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New Hedging Techniques to Reduce Cotton Price Risk

by
Aaron Smith

The futures market provides an effective medium for mitigating price risk, but it sometimes functions imperfectly. This article illuminates these market imperfections and shows how to reduce price risk by avoiding them.

Commodity prices are notoriously volatile, which makes it difficult for agricultural producers to plan effectively. For example, at the beginning of the planting season in March 2001, the San Joaquin Valley (SJV) cotton price was $0.51 per pound. Growers who expected that price to persist would have been surprised when their product was only worth $0.36 in December of that year. This article illustrates how to protect against such price fluctuations using the futures market and how a futures hedging strategy that focuses on the fundamental value of cotton can further reduce price risk.

New York Board of Trade Cotton Futures

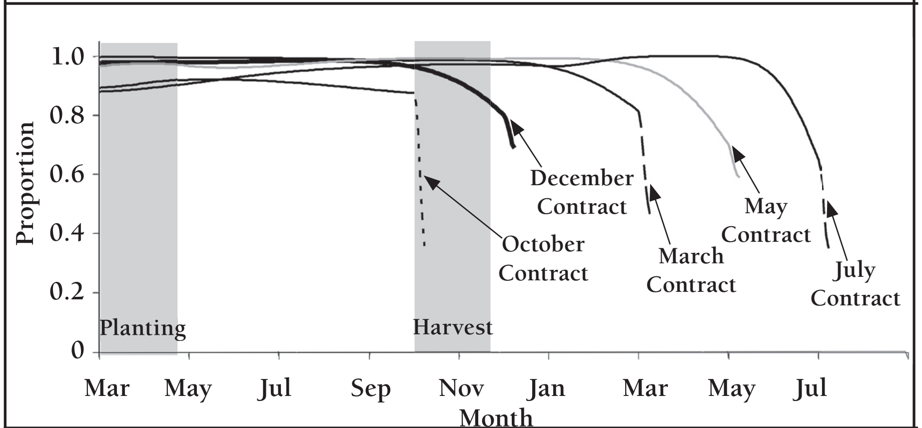
Futures contracts enable the purchase or sale of a commodity at a fixed price in a particular month in the future. For example, consider a California cotton grower. On March 1, 2001, this grower could have gone to the New York Board of Trade (NYBOT) and entered a futures contract to sell cotton in December of that year for $0.56 per pound. Growers holding such a contract can deliver the product to one of five locations: Galveston TX, Greenville SC, Houston TX, Memphis TN and New Orleans LA. These locations are all inconvenient for our California grower because of shipping costs and the availability of willing buyers in California.

Instead of delivering on the futures contract, our California grower could have canceled it by entering a futures contract to buy exactly the same quantity of cotton in December. On December 1, 2001, the futures price was $0.35. By effectively buying for $0.35 and selling for $0.56, the grower would have made a profit of $0.21 per pound. If this grower then sold in the SJV at the December market price of $0.36, the grower's revenue would have been 0.36 + 0.21 = $0.57 per pound, which only differs by $0.01 from the price that was expected when the grower first entered the futures contract in March.

This example shows a case where the cotton price decreased during the growing season, but the use of futures caused a grower's returns to be relatively unaffected. Instead, if cotton prices had increased in 2001 the grower would have been able to sell for a high price in the SJV but would have made a loss in the futures market, again ending up with revenue close to what was expected at planting time. Thus, using futures markets to hedge price risk enables growers to make decisions with better information about the likely outcomes from those decisions. In years when prices are high, growers could lock in those high prices at the time of planting and may choose to plant more acres. On the other hand, when futures prices are low, growers may choose to plant less cotton.

Also in this issue.........

Figure 1. Proportion of Future Price Variation Related to the Fundamental



Note: Curves generated using daily settlement prices on all NYBOT futures contracts traded between 1991 and 2000.

How Well Does the Futures Market Work?

In the preceding example, our grower's revenue differed by $0.01 from what was expected in March because the December SJV price was $0.36 and the December futures price was $0.35. This price difference is known as the *basis*; the most effective hedging strategies yield a basis as close as possible to zero as often as possible. The basis depends on how the SJV and futures prices each relate to the fundamental value of cotton at the delivery locations. The fundamental value is the market price that would exist if there were no costs of transporting cotton to the delivery locations and if there were always plenty of buyers and sellers in the market. Hedgers can reduce basis risk by choosing a futures contract that is closely related to the fundamental.

