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Grower Benefits from the Adoption of Genetically Modified Rice in California

by

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Genetically modified (GM) rice has not yet been commercialized anywhere in the world but may soon be available. We estimate that the economic gains to California growers from adoption of GM rice could be around $70 per acre. Besides the agronomic and economic benefits to the grower, there are significant environmental benefits for California.

California rice farmers are experiencing an "epidemic" of herbicide resistance in grassy weeds, and this resistance, especially in the case of watergrass, has resulted in annual herbicide costs of up to $200 per acre for some growers. The higher production costs associated with weed control lowers grower returns, and has led to considerable research effort to improve overall weed management through cultural, chemical and other management means. One strategy that is on the horizon is the adoption of genetically modified (GM) rice that is resistant to certain chemicals for which current weeds are not resistant. GM rice would not only reduce weed problems, but would lower chemical use in rice farming and simplify the management of rice production.

If accepted in the marketplace, there is good reason to believe that GM rice could lead to economic gains for the grower, as well as benefit the environment, given that conventional rice production in California involves heavy use of chemicals. Major rice producing and consuming countries, including the United States, China and Japan, are developing and testing this new GM technology. For instance, China has approved seven different GM rice varieties for environmental release. Many of these varieties have the potential to be of value to producers through reduced disease or pest control costs and of value to the environment through reduced chemical usage, thereby reducing runoff and water pollution. If GM rice is first commercialized outside of California, this will reduce California's competitiveness. So it is essential that the California industry identify the conditions under which GM rice would be successful in the state.

We have evaluated the potential short-run economic impact of the adoption of one GM rice cultivar on California rice growers. The cultivar is resistant to the broad-spectrum herbicide Liberty® (glufosinate), currently under development by Bayer CropScience, and is not commercially available at this time. Potential farm-level economic benefits, measured by net returns over operating costs, are calculated using a partial budgeting approach. Sensitivity analysis is then utilized to represent the heterogeneity in growing conditions in the state, as well as uncertainty regarding the yields, technology fee and other assessments on the GM seed.

Background

The main farm-level effects of GM rice adoption in California would be lower herbicide costs and yield improvement. GM crops are not engineered to increase yields; rather, they are designed to prevent yield losses arising from weed infestation. As such, potential yield gains are dependent on the degree of the weed problem and the effectiveness of the treatment relative to the alternatives. Many adopters of GM crops have experienced yield effects ranging from zero percent to twenty percent, although some have reported small yield losses.

While herbicide costs are likely to decrease for a typical grower, it is probable that the cost of GM seed will be higher than conventional seed. Companies that sell GM crops typically charge a technology fee, either through direct agreement or pricing of associated products such as herbicides, in order to recoup their research investment costs. Using Monsanto's Roundup Ready® corn and soybeans as a reference point, the technology fee is approximately thirty to sixty percent of conventional seed costs per acre.

In addition to the technology fee, seed costs for GM rice will likely change as a result of the California Rice Certification Act (CRCA) of 2000. The CRCA classifies rice varieties that have "characteristics of commercial impact," defined by "…characteristics that may adversely affect the marketability of rice in the event of commingling with other rice and may include, but are not limited to, those characteristics that cannot be visually identified without the aid of specialized equipment or testing, those characteristics that create a significant economic impact in their removal from commingled rice, and those characteristics whose removal from commingled rice is infeasible." Under this legislation, any person selling seed deemed to have characteristics of commercial impact, which would presumably include any GM varieties, must pay an assessment "not to exceed five dollars per hundredweight (cwt)."

Table 1. Cost and Returns: Conventional Versus GM Rice

		Projected GM Rice Cost & Returns	
	High Cost Scenario[c]	*1 App. of glufosinate*	*2 Apps. of glufosinate*
Gross value of production		------per acre-------	
Primary product: Rice	$520	$520	$520
Farm Bill Provision	$264	$264	$264
Total gross value of production	$784.01	$784.01	$784.01
Operating costs			
Seed	21.00	21.00	21.00
Fertilizer	71.44	71.44	71.44
Insecticide and Fungicide	14.82	14.82	14.82
Herbicide[a]	98.01	16.03	32.05
Purchased irrigation water	59.13	59.13	59.13
Equipment Rent	14.67	14.67	14.67
Custom operations[b]	79.90	63.70	75.70
Contract operations	143.80	143.80	143.80
Labor	59.46	59.46	59.46
Fuel, lube and electricity	50.39	50.39	50.39
Repairs	13.00	13.00	13.00
Interest on operating capital	16.65	12.91	13.90
Assessment	7.20	7.20	7.20
Total operating costs per acre	$649.48	$547.56	$576.57
Net Returns above operating costs per acre	$134.53	$236.45	$207.44
Net Returns above operating costs per cwt	$1.68	$2.96	$2.59
Supporting information:			
Price ($ per cwt at harvest)	6.50	6.50	6.50
Yield (cwt per planted acre)	80	80	80
Farm Bill Provision Payments			
Direct Payments	$151.81	$151.81	$151.81
Counter Cyclical Payments	$112.20	$112.20	$112.20
Effective price per cwt	$9.80	$9.80	$9.80

