planted acres (170 hectares) on average for all farms. Despite the high cost of production in the last years, rice registered comparatively high returns in relation to other crops, as a result of the high yields obtained and the rise of the price of rice in recent years.

The challenges of the U.S. industry for the future are the combination of high operating costs (fuel, fertilizer, and irrigation expenses), steady growth in imports, and stiff competition from Asian suppliers. In recent years, Asian producers have improved considerably in levels of efficiency in production, reliability of delivery time and quality of the grain. This has reinforced its dominant position in the largest importing regions such as Sub-Saharan Africa and Middle

East. The United States, despite maintaining the volume of exports with its major trading partners, is losing competitiveness in global markets where it currently exports half of its production. On the other hand, the consumer demand in the domestic market is increasing, but also diversifying to the aromatic varieties imported that register the greatest increase in consumption.

The challenge also facing the rice industry is the high costs of rice production. Fuel, fertilizer, and irrigation are the highest operating expenses for production. The highest overhead costs are the opportunity cost of the land and the capital recovery of the capital on the production assets. The high initial investment costs on land and specific assets have resulted in a barrier to the entry of new farmers in the last years.

Figure 8. Rice production costs per acree in 2008 and 2009



Source: USDA.

The high operation costs have also led to internal changes in the farm structure and distribution. In efforts to reduce the unit cost, the number of farms has declined in recent years, but the total crop area is stable as a result of enlargement on existing farms. Additionally, there is an increased concentration of production in regions of low-cost production of the South. Thus, the region of the Gulf Coast with higher costs of production has suffered the greatest reductions in the total rice area in recent years that shifted to the Arkansas Non-Delta region and Mississippi River Delta. The production of a different high quality medium and short grain in California contributed to maintain the area of rice despite the high production costs.

ii. Rice as a multifunctional Crop. Evidences from Europe and Asia

Paddy rice, beyond its primary function of supplying rice for food consumption has been extensively studied for a wide range of multifunctional attributes, including those to land use, such as protection of wildlife habitats, biodiversity; and the provision of rural amenities through various social attributes such as to cultural heritage, the viability of rural communities, and food security.

The multifunctionality of paddy rice field has produced a extensive research in the Asian regions (Matsuno, Nakamura, Matsuno, Matsui, Kato, & Sato, 2006). Findings in the valuation of the multifunctional non-commodity benefits show that monetary values can be significant, however they are very site and context specific (Sajise & Sajise, 2006). In addition, in monsoon areas of Asia, rice is a staple food crop, which has centuries of history and it is rooted in cultural and landscape values (Kim, Gim, & Kim, 2006). For the characteristics of rice production in Japan on the slopes of the mountains, the existence of this crop is defined as a key feature in flood control, associated with other hydrological contributions such as creating secondary natural environments with wetlands and water networks or recharging groundwater with water from the paddy rice (Matsuno, Nakamura, Matsuno, Matsui, Kato, & Sato, 2006).

Some authors have argued that due the importance of rice for food security, multifunctional attributes provide a way to continue to support economically rice producers in the Asian countries, as a response to the high volatility of rice prices (Sakamoto, Choi, & Burmeister, 2007). Especially since the paddy rice based agriculture is threatened by ongoing trade liberalization pressures from both bilateral and multilateral (WTO) sources.

In Europe the multifunctionality is taken more as a framework on which to base the common agricultural model in a global perspective. However, the rice production has been specifically enhanced in the maintenance wetlands habitats, along with maintaining traditional landscapes, under pressure from urban and other uses (FERM, 2011). Wetlands are poorly represented in Europe and recognized as areas of high biodiversity and with important roles in managing water in the regions and preventing salinization of farmland. However the low competitiveness of rice producers in Europe compromises these functions. Without the element of economic security provided by the Common Agriculture Policy, rice producers would be unable to be sustained in the long term either for the food security or other public goods created through rice cultivation.

4. Data

This research uses data from the USDA's Agricultural Research Management Survey (ARMS) to characterize U.S. rice farm operations that adopt multifunctional practices. ARMS is an integrated data collection system that provides an annual source of data in the United States on the commodity production practices and the financial status of the farm situation and its operator's household. The data collection is conducted through interviews with farmers in three phases. The first phase is more a screening questionnaire to verify the participation of the farmer, while Phase II includes data on production practices and costs at a field level; and, Phase III focuses on cost and returns of the operations of the whole-farm. The survey collects specific information on the commodities on a rotational basis, with a more intensive survey for the important commodities on an irregular basis. For rice production, farms where surveyed intensively in 2000 and 2006.

This study will be based on the data collected from Phase II for rice farms in 2006 complemented with Phase III. For the 2006[3] year, farms were randomly surveyed in six different states (Arkansas, California, Louisiana, Mississippi, Missouri and Texas) where 99% of U.S. rice is produced. From this sample of farms, our sample for the study consists of 489 farms that were surveyed in both Phase II and Phase III.

The ARMS system uses stratified sampling in selecting observations. Due to the major importance in the performance and impacts in the markets, the ARMS database focuses on commercial farms to collect data, with smaller farms sampled less intensively. Each observation is based on the representativeness of similar number of farms according to factors such as farm size, crop type, etc. To avoid errors due to the stratification, the National Agriculture Statistics

[3] The year 2006 was a year in wich ARMS surveyed rice farm operators at a greater than normal frequency to be able to analyze rice operations more accurately.

Service (NASS) provides a set of weights that yield valid inferences for the whole population. The inclusion of these weights for each observation facilitates valid inference on parameter estimates when population parameters vary by strata.

The observational unit is individual rice farm operators[4]. Important farm characteristics are included to identify common factors that may affect the adoption of multifunctional activities. A logit model is estimated to identify the factors that influence participation in multifunctional programs. The survey respondents were classified a participant in multifunctionality practices when they were receiving income from conservation programs (CRP, CREP, WRP), working land programs (EQIP, CSP) or recreational and agritourism activities. Among the 489 observations, 20 % of the farms in the sample (unweighted percentage) were receiving income from at least one of these programs.

[4] Farm operator is defined by the USDA as the person who runs the farm, making the day-to-day management decisions. The operator could be an owner, hired manager, cash tenant, share tenant, and/or a partner. If land is rented or worked on shares, the tenant or renter is the operator.