Because growers can choose to sell their product at the time when prices are highest, the prices of futures contracts for different delivery dates should move together. If the price on a particular futures contract does not move in step with the others, then this contract is not priced correctly and should not be used for hedging. To determine the extent to which futures prices move together within crop years, I used a dynamic statistical model. This model computes the proportion of the variation in futures prices that is associated with variation in the fundamental. Figure 1 presents this proportion for a typical crop year from the beginning of planting season through the end of the marketing season for each of the five annual NYBOT contracts.

Prior to harvest, the December, March, May and July contracts all move closely with the fundamental, as indicated by the curves in Figure 1 being close to one for these contracts during this period. The October contract performs the worst of all and is thus an inferior hedging tool. After harvest, the December, March, May and July contracts perform well until about two months before delivery when they begin to deviate from the fundamental. Such deviations arise just before delivery because of the high cost of transporting cotton for delivery at short notice and because there tend to be fewer traders in the market at this time. A small number of traders implies that hedgers are unlikely to find someone in the market who is willing to trade with them at the fundamental price. Thus, a California grower who intends to sell locally should cancel out a futures position at least two months before the contract comes to delivery.

Hedging Strategy Performance

Suppose that growers make four hedging decisions each year depending on whether they intend to sell in December, March, May or July. At the beginning of planting,

Figure 2: Hedging Example: Dec 2000-March 2001

The best hedging strategy is the one that yields revenue the closest to the expected selling price. In December 2000, the expected March 2001 price was $0.676 per pound.

Traditional Hedge (uses March 01 futures contract)

Dec 00	**Mar 01**
0.676	0.531

Futures Profit	(0.676 – 0.531)	0.145
SJV Selling Price		0.508
Total Revenue		0.653
Prediction Error		-3.4%

Fundamental Hedge (uses May 01 futures contract)

Dec 00	**Mar 01**	**May 01**
0.690	0.538	

Futures Profit	(0.690 – 0.538)	0.152
SJV Selling Price		0.508
Total Revenue		0.660
Prediction Error		-2.4%

the grower decides how to hedge cotton to be sold after the harvest in December. This type of hedge is known as a production hedge. In December, March and May, a grower decides how to hedge cotton for sale in March, May and July. These latter three hedges are known as storage hedges.

In each of the 12 years from 1992-2003, I compared a hedging strategy that minimizes deviations from the fundamental to the alternatives of (a) not hedging, and (b) traditional hedging. I calculated the percentage difference between revenue received in each year and the price that was expected at the time the hedging decision was made. I refer to these percentage differences as prediction errors. These prediction errors average close to zero for all three hedging strategies.

Table 1. Performance of Three Hedging Strategies for SJV Growers

	Production	*Storage*		
	Planting–Dec.	Dec.–Mar	Mar–May	May–July
Standard Deviation of Prediction Errors				
No Hedge	15.0	17.3	14.9	14.9
Traditional	7.3	6.8	6.2	7.1
Fundamental	6.8	6.3	6.3	
Largest Prediction Error				
No Hedge	–35.7	–38.5	–24.7	–31.8
Traditional	–12.8	–13.2	–11.3	–10.3
Fundamental	–10.4	11.8	–9.4	

Note: SJV prices are USDA market news prices and futures prices are settlement prices on the 1st day of the relevant month.
Planting is defined as March 1.

Traditional hedging uses the futures contract that comes to delivery in the month a grower intends to sell. Based on the information in Figure 1, fundamental hedging uses the next contract that comes to delivery after the intended month of sale. Figure 2 illustrates traditional and fundamental hedges for a grower storing cotton between December 2000 and March 2001. Relative to the expected March 2001 price of $0.676, the fundamental hedge generates a 2.4 percent prediction error, which is smaller than the 3.4 percent error of the traditional hedge.

The most effective hedging strategies are those with the most prediction errors close to zero. I measured closeness to zero by the standard deviation of the prediction error around its mean value and by the largest prediction error in the 12-year period. These measures are presented in Table 1. To interpret the standard deviations, we can use the statistical rule of thumb that in approximately one out of every three years, the prediction error will exceed the standard deviation. For example, for growers who do not choose to hedge production, one third of prediction errors are likely to be greater than 15 percent.

Table 1 shows that traditional hedging markedly reduces price risk relative to not hedging. The standard deviation for production hedging is 7.3 percent compared to 15 percent for a strategy of no hedging. Similarly the standard deviation for the traditional storage hedge is less than half as much as the standard deviation for no hedging. The worst year for those who did not hedge during production resulted in a 35.7 percent prediction error. In contrast, the worst year for traditional hedgers generated a 12.8 percent prediction error. The storage hedges show similar performance improvements.