a. Includes chemical material costs only.
b. Includes chemical application costs.
c. Changes from adjusted costs include 100 percent ground application, one additional application of grass herbicide on 50 percent of acreage, evaluated as mean cost, and 10% savings on chemical application from ground application.

An overriding issue affecting the farm-level returns from adoption of GM rice in California is market acceptance. Many California producers have voiced concern over the opposition to GM food crops in some markets–especially in Japan, the largest offshore market for California rice. However, Japan now imports substantial quantities of both GM and non-GM soybeans and corn from the U.S. and elsewhere. It is also the world's largest importer of GM canola. The non-GM grain brought into Japan is kept segregated in the handling, storage and marketing system. The segregation system works well, and Japanese importers pay a small price premium for non-GM cargoes to cover the segregation costs, as well as the higher production costs associated with non-GM crops. Under Japan's GM labeling regulations, there is a five percent threshold level for adventitious presence of (approved) GM material in non-GM shipments. Given the importance of the Japanese market, an adequate segregation system is therefore a necessary requirement for the commercialization of GM rice in California, as is food, feed and environmental approval for GM rice in Japan.

Table 2. Estimated Dollar Per Acre Potential Gains for Adopters of GM Rice

Technology Fee ($ per acre)	Percent Change in Yield with GM rice: 0%	5%	10%
$0	$64.46	$82.55	$100.64
2.50	61.85	79.94	98.03
5.00	59.24	77.33	95.43
7.50	56.63	74.72	92.82
10.00	54.02	72.11	90.21
12.50	51.41	69.51	87.60
15.00	48.80	66.90	84.99

Note: We assume two applications of glufosinate.

Farm-Level Potential Benefits of Genetically Modified Rice Adoption

To estimate the potential per-acre net returns of adoption for a single year, we utilize rice production cost estimates from the University of California Cooperative Extension and pesticide-use data from the California Department of Pesticide Regulation. The cost of production estimates were updated using the most recent pesticide-use data and prices, and compared to estimated costs of the Liberty Link® GM system, with yields, seed prices, assessments and rice prices held constant at the level of the conventional technology. See Table 1 for estimated costs and returns of conventional versus GM rice. Depending on the number of Liberty® (glufosinate) herbicide applications (one or two) necessary to control weeds, overall cost savings of adoption were estimated to be approximately $73 to $102 per acre, or about 11 percent to 16 percent of non-GM operating costs.

It is unlikely, however, that the individual producers will capture all of these cost savings, or that returns will be identical across growers. A technology fee, typically 30 to 60 percent of per acre seed costs ($6 to $13 for rice), is likely to be charged to adopters by developers of the technology, and the CRCA regulations will impose additional unit costs. Table 2 presents a range of estimates of per acre gains incorporating these uncertain variables, assuming that growers pay 100 percent of the CRCA assessments and use two applications of glufosinate per year on GM rice. Despite these conservative assumptions, the table indicates that adoption of GM rice will increase net returns per acre under most realistic scenarios. The most likely gains are shown near the bottom of Table 2. For instance, if the technology fee is $15 per acre and the yield gain is five percent, then the potential gain to adopters is almost $70 per acre.

Environmental Impact

Also of considerable interest is the effect of GM adoption on the industry's total chemical use. Most commercial rice production in the Sacramento Valley region is under flooded field conditions, and is heavily dependent on chemical herbicides and insecticides to control weeds and insects. Release of the standing water into the Sacramento Valley watershed is thus an important externality arising from rice farming, and one which will be affected by the introduction of transgenic varieties.

The California rice industry has a history of addressing water quality issues, beginning with implementation of the Rice Pesticides Program by the California Department of Pesticide Regulation in 1983. This program was originally designed to reduce herbicide pollution of local waterways, and was expanded in the early 1990s to include performance goals for additional herbicides and insecticides, as well as addressing damage done by drift and dust from aerial application of herbicides. Furthermore, the Central

Potential adoption of GM rice varieties is one way for growers to reduce chemical application in the Central Valley.