5. Methodology

Participation in conservation programs introducing and encouraging environmental considerations in agricultural operations is identified as an approximation of U.S. agriculture to a multifunctional approach. This approach is also reflected in the engagement on farm income diversification through the provision of recreational activities and agritourism services. Understanding the key factors in the adoption of any of these practices of rice farmers in the United States is a necessary step to develop future business strategies and to increase participation in these programs in the future.

In general, working-land and land retirement programs play complementary roles to reduce the environmental consequences of agricultural production, often used by different types of farms. Whether to take marginal land out of production, diversify their operation to include hunting or scenic viewing, address conservation concerns, or reduce variability in farm returns, enrolling in multifunctional activities may be a logical part of a profit maximizing farm operation.

The goal of this study is to determine the factors that influence the participation in programs or activities associated with a more multifunctional approach to agriculture by rice producers. In order to do so, a logit analysis to determine the likelihood of participation is estimated as a function of land tenure, financial characteristics of the operation, socio-demographic characteristics of the operator and cultural practices. For this purpose, the literature indicates that some of the household attributes and farm business characteristics may affect the likelihood of operators to participate in multifunctional programs.

a. Conceptual framework

To understand the adoption of multifunctional programs or activities, a range of variables were selected to include in the logit model. These variables are necessarily inclusive of all factors affecting the adoption of multifunctional practices; however, the literature suggests the inclusion of the following variables (Table 2).

The literature provides references to factors that affect the adoption of best environmental practices or conservation programs for the U.S. (see for example Caswell et al., 2001; Lambert et al., 2007; Prokopy et al., 2008; Chang and Boisvert, 2009). Although there are similarities among various studies, not all the studies use the same variables and the impact of the selected variables sometimes differ from one study to another. Table 2 provides a list of all these variables from the literature reviewed for the present study.

Table 2. Factors suggested by literature to be relevant in multifunctional acivities.

Farm characteristics	Operator characteristics
Farm size *Area operated that are owned by the household* *Yield* *Net farm income* *Debt to asset ratio* *Asset turnover ratio* *Government payments* *Percentage of acres of rice* *State (Location)*	*Age* *Number of operators* *Farming experience* *Gender* *Ethnicity* *Education* *Major occupation* *Retired*
Household characteristics	**Other conservation management practices**
People living in the household *Level of Off farm-income*	*Tech. Assistance for conservation practices on field* *Conservation plan to reduce soil erosion* *Nutrient management plan for applying fertilizer & manure* *Nutrient management plan for applying manure only* *Pest management plan for applying pesticides* *Water management plan for applying irrigation water*

Soule et al., (2000) found that scale of the farms and land tenure are an important component when adopting and installing new practices. Caswell et al. (2001), explain that the size of the farm is usually related to the adoption of environmental considerations, because they have access to greater economies of scale, relating to efficiency issues and capacity of innovation. The importance of land tenure is associated with future considerations on the sustainability of the operation, therefore to personal gains. It has been also suggested that operators who live close to their farm activities are affected by possible negative effects. The effects of size of operation are measured with the size (acres) of the operation, using a natural logarithm allow for decreasing marginal effects of this variable. Land tenure is measured with the proportion of land owned by the operator.

Lambert et al. (2007) suggests using financial characteristics of the farm such as net farm income, debt to asset ratio and asset turnover ratio. Net farm income measures the capacity to invest in new practices, based on the idea that more efficient practices are more profitable. The asset turnover ratio is a measure of efficiency of the investment to estimate the capacity of the operation to incorporate new techniques and equipment. The literature suggests that both may be positively related to adoption of multifunctional practices. On the other hand, farmers with higher debt levels are considered to be in a situation of greater risk, likely using high intensive crop techniques without regard to conservation issues.

Government payments other than conservation payments are also included as a variable. Farms that already receive some form of government payments are considered to be more informed and may participate in additional programs of conservation programs (Featherstone and Goodwin, 1993; Lambert et al. 2007).

Education is usually assumed to have positive effects on the adoption of conservation programs and new technologies in general. Lynch et al., (2001) views education as a measure of human capital in the decision process. Caswell et al. (2001) considers farm experience to have the same effect as education, but observes a possible conflict with the age of the operator which is generally considered to have a negative effect.

Lambert et al. (2007) find that retired operators are less likely to adopt management intensive practices, thus adopting conservation programs when they do not require major changes to save time and effort. Similar reasons apply to operators when off-farm incomes are considerable (Chang and Boisvert, 2009). Those operators may adopt retirement land programs and the payments also may stabilize the farm income.

There is no clear evidence on the impact of gender and ethnicity in the decision although they have been previously included in studies. However, Nickerson and Hand (2009) suggested the unequal incidence of these programs for all different types of farmers, expressing the need to include future considerations for a major impact on beginning, limited-resource, and socially disadvantaged operators.

The size of the household can be related to the possible succession of the operator, being considered to have the same effect as land tenure (Lambert et al. 2007).

Prokopy et al. (2008) considers that business networks can work as a linkage among operators and increase the access to information and new practices, being exposed to ideas from others. Belonging to an agency network provides access to information with vertical relationships, where among relations the farmer-to-farmer the relationship is horizontal with less dispersion of information.

In their review, Prokopy et al. (2008) also raise the importance of the farmers' attitudes towards the environment in other environmental issues. The request for technical assistance as well as the implementation of environmental management plans is more likely to take place on those farms that are already engaged in conservation measures.

In studies like Lambert (2007), variables accounting for the different crops are included, arguing that diversity should be a positive factor in the implementation of practices related to conservation. The results usually depend on the opportunity cost associated with reducing the production of this crop and the incentive payments associated. A variable that expresses the proportion of rice on all the acres operated may be somewhat indicative of the diversity or degree of specialization in production.

Finally, some studies incorporate variables to specify location, population density, environmental status or marketing systems. In this study, location is considerate included by including the state where the operation resides.

b. Model for the study: Logit analysis

A model based on the utility theory resulting in a binary choice model is used to determine the influence of the independent variables selected. Binary choice models are used to model situations that arise in a context where the dependent variable is constrained to one of two alternatives. In essence the binary logit model allows the computation of the marginal change in the odds ratio of an outcome as a function of a given independent variable.

Prob (event j occurs) = Prob (Y = j) = F [relevant effects, parameters].

eq.1

One of two models for dichotomous or binary outcome variables is usually selected: the probit or the logit. The choice of probit versus logit depends largely on individual preferences. The results typically show significance for the same independent variables, but the logistic form usually provides some advantages, like relatively simple interpretation of the coefficients in terms of odds ratios.