The fundamental hedging strategy causes further reductions in the standard deviation of the prediction errors. For the production hedge and the first storage hedge, the standard deviation drops by 0.5 when fundamental hedging is used instead of traditional hedging, although it increases slightly for the second storage hedge. The largest prediction errors for the fundamental hedging are all smaller than for traditional hedging; the worst year for fundamental production hedging resulted in a 10.4 percent error compared to 12.8 percent for traditional hedging. Fundamental hedging cannot be used for the May to July storage period because the July contract is the last one in the crop year.

Conclusion

In two out of every three years, a fundamental production hedger will receive revenue within 6.8 percent of what was expected at planting time. For post-harvest storage, two out of every three years will yield revenue within 6.3 percent of what was expected at the beginning of the storage period. The fundamental hedging strategy improves upon traditional hedging by allowing a grower to avoid imperfections in the futures market close to the delivery month.

For details on the dynamic statistical model that generated Figure 1, the author recommends the following reading:

Smith, A. (2004), "Partially Overlapping Time Series: A New Model for Volatility Dynamics in Commodity Futures," available at http://asmith.ucdavis.edu.

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New Giannini Foundation Publications

California Agriculture: Dimensions and Issues

edited by Jerry Seibert

This book represents a comprehensive revision and update of the influential 1997 publication, *California Agriculture: Issues and Challenges*. The new book features 12 chapters written by leading experts in their respective fields on the major topics and issues important to California's agriculture and natural resource sectors. Key topics addressed in the book include the profile of California agriculture and its economic importance, both domestic and international marketing of California's agricultural production, agricultural policy issues relevant to California, water allocation and related issues, farm labor issues, environmental issues, organic agriculture, science and technology, and the agricultural-urban interface. The book will provide a key resource on California's agriculture and natural resources for years to come.

Marketing Order Impact on the Organic Sector: Almonds, Kiwifruit and Winter Pears

by Hoy F. Carman, Karen Klonsky, Armelle Beaujard and Ana Maria Rodriguez
Research Report 346

This report includes case studies on organic production and marketing for California almonds, California kiwifruit, and Washington-Oregon winter pears. Organic production accounts for slightly over six percent of production of California kiwifruit, three percent of winter pears and less than one percent of almonds.

Handlers of organic almonds report recent sales at two to four times the conventional price and expect production to expand. Price premiums for organic kiwifruit and winter pears (20 to 30 percent) have been decreasing as production has increased, and handlers for both commodities are concerned that the anticipated increased production will place greater downward pressure on price premiums. Ultimately, the future for organic products depends on the size and growth of the market segment that strongly prefers organically produced products and is willing to pay a premium for them.

The report also surveys organic producer/handler views on marketing order provisions. Mandatory assessments under the marketing orders fund provisions for minimum quality standards, research, and generic advertising and promotion programs. Many handlers believe that organic products are a separate niche market that gains little from increases in overall commodity demand.

Economic Contributions of the California Nursery Industry

by Hoy F. Carman
Information Series Report 04-1

The California nursery and floral industry is the largest in the United States, with sales totaling almost $3.086 billion in 2001. When floral and nursery product sales are combined, the industry ranks second among all California agricultural products. It accounts for 10.6 percent of total California agricultural output.

A regional economic model was used to trace the direct, indirect and induced effects of California nursery and floral production and lawn and garden retailing through the California economy. Overall, nursery and floral production and lawn and garden retailing contributed over $10.3 billion to 2001 California output and was responsible for almost 169,000 jobs. Total value added attributed to California nursery and floral production and lawn and garden retailing was $8 billion, while the labor income impact was over $4.9 billion.

A Statistical Profile of Horticultural Crop Farm Industries in California

by Hyunok Lee and Steven C. Blank
Research Report 348

This report provides a detailed statistical profile of California's horticultural farm industries, based on survey data collected from approximately one-third of all horticultural crop producers in the state in the spring of 2002. The survey was designed to elicit information on the current status of horticultural farm industries on their risk management practices and attitudes.

The industries featured in this study accounted for more than $17 billion of gross farm revenue in 2002. The statistical information presented here is the most comprehensive ever undertaken for this important segment of California agriculture. The main body of the report describes industries in seven sections: 1) Farm size and regional profile, 2) Crop diversification, 3) Marketing, 4) Yield, price and profit fluctuations, 5) Risk management, 6) Crop insurance, and 7) Financial characteristics.

These and several other Giannini Foundation publications are available in PDF format online at http://giannini.ucop.edu. Hard copies can be ordered from University of California Agriculture and Natural Resources (ANR) Communication Services, 6701 San Pablo Avenue, Oakland, CA 94608 or by phone at 800-994-8849.