Photo courtesy of Dana Dickey, CA Rice Research Board

Valley office of the California Regional Water Quality Control Board passed an amended conditional waiver of waste discharge requirements for irrigated lands in 2003, which tightens quality standards for water released from agricultural uses in the Central Valley, as well as requires monitoring and reporting of water quality and implementation of management practices that improve discharged water quality. This conditional waiver expires in two years, and expectations are that standards for water quality will tighten further, increasing costs and reducing pest control options for rice growers. The courts are also encouraging rice farmers to reduce the use of chemicals. U.S. District Judge John Coughenour recently ordered the creation of pesticide-free buffers around streams and rivers to protect fish in California, Oregon and Washington. These buffers are expected to impact California rice growers who use aerial spraying.

Potential adoption of GM rice varieties is one way for growers to reduce chemical application in the Central Valley. Total poundage of chemical herbicides applied per acre is expected to decrease by at least 84 percent, and total poundage of active ingredients is predicted to decrease by at least 87 percent using the two-treatment Liberty® scenario.

Cultivation of GM rice in California could thus decrease total herbicide poundage by between 7.27 and 10.9 million pounds, and active ingredient poundage by between 1.69 and 2.53 million pounds, assuming 50 percent to 75 percent adoption. This is in accordance with previous studies that concluded cultivation of GM crops, in general, are consistent with increased environmental stewardship. However, this simple measure ignores toxicity, mobility and persistence of different chemicals in the soil and water, likely to significantly affect the external damage costs associated with chemical pest control.

Conclusions

This article reports our estimates of the potential short-run economic impacts of GM herbicide-tolerant rice adoption at the farm level, as well as the effects of adoption on the industry's herbicide use. We conclude that a weed management strategy including GM rice varieties will most likely lead to large economic benefits for the farmer, but these benefits will vary from grower to grower. However, this study does not thoroughly address market acceptance issues that may affect both domestic and export demand for conventional and GM rice, nor does it address the dynamic effects of adoption. Nevertheless, if California rice growers perceive that expected net benefits from adoption of the technology are positive and considerable, there is little doubt that the technology will be embraced by California rice growers and that a segregation system will be developed to allow the industry to supply non-GM rice to certain markets such as Japan. The environmental benefits for society from adoption of GM rice are also significant, but we do not estimate their exact magnitude. We note that agricultural runoff as a source of water pollution is becoming a heated issue in California, and changes to regulations regarding agricultural water standards will reinforce the arguments for introduction of GM rice cultivars in the state.

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The California Wine Industry: Entering a New Era?

by

Philip Martin and Dale Heien

The California wine industry is fragmenting into larger and smaller units to reflect the evolving consumer market in which sales of relatively expensive and relatively cheap wine are growing fastest. The future may be one of large wineries with many labels and small wineries that sell most of their wine to retail consumers.

In September 2002, California grape growers picketed a Gallo grape-receiving facility in Fresno, protesting the $65 a ton offered for their grapes– just enough to cover picking costs. Meanwhile, swank restaurants served wines made from Napa cabernet grapes worth $3,700 a ton. The wine industry in California and the world is entering a new era, as many people drink less but better wine. Will producers of lower-priced grapes raise their quality enough to attract more upscale wine drinkers, putting downward pressure on all grape and wine prices, or will the wine grape industry continue to fragment into distinct quality and price segments, allowing one segment to prosper while another languishes?

These changes have their origin in 1976 when a blind tasting pitted several California wines against top French vintages. To the eternal chagrin of the (French) judges the California wines—Stag's Leap Cabernet and Chateau Montelena Chardonnay—were voted superior. American consumers in the 1980s and 1990s took a new interest in wine and the lifestyle associated with fine wine and food. This new interest increased consumer appreciation of the fact that the taste of wine reflects where the grapes are grown and how the wine is made. Changing consumption patterns, the consolidation of production, and the globalization of sales and tastes are causing the reconfiguration of the California, and world, wine economy.

Consumption: Less but Better

U.S. wine drinkers have upgraded their tastes over the past quarter century, as baby boomers with leisure time and money began to explore wine. Consumption of cheaper table wines, those costing $3 a bottle or less, was stable during the 1980's. In November 1991, the CBS television program *60 Minutes* aired a segment on the French Paradox, the fact that moderate consumers of red wine have less coronary heart disease. Better quality table wine consumption rose sharply in the 1990s (Table 1). Wines carrying labels like Chablis or Burgundy and classified as jug wine fell from 65 percent of consumption in 1991 to 36 percent in 2001, while wines costing $7 a bottle or more were nine percent of sales in 1991 and 28 percent of sales in 2001. The average price of a bottle in inflation-adjusted prices rose from $3.50 in 1991 to $4.60 in 2001, an increase of 2.5 percent annually, which led to the mantra that consumers were drinking "less but better." There are about as many cases of popular-premium or fighting varietal wines sold as jug wines sold.