In logit models, odds ratios can be estimated. The term “odds” is defined as the ratio of the expected number of times that an event will occur to the expected number of times it will not occur. There is a simple relation between probabilities and odds, but the use of odds in the model provides some advantages in terms of sensitivity analysis. The odds, like probabilities, have a lower bound of 0, but no upper bounds. Thus, transforming the probabilities that are bounded by 0 and 1 to odds removes the upper and lower level bounds and results with the log of the odds ratios as a linear function of the independent variables.

The logit model can be described as;

$\log (P_i/1-P_i)= \alpha+\beta_1 X_{i1}+\beta_2 X_{i2}+...+\beta k X_{ik}$

eq2.

In the equation the α and the β_j parameters to be estimated and the X_{ik} are the values of the j^{th} independent variable for the i^{th} farm operator. P_i is the probability that the event of interest occurs, $y_i=1$. The expression "log (P_i/1-P_i)" is usually referred to as the logit or log-odds ratio. If we simplify the equation to obtain the logit equation for p we obtain;

$$P_i(Y = 1 \mid X_1, \dots, X_p) = \frac{1}{1+\exp\left(-\alpha-\beta_1 x_{i1}-\beta_2 x_{i2}-\cdots-\beta_k x_{ik}\right)} \qquad \text{eq.3}$$

PROC LOGISTIC procedure of the statistical package SAS was used to obtain estimates[5]. In a first assessment of the estimated model, all the variables suggested from literature where included in a preliminary model. Based on the results of the preliminary model and the descriptive statistics of the variables, a second model was estimated only including those variables more significant in the original logit model or strongly suggested in the literature. These variables and their sample means are included in table 3.

Table 3 Variables included in the logit model for the logit analysis

Variable	Measurement and explanation	Mean
netw_mil	Net worth (million $). Measure of size of the farm operations	1.36
ExperYr	Operator years of experience	

[5] As noted in Dubman (2000), the ARMS applies "…complex stratified, multiple-frame, probability-weighted, and sometimes multiple phased sampling methods…" (pg. 1). Because of this sampling method, standard errors from the output of standard statistical software like SAS are not valid. Alternative techniques must be used. In this application a bootstrap is used with 200 replications to derive the standard errors.

		26.14
pctown	% Operated acres owned	22.86
pctrice	% Operated acres of rice harvested	42.53
STATE	Categorical variables accounting for State in which farm is located	
highered	A dummy variable considering if the operator education above high school	64.08
TechAsst	A dummy variable for whether operators received technical assistance for applying conservation practices on field	4.03
IrrMgt	A dummy variable for whether farm implemented water management plan for irrigation water	5.87
riceyld	Rice yield/acre (cwt)	68.39

Source: Wailes et al. Staff Report University of Arkansas, July 2011.

There are two stages in model estimation and validation. First, the parameters of the model are estimated and, second an assessment must be made to determine of how well the model fits the observed data. The parameters estimated are the constant (α) and the logistic regression coefficients (β_j). In the logistic regression, the method of estimation is Maximum likelihood estimation (MLE), where the likelihood function is defined as;

$$L = \prod_{i=1}^{n} Pi(Y|X_{i1}, \ldots, X_{ip}) = \prod_{i=1}^{n} \frac{1}{1 + \exp(-\beta' x_k)}$$

eq. 4

Where the likelihood, L, is defined as the product across the sample data of the probabilities of success or failure. The set of parameter values (α, β_j) are estimated to maximize L so that the estimation method is maximum likelihood (MLE).

The ML estimates are calculated for the data set. The statistical significance of each of the parameters estimated for the model is obtained from the Wald statistic, based on the estimated standard error. Similarly, to validate the model the null hypothesis that all the coefficients equal 0, H_0: $\beta_j = 0$ for all j should be tested.

Finally, the use of data obtained from a complex, stratified sample suggests the use of a resampling statistical method, the bootstrap to estimate the parameter estimates standard errors. Bootstrapping is a resampling method used in statistics with the purpose of deriving robust estimates of the standard errors and confidence intervals of the estimated parameters. Based on bootstrap methods, the basic idea is to build a sampling distribution model for certain estimated parameters. The standard errors of parameter estimates are determined by simulating a large number of random samples constructed directly by resampling with replacement from the observed sample. That is, we use the original sample to generate new samples as a basis for estimating the dispersion of the sampling distribution, rather than from a theoretical distribution. However, if we assume that the basic probability of participation is the same for every farm in the population regardless of strata or method of selection into the sample, then the logit model can be estimated without weighting each observation.

c. Interpretation of the results

A first step in the interpretation of the results is to observe if the variables are significant, typically observing if the p-values are less than 0.05. When the variables are not significant, they usually are deleted from the model and a new model is estimated.

Once the best model has been selected, the next step is the interpretation of the signs of the parameters estimates. Positive signs indicate positive association between the increase of the independent variable with the increase in the probability of observing that the event happens. In opposition, negative signs mean that a unit increase in the independent variable reduces the probability that the event of interest happens.

The parameter estimates (β^*) in the logit model are difficult to interpret. For that reason, in the interpretation of the parameters is made using the “odds ratios”, which are obtained from the parameters estimates by computing e^{β^*}. Usually the column of odds ratios is referred also as adjusted odds ratios because they assume other variables in the model are held constant.

In the interpretation of odds ratio for binary variables the predicted odds indicate how much higher or lower are the odds of the observed event when the binary variable goes from 0 to 1. Odds ratios higher than one represent an increase in the probability of the event, and odds ratios lower than one indicate a decrease. When interpreting the odds ratios of quantitative variables, it is useful to express the percent change in the odds for each 1 unit increase in the independent value, computing $100(e^{\beta^*}-1)$.