Market Effects of Searching for Mad Cows

by
Colin A. Carter and Jacqueline Huie

Mad cow disease was first discovered in Europe, followed by Japan, and more recently in North America. The disease has distressed the cattle industry in Europe, Japan and Canada but not so much in the United States. At present, the U.S. does relatively little searching for mad cows and any decision to increase testing presents an interesting tradeoff.

Bovine Spongiform Encephalopathy (BSE)—"mad cow" disease—is a brain infection that kills cows. This disease has become so well known that a rock and roll band has capitalized on the name recognition value and the band calls itself the "Mad Cow Disease Rock Band." Almost 200,000 mad cow cases (the disease, not the band) have been reported in over 20 countries worldwide since the late 1980s, with the vast majority of these cases in Europe.

North America was considered BSE-free until Canada and the United States each discovered a single case last year, immediately creating a scare among domestic consumers and the cattle industry. U.S. cattle futures prices plummeted in the few weeks following the U.S. discovery of BSE, with nearby futures prices falling by more than 15 percent. The futures market may have initially reflected the fear that the U.S. industry would suffer large economic losses because of reduced domestic beef sales and exports. As it turns out, the overall economic impact on U.S. beef producers has been much smaller than what the initial futures market sell-off predicted.

Consumers in North America have not turned away from beef, because they may well recognize that the risk to them from a BSE-related death is close to zero and that BSE is largely a European problem. If a human eats BSE-infected beef, there is a rare chance of catching a fatal human form of the disease called variant Creutzfeldt-Jacob Disease (vCJD). According to the British government, less than 200 UK residents have died of vCJD since the disease was first identified. However, vCJD has a very long incubation period of up to 30 years.

Unlike in the United States, a single BSE discovery has been very costly to the Canadian cattle industry. The purpose of this article is to offer a brief explanation as to why the economic impact on the U.S. cattle industry was much less severe compared to the situation in Canada. The basic reason is that the U.S. is a large net importer of live cattle and beef, whereas Canada is a large net exporter of beef and cattle. Both countries have lost exports, but the U.S. (exportable) beef has been redirected to domestic markets, displacing imports. Since BSE was reported in North America, the Canadian market has had surplus beef and the U.S. has experienced tight supplies. In addition to discussing the North American situation, we also review the experiences with mad cow in Japan and the European Union (EU), where the market was severely disrupted due to BSE.

After the mad cow discovery in the U.S. last year, about fifteen countries, including key importers such as Japan and Mexico, imposed a ban on imports of U.S. cattle and beef products. Mexico has since lifted the ban but Japan has not, and negotiations to lift the ban are focused on U.S. testing regulations. Japan wants all U.S. slaughtered animals to be tested, but the U.S. government rejects this idea as being too unscientific and too costly. If the U.S. started testing every animal, Japan may resume imports. However, with increased testing there is always the chance that another animal will test positive for BSE and Japan would then possibly close the border again.

The U.S. government continues to search for "mad cows" and, as a result, more U.S. cattle are now being tested. However, the U.S., Australia and Canada conduct minimal testing compared to the other nations listed in Table 1.

European Union and Japan

Mad cow disease was first discovered in the United Kingdom (UK) in 1986, and the British government initially asserted that humans were not at risk from eating beef infected with BSE. This turned out to be a foolish and incorrect message to send to consumers given the widespread nature of the disease in the UK. The government then backtracked and quickly introduced strict policies regarding feed use and testing for BSE. The incidence of the disease did not decline quickly, however. Since the 1986 discovery, over 180,000 cases of mad cow have been reported in

Table 1. International Testing for Mad Cow Disease: 2002

	U.S.	Australia	France	Italy	Germany	Canada	UK	Japan
Slaughtered (×1 million)	35.74	9.23	5.78	4.34	4.27	3.46	2.28	1.30
Tested (×1,000)	19.99	1.78	3,145	718	2,967	3.30	355	1,300
% tested	0.06%	0.02%	54.5%	16.55%	69.4%	0.10%	15.5%	100%
Cases of mad cow in 2002	0	0	239	38	106	0	1,144	2

Source: McNeil Jr., Donald G. "Doubling tests for mad cow doesn't quiet program critics." New York Times *9 Feb. 2004: A8.*

the UK. The number of reported cases in the UK is now on the decline and last year the UK reported "only" 612 cases.

In addition to the UK, the entire EU has been hit hard by BSE because animal products were regularly used in cattle feed in the EU prior to the discovery of BSE. The height of the epidemic occurred in 1992 when annual UK cases peaked at 37,280. From 1989 to 2003, France reported over 900 cases and recent research suggests that many more French cattle may have been infected in the 1980s and 1990s.