Higher grape and wine prices have led to increased plantings, especially in coastal areas associated with higher-priced wine grapes. At the beginning of the wine boom in the late 1970s, producer prices for wine grapes rose in all areas, but increased production in the 1980s led to lower prices and reduced acreage— acreage fell

Table 1. U.S. Wine Consumption by Retail Price (750 ml bottle),1991-2001

	Retail Price	1991	1995	1998	1999	2000	2001
Cases Sold (millions)							
Ultra-Premium	Over $14	2.4	3	5.5	10.1	14.4	14.8
Super-Premium	$7 to $14	7.1	10.1	21.4	24.5	24.5	26.4
Popular-Premium	$3 to $7	28.1	34.5	48.1	49.5	52.6	51.3
Jug Wine	Below $3	69.2	69.4	67.8	65.7	55	52.6
Total Table Wine	Mil cases	106.8	117	142.8	149.8	146.5	145.1
Average Price	Table wine	$3.44	$3.88	$4.60	$5.21	$5.88	$5.96
Percent of Total Volume							
Ultra-Premium	Over $14	2%	3%	4%	7%	10%	10%
Super-Premium	$7 to $14	7%	9%	15%	16%	17%	18%
Popular-Premium	$3 to $7	26%	30%	34%	33%	36%	36%
Jug Wine	Below $3	65%	59%	47%	44%	37%	36%

Source: Selected Gomberg-Fredrickson Reports

** Weighted average price is based on midpoint prices for each category times the share of total cases in each category. Retail price categories and weighted average prices are not adjusted for inflation.*

Table 2. California Winegrape Varieties, 1972 and 2001

Percent of acreage	1972		2001
Carignane	12%	Chardonnay	21%
French Colombard	10%	Cabernet Sauvignon	15%
Zinfandel	9%	Merlot	11%
Grenache	7%	Zinfandel	10%
Barbera	6%	French Colombard	8%
Top 5	44%		63%

Source: Grape Acreage Report, California Agricultural Statistics Service, http://www.nass.usda.gov/ca/

ten percent between 1982 and 1991. As the dollar rose in value in the 1980s, wine imports surged, achieving a 27 percent market share in 1984. During the late 1980s, the California wine industry again began to expand, but this time growers planted varietal grapes such as Chardonnay, Zinfandel, Cabernet Sauvignon and Merlot. The top five wine grape varieties accounted for 44 percent of the acreage in 1972 and 63 percent in 1997, but only French Colombard and Zinfandel were among the top five in both years (Table 2).

Winegrape production methods also changed. In the early 1970s, most growers planted vines in rows that were 10 to 12 feet apart, which reduced disease risks by increasing air circulation but also limited yields on what was becoming more expensive land. The most common trellis system had three wires: one for the irrigation hose; one for the cordon or vine; and a "catch wire" to support the vine's foliage. During the 1990s, trellises became more complex, often having wires to guide the shoots upward and thereby foster growth and facilitate exposure to sunlight. Grape clusters that are slow to ripen are removed, intensifying the flavor of the wine produced from the remaining clusters.

Grape growers have become more sensitive to terroir or local conditions. Rootstocks have been developed for particular areas, so that the vines have more disease resistance or drought tolerance, suggesting that parts of California may develop a French-style system that associates specific grape varieties with particular areas, such as Cabernet in the Napa Valley, Chardonnay in the Carneros area of Napa and Sonoma counties, and Zinfandel in the foothill counties.

During the 1990s, the demand for wine increased, and some wineries offered growers multi-year "planting contracts" with guaranteed prices. Plantings increased 48 percent between 1991 and 2001, with the fastest growth in the North and Central Coast areas (Table 3). Non-bearing acreage increased even faster, although the exact amount of non-bearing acreage remains uncertain because some growers have not fully reported their acreage.

In 2001-02, the increased supply of grapes and recession led to declining prices for winegrapes in all areas except the North Coast. In the southern San Joaquin Valley, the result was extremely low prices, which prompted the protests at Gallo. Thompson Seedless, which make-up over 60 percent of the grape acreage in the southern San Joaquin Valley (Madera, Fresno and Tulare counties), can be marketed as table grapes, dried into raisins, or crushed to make wine or grape juice concentrate, a natural sweetener added to soft drinks and confectionery products. Many southern San Joaquin Valley growers do not have contracts with wineries, which explains why they were protesting low spot market prices in 2002.