It is also possible to interpret the results of the logit model in terms of probability, there are graphical and tabular methods available (Long 1996), or it can be made using the equation:

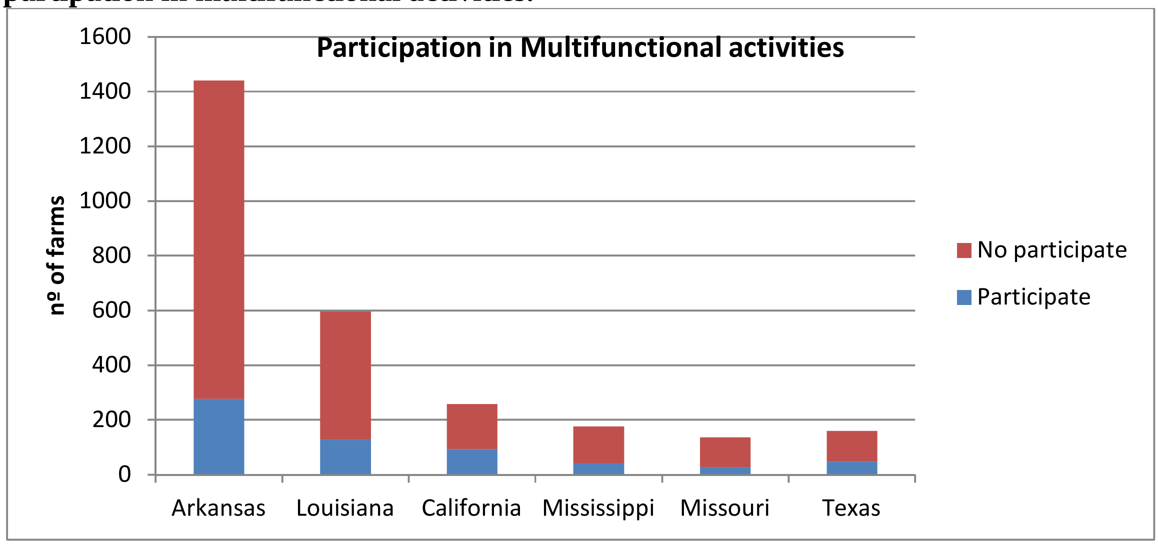
$$\frac{dp}{dx} = \beta p_i(1-p_i) \qquad \text{eq.5}$$

6. Results and discussion

The estimated logit model can be used to identify and understand the impact of factors affecting choice of rice farms to engage in multifunctional activities, either because they receive income or cost sharing from conservation programs and working land programs, or because they receive income from conducting recreational activities or agritourism on the farm.

Based on the sample of ARMS database, an estimated twenty-two percent of the farms registered income for the multifunctional activities considered for the 2006. Fig. 10 shows the estimated distribution of the total number of rice farmers' participants in multifunctional practices for the different States. The lowest levels of participation are in the States of Arkansas and Missouri with a 19 % of the participation, slightly below the national average. California with a 36% and Texas with 30% show the highest rates of participation.

Figure 9. Estimated total number of farms represented in the model, with share of partipation in multifunctional activities.



Souce: Staff report University of Arkansas, July 2011.

The final model only includes those variables significant in the preliminary model, or whose importans was emphasized in previous studies. The variables included in the final model were:

$$\log (P_i/1\text{-}P_i)= \alpha+\beta_1\text{*netw\_mil}+ \beta_2\text{*ExperYr}+ \beta_3\text{*pctown}+ \beta_4\text{*pctrice}+ \beta_5\text{*StateAR}+ \beta_6\text{*StateLA}+ \beta_7\text{*StateMS}+ \beta_8\text{*StateTX}+ \beta_9\text{*highered}+ \beta_{10}\text{* TechAsst}+ \beta_{11}\text{*IrrMgt}+ \beta_{12}\text{*riceyld}$$

eq.6

Table 3 shows the results of the analysis of the logistic procedure in the estimation of the parameters. The standard errors are computed using the Bootstrap method and the observations are weighted with the weights scaled to sum to the sample size.

As previously mentioned, for the final estimated model only includes those variables significant in the preliminary model (inference based on the computed maximum likelihood standard erros, not the bootstrap), so many of the remaining variables are significant under the criterion of p-value < 0.05.

Table 4. Logit estimates with standard error from bootstrap

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error[a]**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-2.9878	1.7960313	2.76742107	0.0094
netw_mil		1	0.0548	0.2348002	0.05447085	0.4374
ExperYr		1	0.00480	0.0177571	0.07306988	0.6160
pctown		1	0.00387	0.0100811	0.14736898	0.3539
pctrice		1	-0.0146	0.0099276	2.16280403	0.0160
STATE	**AR_MO**	1	-0.9515	0.7798504	1.48865818	0.0561
STATE	**LA**	1	-0.5647	0.7923408	0.50793897	0.3171
STATE	**MS**	1	-1.3761	1.0739663	1.64179407	0.0479
STATE	**TX**	1	-0.7256	0.8103051	0.80185788	0.2544
highered	**Yes**	1	1.3646	0.4331929	9.92311613**	<.0001**
TechAsst	**Yes**	1	1.1264	0.6277014	3.22017215*	0.0432*
IrrMgt	**Yes**	1	0.3656	0.5389947	0.46009063	0.4725
riceyld		1	0.0259	0.0176062	2.16405486	0.0234

[a]Estimates from bootstrap techniques, Significant variables in logit model: ** p < 0.01; * p < 0.10

Sorce: Wailes et al. Staff report University of Arkansas, July 2011.

For the final model, higher education and technical assistance were found to be statistically significant at the 0.01 and 0.010 levels, respectively . The other variables were found to be not significant, however the parameter estimates for those variables suggests the effect of these variables on the decision to become multifunctional. The suggested effects will be discussed, in order to obtain an impression of the four different categories of factors suggested for literature to influence the participation in multifunctionality (Table 2).

There are also potential issues of endogeneity in the independent variables that may be making it more difficult to find statistical significance. Yield is a potential example. Participating in a land conservation program could require the retirement of land so that less productive land would be retired and, as a consequence, yield would increase. Another variable, implementation of water management plans for irrigation, was found not significant but it may have an endogenous effect on the dependent variable as participation in a conservation program may require development of a water management plan for irrigation.

The signs of the parameters indicate that the increase of almost all the variables (excluding the four regional variables) corresponds to an increase in the odds of adopting multifunctional activities. The only variable with a negative sign is the percentage of rice of all crops on the farm and the variables associated with the State. For the State indicator, taking into account that the intercept represents California, means that farms in the other states are less likely to have multifunctional activities.

The negative relation of the percentage of rice of all crops on the farm means that farms that are more specialized are less likely to have multifunctional activities. As discussed in the literature, multifunctionality is often negatively related to the lack of crop diversity on the farm.

For the interpretation of the coefficients, as mentioned in the methodology, the direct interpretation of parameter estimates is not intuitive. For this reason, it is a common practice to interpret the signs of the estimates, and then use the odds ratio (e^{β_j}) instead to interpret the parameter estimates.