Consolidation

The farm and food industries are consolidating so that fewer and larger firms account for an increased share of the total sales. The same squeeze on mid-sized players is occurring in the wine industry. The top three wineries, Gallo, Canadaigua and The Wine Group, account for over 60 percent of U.S. wine shipments. In the current consolidation, larger wineries are buying smaller ones, in part to improve their bargaining position with retailers such as Costco. For example, Constellation Brands owns Canandaigua Wine Co, the second largest wine producer after E & J Gallo, as well as Franciscian Estates, giving it a total of 51 brands in 14 market categories, including Almaden, Cribari, Inglenook, Paul Masson, Taylor California Cellers, Nathanson Creek, Dunnewood, Talus, Manischewitz, Cook's and Taylor Sparkling wine, and Wild Irish Rose. Diageo owns BV, Domain Chandon and Dom Perignon, while The Wine Group owns Glen Ellen, Franzia and Mogen David. Consolidation enables one producer to market many labels, thus gaining shelf space in retail stores and facilitating exports and joint ventures.

Mid-size wineries are at a competitive disadvantage vis-à-vis both larger and smaller ones. Small wineries in areas frequented by tourists can sell wine directly to consumers through their tasting rooms, thereby eliminating middlemen and retailer markups. For example, the Napa Valley has 300 wineries, a third of the wineries in California, and most sell much of their wine to visitors. Mid-sized wineries, by contrast, must often sell their wine via middlemen who can have considerable market power under state laws regulating alcohol sales. In the traditional three-tiered marketing system for wine, wineries sell to distributors who sell to supermarkets and liquor stores. The markup from winery to consumer is often 100 percent or more, with much of the profit going to distributors. There is an ongoing effort to eliminate the middleman in wine marketing via internet sales, but that effort has been slowed by the constitutional right of states to regulate alcohol sales. Several lawsuits opposing the ban on internet sales of wine are presently in court.

Large wineries aim to achieve economies of scale and produce uniform wines with vertical integration, growing grapes in their own vineyards or having grapes grown for them according to winery-set specifications. Many of the largest vineyards are in the Central Coast region, which lends itself to large-scale production of varietal winegrapes. There are also economies of scale in wine making, with more fermentation and storage capacity smoothing production and reducing wine crush and fermentation costs. Technological changes in fermentation and quality control have made it easier to produce wine with a consistent taste, and research continues on understanding the chemical composition of wine to improve consistency in wine production.

Globalization

Even though wine is one of the world's oldest drinks, production and consumption remain concentrated in Europe, which produces 74 percent of the world's six billion gallons of wine, equivalent to one gallon for each of the world's six billion residents. The big three wine producers are France, 22 percent; Italy, 21 percent; Spain, 12 percent; the other major European wine producers account for 19 percent of global wine production.

The U.S. is the fourth-largest producer of wine, accounting for about eight percent of world production. Other major New World wine producers are Argentina, five percent; South Africa, three percent; Australia, two percent; and Chile, two percent. They are New World countries in the sense that they share a common wine style (fresh and fruity) and were largely settled by immigrants from Europe. The dynamic trio are Australia, Chile and South Africa, which collectively produce ten percent of the world's wine, but have just one percent of the world's population, which means that most of the wine they produce is exported. For example, Australia exports 90 percent of the wine it produces. The import share of U.S. wines has a V-shape: imports were 25 percent of the volume of U.S. wine consumed in the early 1980s, reached a low of 12 percent in 1990, and are now about 22 percent. Imports in the mid-1980s mostly affected U.S. producers of jug wines, as Italian imports such as Riunite and Bolla increased their U.S. sales. Today's import surge is led by two Australian labels, Lindemans and Rosemount Estate, that compete with wines produced in the Central Coast and Lodi/Woodbridge areas. In 2001 the U.S. imported 127 million gallons of wine and exported 80 million gallons; about 70 percent of U.S. wine exports go to Great Britain, Canada, Netherlands and Japan.

A battle is fermenting between Old World European producers and New World producers. In Old World Europe, there are thousands of grape growers, many

Table 3. California Grape Acreage, Production and Price

	1982	1991	2001
North Coast: Napa, Sonoma, Lake, Mendocino counties			
Winegrape Acreage	71,349	84,086	122,444
Winegrape Crush (tons)	251,600	347,400	383,000
Share of Total Crush	12%	17%	13%
Price/ton ($)	621	1,046	2,219
Grower receipts ($1,000)	156,244	363,380	849,877
Central Coast: Monterey to Santa Barbara counties			
Winegrape Acreage	54,152	49,854	86,501
Winegrape Crush (tons)	165,200	195,200	407,400
Share of Total Crush	8%	10%	14%
Price/ton ($)	460	749	1,240
Total Receipts ($1,000)	75,992	146,205	505,176
Central San Joaquin: Lodi-Woodbridge area			
Winegrape Acreage	80,791	73,111	114,765
Winegrape Crush (tons)	493,400	519,600	797,700
Share of Total Crush	24%	25%	28%
Price/ton ($)	150	240	390
Total Receipts ($1,000)	74,010	124,704	311,103
Southern San Joaquin			
Winegrape Acreage	140,474	108,076	142,463
Winegrape Crush (tons)	1,109,000	989,300	1,290,000
Share of Total Crush	55%	48%	45%
Price/ton ($)	143	157	185
Total Receipts ($1,000)	158,587	155,320	238,650

Source: Grape Crush Report, CASS
http://www.nass.usda.gov/ca/

Table 4. Top Four Wine Imports in U.S., 2001

Country of Origin	Gallons (1,000)	Major Brands
Italy	47,061	Riunite, Bolla, Casarsa, Ecco Domani
France	27,348	Georges Duboeuf
Australia	19,142	Lindemans, Rosemount Estate
Chile	13,669	Concha y Toro, Walnut Crest

Source: Gomberg Fredrickson Report, vol. 21, no. 12, page 21.

with fewer than five acres of grapes, and most send their grapes to co-op wineries—the famous Chateaux that grow grapes and bottle wines with their own labels are exceptions. Most European wines are a blend of several varieties of grapes, and the wine is labeled to reflect the region in which the grapes were grown, such as Bordeaux or Burgundy. The quality and quantity of wine varies from year to year, which means that vintage charts are needed to determine the best wines.

In the New World, grape growing and wine making are often integrated operations in which the winemaker aims for consistency so the first and last bottle taste the same. New World wines, often produced with more technology, tend to be preferred by consumers in countries that do not produce much wine, such as the UK.

Whither California Wine?

Parts of the California wine industry have transformed themselves from producers of jug or generic wine to producers of high quality wine, from producers of wines labeled "Chablis" or "Burgundy," which are wine growing areas of France, to producers of world-class Chardonnay and Cabernet Sauvignon wines. The ground work for the 1976 Paris surprise was laid by UC research and individuals in the Napa Valley. The wine boom they launched made parts of the wine industry among the most successful in the state.

The question facing the industry is how fast producers can respond to changing consumer tastes, as wine drinkers shift from jug wine to fighting varietals, fighting varietals to premium, and premium to ultra premium wines. Analysts who do not distinguish between these different categories predict a "wine glut of historic proportions," as the financial paper *Barron's* asserted on August 3, 1998 and again on August 27, 2001. *Barron's* emphasized that, with wine production rising four to five percent a year, and consumption rising zero to one percent per year, "the basic laws of supply and demand guarantee that the coming glut will have a depressing effect on retail wine prices." However, this prediction of a glut ignores the possibility of a segmented wine industry, as well as alternative outlets for lower quality grapes. In a segmented wine industry, some parts may be booming while others go bankrupt. Displaced growers have alternatives in the grape concentrate (sweetener), raisin and table grape markets. Thompson Seedless grapes, which are one-third of California grape acreage, can be marketed in any one of the four markets. However, profitability in these alternatives, especially raisins and wine, is presently very limited.

A related question is how long will the trend toward more expensive wines last? Today's senior cohort is the wealthiest in history. Many marketers feel this is the source of the shift to more expensive wines and they note that the size of the babyboom generation is unique in U.S. history. At some point the shift to wine and to higher-priced wines may cease. Current levels of consumption, even the upper end, have been stagnate over the 2000-2002 period. This may be due to current economic forces and perhaps 9/11, or it may foretell a plateau in wine consumption as experienced in the 1980s.

In addition to this change in tastes, considerable concern exists regarding the level and direction of imported wines both bottled and bulk—which are used for blending. California vintners in partnership with foreign wineries, or California wineries with vineyards abroad, may prosper, but the fate of growers is less clear. Other concerns arise over the impact of consolidation, especially on medium-sized wineries. The outcome could well be a few large wineries and many small wineries marketing to the agro-tourist and internet trade.

The wine industry has been among the most successful of California's farming sectors. Optimists emphasize that the growing number of educated wine drinkers means that the demand for premium wines can continue to expand. If the demand for jug or generic wines continues to fall, the 21st century wine industry may operate at very different speeds, with one segment enjoying record profits while another pulls out unprofitable grapes.