Table 5. Odds ratios estimated in the logit model with bootstrap errors

Effect	odds ratio mean	odds ratio mean lower CL	odds ratio mean upper CL	odds ratio std deviation*	Percentage change in the odds for unit increase
ExperYr	1,005	1,00447	1,00946	0,01792	0,5
highered Yes vs No	3,914	1,58623	1,85592	0,96706	291,4*
IrrMgt Yes vs No	1,441	0,38878	0,56227	0,62212	44,1
netw_mil	1,056	0,64348	0,73444	0,32615	5,6
pctown	1,004	2,1564	2,85171	2,49325	0,4
pctrice	0,985	0,82264	0,97802	0,55715	-1,5*
riceyld	1,026	0,615	0,94305	1,17633	2,6*
STATE AR_MO vs CA	0,386	3,53082	4,73623	4,32237	-61,4
STATE AR_MO vs LA	0,679	1,35252	1,73237	1,36204	-32,1
STATE AR_MO vs MS	1,529	0,23375	0,41335	0,644	52,9
STATE AR_MO vs TX	0,798	0,46831	0,58345	0,41287	-20,2
STATE LA vs CA	0,569	0,51511	0,66574	0,54014	-43,1
STATE LA vs MS	2,251	3,47715	4,17519	2,50305	125,1
STATE LA vs TX	1,175	3,99493	4,5208	1,88568	17,5
STATE MS vs CA	0,253	1,16069	1,24775	0,31217	-74,7
STATE MS vs TX	0,522	0,99929	1,00209	0,01004	-47,8
STATE TX vs CA	0,484	0,98221	0,98494	0,00976	-51,6
TechAsst Yes vs No	3,084	1,02667	1,03174	0,01817	208,4*

Source: Wailes et al. Staff report University of Arkansas, July 2011 .

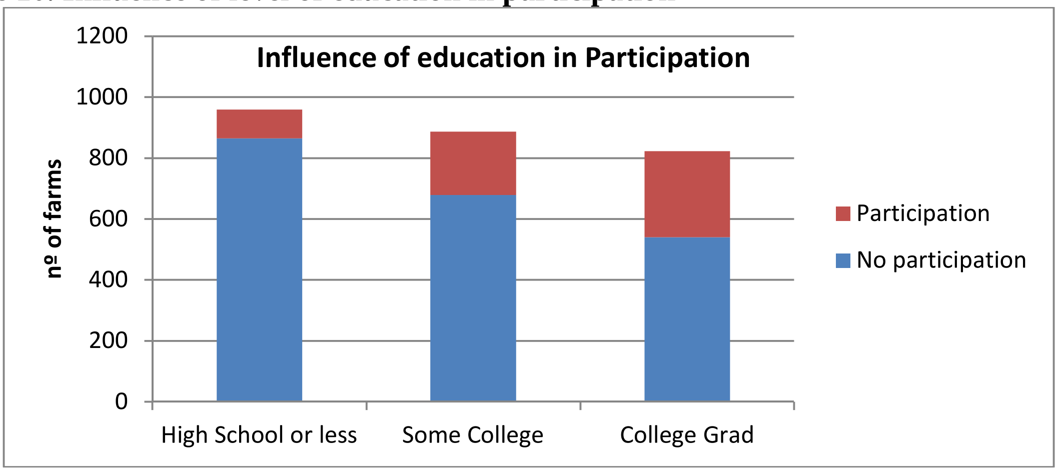
*Significant variables

The last column accounts for the percentage change in the odds for a one unit increase in the independent variable, as suggested in literature, for a clearer interpretation of changes in the variables.

The estimated odds ratios indicate that higher education and farms that have received technical conservation assistance are highly significant in the estimated model. The percentate change show that not only are more education and technical assistance significant, but that they have reasonably large impacts. The variables with lower odds ratios and therefore with a lower impact on the adoption of multifunctional activities are percentage of rice on the farm and rice yield.

According to the model estimates, the operator educational level has a major impact on the adoption of multifunctional practices. A higher level of education is associated with an increased ability to learn new practices and adapting innovations at the farm level, indicating a greater ability to access information and more operator human capital. Figure 11 shows the incidence of practices observed for each educational level, suggesting differences in the adoption rates.

Figure 10. Influence of level of education in participation



Source. Wailes et al. Staff report University of Arkansas, July 2011

The estimates in the model suggest that farm operators with some college education or higher increase their odds ratios of participation by a factor of 2.91, than the ones without college education.

Another binary variable that increases the probability of multifunctionality is conservation technical assistance with an increase in the odds by a factor of 2,08 . The access to technical assistance helps farmers solve crop management problems, while giving information and advice on practices and initiatives that increase the viability of sustainable production and optimizing resources. According to this result, increasing the supply of services to provide technical assistance could also increase producer participation in multifunctional agriculture.

For quantitative variables it is important to allow for the range of variability in the observation on the variables themselves as well as the magnitude of the odds ratios. Thus, changes in yield and percentage of rice vary in a unit of measurement as well as the magnitude of the odds ratios. The positive relationship with yields suggests that farms with greater technical efficiency (i.e. higher yields) are more likely to be involved in multifunctional activities. At the same time we should remember that one of the conservation programs (CRP) removes the less productive land (and also land more susceptible to erosion) from production, so the average increase in yields is also a consequence of only using the best land for rice production[6]. Another variable found not signicant that may have the same effect as than technical efficiency is the implementation of water management plans for irrigation, especially on rice production where the use of a large amount of water is required[7].

The lack of crop diversity on a farm has been related in Europe with lower levels of multifunctionality for all agricultural regions, therefore the negative relationship with the probability of participation.

[6] It follows that yield is an endogenous variable since is affected if the farm operator retires some land under a conservation program. This violates one of the logit assumptions. However, it seems likely that the yield reducing effect is minor so that the estimated model is still a useful and informative model. Further research should pursue if this endogeneity has a substantive effect on parameter estimation and inference. A conditional logit model, as opposed to the multinomial logit model used here, might be an appropriate way to properly model this endogeneity.

[7] The same problem with the endogeneity of yield may appear as well with irrigation management, therefore presenting endogeneity.

The other variables were found not to be significant in the model. However, the signs suggest the effects that these variables may have in the likelihood of becoming multifunctional and might become more significant with a larger sample or different crops.

For the state indicator, taking into account that the intercept represents California, the estimates mean that farms in the other states are less likely to have multifunctional activities. The results indicate that California producers have greater odds of participation in multifunctional activities than any of the other states but not significantly so. For the other states, the odds of participation are lower. This tendency seems to show an inverse relationship to the level of profitability in recent years. Farms of these states have increased rice farming activities as a result of increased profitability which has led to the expansion and consolidation of farms in Arkansas and Missouri (Baldwin et al., 2011).