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Targeting Payments for Environmental Services: The Role of Risk

by

Jennifer Alix-Garcia, Alain de Janvry and Elisabeth Sadoulet

Payments for environmental services have become increasingly popular in both the developing and developed world. Existing programs, however, could be made more efficient by taking into account the risk of losing these services in the design of such programs.

Programs of payments for environmental services (PES) are found everywhere from the Americas to Uganda and their variety and scope is growing every day. They range from the very specific (one city paying one forest owner in Mexico) to the general (paying for water table regulation, biodiversity conservation and carbon sequestration in Australia). The United States boasts one of the largest PES programs in the world, the Conservation Reserve Program (CRP), and in addition is home to hundreds of local land trusts, wetlands preservation and restoration programs and others intended to conserve or renew valuable ecosystems. The justification behind such payment programs is that natural resources may provide services for society that are larger than the individual owner's benefits. While the owner of a resource may find it profitable to exploit these resources, the losses to the world may be greater than the money the resource owner makes. In these cases, it is worth the effort to pay the owner not to exploit the resource. In some cases, it is even worth reimbursing the owner to restore a resource that has already been exploited.

The question of to whom and how much to pay for environmental services has generated a large amount of research. The main conclusion is that an efficient payment program will try to maximize the amount of environmental benefits purchased per dollar spent. In addition, however, new research shows that substantial savings can be had by targeting those pieces of land that are at high risk of being lost. It makes little sense to give large payments for remote areas that are not threatened, particularly where budgets for payment programs are very limited. The paragraphs below explore different targeting strategies that take the threat of benefits loss into account and apply these principles to a nascent PES program in Mexico in order to show the efficiency gains that can be made by considering risk, opportunity cost and environmental benefits.

Payment Strategies and Incorporating Risk

PES programs are far from a new concept. Indeed, the Nature Conservancy has been purchasing lands both in and outside of the United States since 1951. Their strategy is to pay the full market value for a tract of land which they then remove indefinitely from the possibility of production. The U.S. CRP makes long term contracts (10 to 15 years) with farmers to remove highly erodible land from production, for which they are given yearly payments based upon local rental rates. The CRP makes an attempt to apply the principle of maximizing environmental benefits per dollar by using an environmental benefits index divided by the local rental rate to rank plots. The index is a point system based upon the perceived environmental quality of different components of the land, including potential for endangered species habitat and proximity to rivers. Both of these strategies give payments equivalent to the opportunity cost of the land—i.e., what the land would be worth to owners were it not being conserved.

An alternative strategy is to pay the value of the environmental benefits produced by a plot of land. In this case, the "environmental rents," the excess value above the opportunity cost of the land, is enjoyed by the land owners rather than by society at large. This approach is difficult to implement, as the valuation of environmental benefits is a murky business at best. There are also payment strategies that allow land owners and program financers to split these environmental rents by charging the same price for all land entering in the program, as is the case with Costa Rica's payments program.

Most recently implemented payment programs, particularly those in developing countries where land rental rates are difficult to establish, pay a flat fee per hectare of forest or other endangered ecosystem, whether the land was located next to a rapidly growing city or on the top of their highest mountain.

These types of payment programs are of the Nature Conservancy variety in the sense that they intend to preserve land rather than change land use from farming to conservation, although in some cases reforestation efforts are also financed. Theoretically, these payments should vary across space according to the risk of losing the environmental benefits. Based upon the above discussion, one can think of various ways of implementing payments that incorporate this risk.

One might pay exactly the expected opportunity cost of this land, in other words, pay what a farmer might earn by cutting down the forest and planting crops in a given area. However, this area is only the land that he intends to cultivate in a given year and not the forest ranging from his front door to the top of a mountain five miles away. Payments of this type should only be made for land for which expected environmental benefits exceed this opportunity cost. Alternatively, one might pay the value of the environmental benefits that are at risk, but again, only when risk exceeds the opportunity cost. Finally, in the face of a limited budget, one might take inspiration from the CRP and rank the potential land in order of those with the highest benefits per dollar, paying the expected opportunity cost for each acre until the money runs out. A simulation of these three schemes is discussed below, where each is compared to the other on the grounds of equity and efficiency, using as a benchmark the standard, flat rate approach.

Table 1. Constructing an Environmental Index

Characteristic	$ per hectare
Cloud forest	
Primary	40
Secondary	30
Temperate or dry forest	
Primary	30
Secondary	20
Added to each hectare of above:	
Overexploited watershed	10
Within ½ mile of a river	
Primary	20
Secondary	10

Case Study: Mexico

Though few experts agree on the exact figure, the consensus is that Mexico has the second highest deforestation rate in the world. In addition, it suffers from decreasing soil quality and increasing water scarcity, problems both associated with forest loss. Furthermore, it is among the most biologically diverse countries in the world, with first place in reptilian diversity, third in bird and fourth in mammal diversity. Its plant diversity exceeds that of the United States and Canada combined, and survival of both the flora and fauna is associated with protection of existing forest according to the Mexican National Forestry Commission (CNF). This combination of facts has thrust Mexican environmental policy into center stage both at home and abroad, and is the inspiration for the paper at hand.

Methodology

According to the CNF, 80 percent of the country's forests are located in ejidos, communities resulting from the post-revolution land reform which hold their property in common. Their large forest holdings make them a logical place to begin addressing the deforestation problem. Using data from a random sample of 450 forest-holding ejidos, we simulated the distribution of payments from the four programs discussed above, beginning with the benchmark, flat payment case. Taking advantage of satellite imagery to calculate deforestation rates, we were able to use the observed deforestation from 1993-2000 as our measure of risk. The payments were simulated for only a year, not over the entire period.

Because environmental benefits are extremely difficult to measure, and because no studies of hydrological forest externalities for Mexico could be found, the budget from the flat payment program was used to establish an overall maximum value for environmental amenities. In order to establish a relative scale of environmental benefits, an environmental benefits index was generated, keeping in mind Mexico's focus on hydrological benefits (the protection of water quality and quantity through maintenance of vegetation). A score was then calculated for each ejido, and these relative scores were then used to calculate environmental benefits at risk. This factor is used in two ways: First, in the expected environmental benefits program, the flat payments budget (the "value" of environmental amenities) is redistributed over these scores. Second, it establishes the benefit/cost ratio used to generate payments in the final program, where ejidos are ranked according to this ratio and then paid their expected opportunity cost. See Table 1 for the point system used to establish the benefits index.

Results

Table 1 shows the results from the simulations. The amount of hectares purchased and overall environmental benefits are highest in the opportunity cost and expected environmental benefits programs, where they are equal by construction. Efficiency is over three times higher in the opportunity cost program. When we compare the flat payments program with the expected environmental benefits program, where the budget is the same for both, we see considerably higher benefits with the latter scheme. The simulation suggests that if a payment strategy had been implemented as a flat scheme in 1993, it would not have affected 47 percent of the deforestation between 1993 and 1994. The expected environmental benefits/opportunity cost program takes as a ceiling the benefits obtained in the flat payments program. The spending required to generate these benefits using the criteria of maximizing benefits per dollar is less than one-tenth that of the actual budget. This final strategy, with an efficiency of .176, is by far the most efficient of the four.

Table 2. Costs, Benefits and Distribution of Different Simulated Programs

Payment type	Flat Payments	Expected opportunity cost program	Expected environmental benefits program	Expected environmental benefits/ opportunity cost program
Total hectares enrolled	1,436,634	1,771,230	1,771,230	1,006,724
Hectares at risk enrolled	12,470	23,207	23,307	11,956
Hectares from ejidos rejecting payments	365,400	15,751	15,751	0
Environmental benefits	226,927	405,675	405,675	226,337
Total budget	$14,420,350	$4,236,857	$14,420,352	$1,310,465
Efficiency (environmental benefits/$)	.016	.096	.028	.173
Gini coefficient of payments	.33	.70	.71	.67

The tradeoff between the flat payments program and the others is equity—its Gini coefficient is considerably lower than the others. (The Gini coefficient is an indicator of inequality that varies between 0 and 1. A score of 0 indicates perfect equality and of 1, perfect inequality.) It is interesting to note that this Gini of .33 is also considerably lower than that of the distribution of environmental benefits (Gini =.76) and of the forest in general (Gini =.73).

Conclusions

We find that the type of scheme typically implemented in PES programs in developing countries is very egalitarian, but highly inefficient. By maximizing environmental benefits per dollar spent, one can preserve the same amount of benefits at one tenth of the cost. A targeting program based on paying only for hectares at risk generates nearly double the environmental benefits of the actual scheme at the same price. A scheme based on paying only the opportunity cost of the forest generates the same amount of benefits, but at a much lower price than one which pays the environmental value of the hectares at risk. Clearly, implementing an environmental payments program is much more difficult than simulating one on a computer. The principles summarized here should, however, be of use to policymakers. In particular, taking into account the risk of losing environmental benefits, the value of these benefits and the opportunity cost will help immensely in designing programs that result in real environmental improvements without straining budgets more than necessary.

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