Given the large disparity in participation rates among the states just discussed, it is surprising that the state binary variables in the estimated model are not statistically significant. In part of our estimation it became clear that participation in Missouri was so small that to get reliable estimates of model parameters we had to combine Missouri into one state with Arkansas. But the lack of a "state" being significant suggests that there is a sample size problem. Since the estimated proportion of farms participating was 22%, there apparently was not sufficient variation to identify a state effect. We suspect that this sample size problem also rolled over to the individual variables. It should also be noted that each observation in an ARMS data set is given a weight to indicate how many farms it likely replicates. So estimation is undertaken using weighted maximum likelihood. In such situations we suspect the weights can skew the impact of particular variables. For example, if large farms are more likely to be multifunctional, then their impact may be overshadowed by smaller, non-participating farms that will enter the estimation routine with larger weights.

Years of farming is positively related to the increase in the likelihood that farm operators adopt new practices; similar to the effects as education, but its coefficient is not close to statistically significant at customary levels. Net worth is also not significant for the model. The parameter estimate suggests that farms with larger capital should be more likely to participate in multifunctionality, but it is clearly not significant unlike the finding by Lambert et al. (2007), indicating that U.S. rice farms may behave differently than farms in prior studies.

Finally, the percentage of land owned suggests the interest of owners adopting more sustainable or diversified practices to maintain the farm into the future. This assumption can be related again with the regions that in the last years had less intensive production systems.

While the binary logit provides a point of departure for the analysis, future investigations should consider using a multinomial logit model. As currently modeled, farms are categorized as being multifunctional or not. But in the binary approach essentially six different forms of multifunctionality are lumped into one category. Analysis will be undertaken to determine if the six forms of multifunctional activities can be modeled separately. Such an approach with the current sample would likely not be successful. Greater numbers of observations could be generated by using a series of years and this might add needed variability to the sample. Also, sample size could be greatly enhanced by expanding the model to incorporate different farm types rather than have it be solely a rice model. Even with more years and farm types, expanding to a multinomial model with six different types of multifuncitonality might be beyond the ability of a logit model to find significant results.

An intermediate aggregation could also be explored where multifunctionality is categorized into groups that are related to: (1) working lands conservation programs, (2) land retirement programs and (3) agritourism/recreation.

7. Conclusion

This paper is the first empirical analysis of factors affecting producer participation in multifunctionality in the context of rice in the United States. Applying the lessons from the research about the European Union experience, the research contributes to an emerging agricultural issue. A second goal is to provide information about a specific group of farmers involved in multifunctionality. For this purpose, a multinomial logit model is estimated to identify those factors affecting the adoption of multifunctional farming practices by rice farmers for U.S. rice producers.

The logit model estimated for the adoption of multifunctional activities –expressed by participation in conservation programs or recreational or agritourism activities- by operators of rice from the United States, suggests that there are several very significant explanatory factors. The variables that were found to be more important were higher education and technical assistance.

The results suggested by this study are similar to other EU studies in the context of multifunctionality. For example, increasing the intensity of cultivation is sometimes associated with lower levels of multifunctionality. At the same time, some authors have suggested that multifunctionality may be related to technical efficiency and the use of resources. Finally the model also suggests the importance of factors such as education, where it seems that the literature offers a consensus on its importance to the adoption of multifunctionality.

In the estimation of factors affecting the participation of farmers in multifunctionality it also could be interesting to separate the two factors considered in the analysis, to observe the different possible factors affecting the adoption of environmental programs or participation in recreational/agritourism activities. However, as suggested in the construction of the model, some of the conservation programs remove land from production, but is used for recreational uses such as hunting. Therefore, in the case of rice the results could be expected to be similar.

In this study the analysis of participation in multifunctionality is based in conservation programs and recreational activities. These are the two main multifunctional activities to consider, based on the idea to understand common factors of participation in programs for all rice farmers in the United States. However, there are other multifunctional activities that rice farms may develop in the context of United States. Thus there is a need to supplement this study with qualitative research, in order to identify innovations or different strategies developed in rice cultivation by farmers. A qualitative research in addition to complementing the results, would solve some of the problems of using quantitative techniques, such as consideration of small-scale experiences, regional experiences and possible strategies of small farmers or hobby farmers.

Some limitations associated with the data used should be mentioned. First, the ARMS database samples U.S. commercial farms more intensively, than small farms that, according to the literature, may participate more intensively in higher levels of multifunctionality. On the other hand, we found limitations in the lack of specifics for the existing databases to cover some aspects related to the multifunctionality of agriculture. This study contributes to a better understanding of the factors that lead to the supply of multifunctionality rather than to the demand for multifunctionality.

The approach of multifunctionality in some ways reflects a change in current farming systems, to include other possibilities or strategies for farmers. Thus, multifunctionality has or should have in the future political implications of the United States. As discussed, there are some national programs that support or consider additional functional programs of the Farm Bill. Other current considerations such as energy production, either with cogeneration from existing crops or specialization in growing energy crops, may be more likely to increase importance in the future Farm Bill. Except for these functions, it does not seem that the whole set of additional activities can or should be considered multifunctional is integrated nationally. Thus, activities that typically can be developed locally under these ideas have their opportunities by creating partnerships and building networks at the territorial level in order to adapt to their environment and take advantage of additional opportunities that agriculture can provide.

There are two ways in the future in which to develop multifunctionality in agriculture nationwide. On the one hand, energy conservation features, with impacts and commonalities across the country are integrated into nationwide policy. On the other hand, other innovative initiatives have to be able to build a regional network to adapt to new needs.

Finally, the multifunctionality approach covers many issues. Given the amount of options in the research under this approach, I want to suggest some topics that from my point of view are particularly interesting in the U.S. agricultural context. First, multifunctionality is an approach that attempts to provide a regional perspective to the study of agriculture, so the same analysis including *all* farm types in a region could provide interesting information as to factors that influence multifunctionality adoption for different crops. Also, particularly interesting seems to be the use of tobit-type models to investigate the intensity in which farmers participate in multifunctionality. In addition, allowing the dependent variable to indicate the type of multifunctionality adopted would also be more informative than the model estimated to indicate what factors influence the type(s) of multifunctionality adopted. Second, studies that seek to determine the joint multifunctional agricultural products that the population demands from agriculture would also be particularly relevant. The last group of studies relevant in the context of the United States, are the landscape-level studies. Generally using GIS tools, the study of the interaction of the different features of the territory could help in design and introduction of different management practices or incentives to increase multifunctionality.

8. References

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APPENDIX I. The Logistic Procedure (Normalized weighted binary logistic regression)

Model Information		
Data Set	WORK.SUBSET2006	
Response Variable	conserve	Conservation payments or recreation income
Number of Response Levels	2	
Weight Variable	vallwt0	Expansion factor (full sample weight) - all version
Model	binary logit	
Optimization Technique	Fisher's scoring	

Number of Observations Read	469
Number of Observations Used	469
Sum of Weights Read	2590.523
Sum of Weights Used	2590.523
Normalized Sum of Weights Used	469

Response Profile			
Ordered Value	**conserve**	**Total Frequency**	**Total Weight**
1	1	95	104.28831
2	0	374	364.71169

Probability modeled is conserve=1.

Note: Weights are normalized to the actual sample size.

Class Level Information					
Class	Value	Design Variables			
STATE	AR_MO	1	0	0	0
	LA	0	1	0	0
	MS	0	0	1	0
	TX	0	0	0	1
	CA	0	0	0	0
highered	Yes	1			
	No	0			
TechAsst	Yes	1			
	No	0			
IrrMgt	Yes	1			
	No	0			

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	499.030	466.521
SC	503.181	520.479
-2 Log L	497.030	440.521

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	56.5085	12	<.0001
Score	55.9424	12	<.0001
Wald	46.1291	12	<.0001

Type 3 Analysis of Effects			
Effect	DF	Wald Chi-Square	Pr > ChiSq
netw_mil	1	0.6030	0.4374
ExperYr	1	0.2515	0.6160
pctown	1	0.8593	0.3539
pctrice	1	5.8077	0.0160
STATE	4	5.4270	0.2462
highered	1	20.3686	<.0001
TechAsst	1	4.0870	0.0432
IrrMgt	1	0.5161	0.4725
riceyld	1	5.1404	0.0234

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.9878	1.1496	6.7543	0.0094
netw_mil		1	0.0548	0.0706	0.6030	0.4374
ExperYr		1	0.00480	0.00957	0.2515	0.6160
pctown		1	0.00387	0.00418	0.8593	0.3539
pctrice		1	-0.0146	0.00608	5.8077	0.0160
STATE	AR_MO	1	-0.9515	0.4981	3.6501	0.0561
STATE	LA	1	-0.5647	0.5644	1.0009	0.3171
STATE	MS	1	-1.3761	0.6956	3.9131	0.0479
STATE	TX	1	-0.7256	0.6367	1.2989	0.2544
highered	Yes	1	1.3646	0.3024	20.3686	<.0001
TechAsst	Yes	1	1.1264	0.5571	4.0870	0.0432
IrrMgt	Yes	1	0.3656	0.5089	0.5161	0.4725
riceyld		1	0.0259	0.0114	5.1404	0.0234

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
netw_mil	1.056	0.920	1.213
ExperYr	1.005	0.986	1.024
pctown	1.004	0.996	1.012

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
pctrice	0.985	0.974	0.997
STATE AR_MO vs CA	0.386	0.145	1.025
STATE LA vs CA	0.569	0.188	1.719
STATE MS vs CA	0.253	0.065	0.987
STATE TX vs CA	0.484	0.139	1.686
highered Yes vs No	3.914	2.164	7.080
TechAsst Yes vs No	3.084	1.035	9.192
IrrMgt Yes vs No	1.441	0.532	3.908
riceyld	1.026	1.004	1.050

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	66.4	**Somers' D**	0.332
Percent Discordant	33.2	**Gamma**	0.333
Percent Tied	0.4	**Tau-a**	0.107
Pairs	35530	**c**	0.666

Wald Confidence Interval for Odds Ratios			
Label	**Estimate**	**95% Confidence Limits**	
STATE AR_MO vs LA	0.679	0.344	1.342
STATE AR_MO vs MS	1.529	0.582	4.019
STATE AR_MO vs TX	0.798	0.306	2.079
STATE AR_MO vs CA	0.386	0.145	1.025
STATE LA vs MS	2.251	0.750	6.760
STATE LA vs TX	1.175	0.398	3.464
STATE LA vs CA	0.569	0.188	1.719
STATE MS vs TX	0.522	0.147	1.858
STATE MS vs CA	0.253	0.065	0.987
STATE TX vs CA	0.484	0.139	1.686
netw_mil	1.056	0.920	1.213

Wald Confidence Interval for Odds Ratios			
Label	**Estimate**	**95% Confidence Limits**	
pctown	1.004	0.996	1.012
pctrice	0.985	0.974	0.997
riceyld	1.026	1.004	1.050
TechAsst Yes vs No	3.084	1.035	9.192
IrrMgt Yes vs No	1.441	0.532	3.908
ExperYr	1.005	0.986	1.024
highered Yes vs No	3.914	2.164	7.080

APPENDIX II. Logit estimates, means for 200 estimations an standard errors (bootstrap standard errors)

Variable	Label	N	Mean	Std Dev
Intercept	Intercept: conserve=1	20	-	1.79603
netw_mil	Net worth (million $)	0	3.1849598	13
ExperYr	Years of experience	20	0.1566154	0.23480
pctown	% Operated acreage owned	0	0.0067842	02
pctrice	% Operated acreage in harvested rice	20	0.0006350	0.01775
STATEAR_	State in which farm is located (2 digit FIPS code)	0	61	71
MO	AR_MO	20	-	0.01008
STATELA	State in which farm is located (2 digit FIPS code)	0	0.0166110	11
STATEMS	LA	20	-	0.00992
STATETX	State in which farm is located (2 digit FIPS code)	0	1.0923396	76
higheredYes	MS	20	-	0.77985
TechAsstYes	State in which farm is located (2 digit FIPS code)	0	0.6201520	04
IrrMgtYes	TX	20	-	0.79234
riceyld	Some College/Graduated College Yes	0	1.7518929	08
	Tech. Assistance for consv practices on field Yes	20	-	1.07396
	Water mgmt plan for applying irrigation water	0	0.8425427	63
	Yes	20	1.3570207	0.81030
	Rice yield/acre (cwt)	0	1.1516313	51
		20	0.4001085	0.43319
		0	0.0286336	29
		20		0.62770
		0		14
		20		0.53899
		0		47
		20		0.01760
		0		62

Obs	Effect	odds_mean	odds_mean_lowercl	odds_mean_uppercl	odds_std
1	ExperYr	1.00697	1.00447	1.00946	0.01792
2	IrrMgt Yes vs No	1.72107	1.58623	1.85592	0.96706
3	STATE AR_MO vs CA	0.47552	0.38878	0.56227	0.62212
4	STATE AR_MO vs LA	0.68896	0.64348	0.73444	0.32615
5	STATE AR_MO vs MS	2.50406	2.15640	2.85171	2.49325
6	STATE AR_MO vs TX	0.90033	0.82264	0.97802	0.55715
7	STATE LA vs CA	0.77903	0.61500	0.94305	1.17633
8	STATE LA vs MS	4.13352	3.53082	4.73623	4.32237
9	STATE LA vs TX	1.54245	1.35252	1.73237	1.36204
10	STATE MS vs CA	0.32355	0.23375	0.41335	0.64400

Obs	Effect	odds_mean	odds_mean_lowercl	odds_mean_uppercl	odds_std
11	STATE MS vs TX	0.52588	0.46831	0.58345	0.41287
12	STATE TX vs CA	0.59042	0.51511	0.66574	0.54014
13	TechAsst Yes vs No	3.82617	3.47715	4.17519	2.50305
14	highered Yes vs No	4.25787	3.99493	4.52080	1.88568
15	netw_mil	1.20422	1.16069	1.24775	0.31217
16	pctown	1.00069	0.99929	1.00209	0.01004
17	pctrice	0.98357	0.98221	0.98494	0.00976
18	riceyld	1.02921	1.02667	1.03174	0.01817

APPENDIX III. The Logistic Procedure for Unweighted binary logistic regression.

Model Information		
Data Set	WORK.SUBSET2006	
Response Variable	conserve	Conservation payments or recreation income
Number of Response Levels	2	
Model	binary logit	
Optimization Technique	Fisher's scoring	

Number of Observations Read	423
Number of Observations Used	423

Response Profile		
Ordered Value	**conserve**	**Total Frequency**
1	1	82
2	0	341

Probability modeled is conserve=1.

Class Level Information					
Class	**Value**	**Design Variables**			
STATE	**AR_MO**	1	0	0	0
	LA	0	1	0	0
	MS	0	0	1	0
	TX	0	0	0	1
	CA	0	0	0	0
highered	**Yes**	1			
	No	0			
TechAsst	**Yes**	1			
	No	0			

Class Level Information					
Class	Value	Design Variables			
IrrMgt	Yes	1			
	No	0			

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	418.031	407.195
SC	422.078	463.858
-2 Log L	416.031	379.195

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	36.8360	13	0.0004
Score	39.7312	13	0.0002
Wald	32.4901	13	0.0020

Type 3 Analysis of Effects			
Effect	DF	Wald Chi-Square	Pr > ChiSq
netw_mil	1	4.7672	0.0290
offinc_k	1	1.2577	0.2621
ExperYr	1	2.0215	0.1551
pctown	1	1.0523	0.3050
pctrice	1	1.1655	0.2803
STATE	4	6.7996	0.1469
highered	1	2.7227	0.0989

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
TechAsst	1	1.5681	0.2105
IrrMgt	1	2.6426	0.1040
riceyld	1	1.1741	0.2786

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-2.7271	1.1811	5.3310	0.0209
netw_mil		1	0.1695	0.0776	4.7672	0.0290
offinc_k		1	0.00237	0.00211	1.2577	0.2621
ExperYr		1	0.0156	0.0109	2.0215	0.1551
pctown		1	0.00498	0.00485	1.0523	0.3050
pctrice		1	-0.00699	0.00648	1.1655	0.2803
STATE	**AR_MO**	1	-0.7334	0.5492	1.7832	0.1818
STATE	**LA**	1	-0.6852	0.5667	1.4621	0.2266
STATE	**MS**	1	-1.3702	0.6486	4.4629	0.0346
STATE	**TX**	1	-0.1859	0.5950	0.0976	0.7547
highered	**Yes**	1	0.5011	0.3037	2.7227	0.0989
TechAsst	**Yes**	1	0.6484	0.5178	1.5681	0.2105
IrrMgt	**Yes**	1	0.6914	0.4253	2.6426	0.1040
riceyld		1	0.0129	0.0119	1.1741	0.2786

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
netw_mil	1.185	1.017	1.379
offinc_k	1.002	0.998	1.007
ExperYr	1.016	0.994	1.038
pctown	1.005	0.995	1.015
pctrice	0.993	0.981	1.006
STATE AR_MO vs CA	0.480	0.164	1.409
STATE LA vs CA	0.504	0.166	1.530
STATE MS vs CA	0.254	0.071	0.906
STATE TX vs CA	0.830	0.259	2.665

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
highered Yes vs No	1.650	0.910	2.993
TechAsst Yes vs No	1.913	0.693	5.277
IrrMgt Yes vs No	1.996	0.867	4.595
riceyld	1.013	0.990	1.037

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	69.6	Somers' D	0.396
Percent Discordant	29.9	Gamma	0.398
Percent Tied	0.5	Tau-a	0.124
Pairs	27962	c	0.698

Wald Confidence Interval for Odds Ratios			
Label	Estimate	95% Confidence Limits	
STATE AR_MO vs LA	0.953	0.462	1.967
STATE AR_MO vs MS	1.890	0.801	4.461
STATE AR_MO vs TX	0.578	0.255	1.311
STATE AR_MO vs CA	0.480	0.164	1.409
STATE LA vs MS	1.984	0.755	5.209
STATE LA vs TX	0.607	0.253	1.454
STATE LA vs CA	0.504	0.166	1.530
STATE MS vs TX	0.306	0.112	0.837
STATE MS vs CA	0.254	0.071	0.906
STATE TX vs CA	0.830	0.259	2.665
netw_mil	1.185	1.017	1.379
offinc_k	1.002	0.998	1.007
pctown	1.005	0.995	1.015
pctrice	0.993	0.981	1.006
riceyld	1.013	0.990	1.037
TechAsst Yes vs No	1.913	0.693	5.277
IrrMgt Yes vs No	1.996	0.867	4.595

Wald Confidence Interval for Odds Ratios			
Label	**Estimate**	**95% Confidence Limits**	
ExperYr	1.016	0.994	1.038
highered Yes vs No	1.650	0.910	2.993