Both domestic sales and exports of UK beef fell sharply in the early 1990s because many countries banned trade in UK beef. Previously, the UK had developed a large export trade in beef and live cattle that was worth about $800 million per year. In the first year of the epidemic, the total estimated economic loss due to BSE in the UK was about $980 million. At the height of the crisis in 1996, beef consumption fell by one-fifth in the UK. In 1999 the EU finally lifted its internal ban on trade in UK beef, which alleviated the situation somewhat for British farmers.

In 2001, Japan announced its first case of BSE—in fact, the first case of BSE outside of Europe. Since then, Japan has discovered a total of 13 cases of BSE, including four cases so far in 2004. Japan was the largest importer of beef in the world when BSE was first discovered there. About 66 percent of the beef sold in Japan was imported mostly from Australia (49 percent trade share) and the U.S. (46 percent trade share). Immediately following the mad cow discovery, beef consumption in Japan dropped by about 60 percent and, as a result, Japan's beef imports fell by 30 percent in 2002, relative to 2001. By mid-2002, Japan's beef consumption recovered to within 10-15 percent of its pre-BSE levels.

Japan banned the use of meat-and-bone meal in cattle feed. It also quickly introduced a system of full testing of all cattle slaughtered in that country—all cattle that are killed before entering the food supply are now tested for BSE in Japan (see Table 1).

North America

In the spring of 2003, Canada reported its first case of a BSE-infected cow from a farm in Alberta. At the time, Canadian regulations regarding downer cattle were stricter than in the U.S.; otherwise this case may not have been detected. Downer cows are injured or sick cows that cannot walk. A Canadian inspector removed the downed animal from the rest of the herd, so that it would not be used for human consumption. Subsequent tests on that animal showed positive signs of BSE. The cow's age suggested that it contracted BSE before the 1997 ban on the use of animal products in feed.

The case of BSE in Canada had a large negative impact on that nation's $7 billion per year cattle and beef industry. After the confirmed case, many countries, including the U.S., imposed an import ban on Canadian beef. Canada's cattle industry is very dependent on exports, as about 50 percent of its beef was exported at the time, mostly to the U.S. Canada also exported about 1.7 million head of live cattle in 2002. According to Statistics Canada, farm cash receipts for cattle were 34 percent lower in 2003 than in 2002, even though more cattle were slaughtered in 2003. In 2003, beef and beef product exports from Canada fell by more than 48 percent from the previous year.

Cattle slaughtered at a relatively young age can be carriers of BSE, but typically the disease has not yet taken hold of the animal and therefore they are less likely to be infectious. As a result, in the fall of 2003 the U.S. and Mexico reopened the border for imports of Canadian boneless beef products from cattle less than 30 months of age. However, the U.S. border remains closed to live cattle imports from Canada.

After the mad cow discovery in the U.S., several countries banned imports of U.S. beef. At the time, the U.S. was the second largest beef exporter (after

Australia) and was exporting over 1.1 million metric tons of beef, worth about $3.3 billion. Japan was the most important market for U.S. exports. The Japanese government has been urging 100 percent testing of all cattle slaughtered in the U.S., before Japan will agree to reopen its border to U.S. beef. However, recently Japan has indicated that it might begin importing beef from younger cattle slaughtered in the U.S.

While consumers in Europe and Japan may have lost their appetite for beef, U.S. domestic consumer demand for beef has remained strong, as in Canada. On a per capita basis, North American consumers eat as much or more beef as they did before the reported cases of BSE in 2003. On the trade side, the impact of the Japanese import ban on the overall U.S. industry has been muted by the fact that U.S. beef imports also fell dramatically because of restrictions on Canadian beef and cattle trade. The upshot is that beef prices have remained relatively high in the U.S. market.

Discussion

Countries that remain BSE-free (such as Australia, New Zealand, Brazil, Argentina and Uruguay) are now exporting more beef because of the presence of BSE in other exporting countries. Australia and Brazil have increased their BSE-free promotion efforts in Japan in an attempt to increase their market share in that country. In 2003, Brazil took Australia's title as the world's largest beef exporter. Brazil exported 1.35 million metric tons even though it was excluded from some major import markets due to foot and mouth disease.

Given Europe and Japan's serious BSE epidemics and the Japanese position on testing, should the U.S. adopt stricter beef testing regulations? When Europe and Japan adopted stricter testing procedures, new cases of BSE were discovered. So if the USDA increases the testing of cattle, more cases of BSE in the U.S. will likely emerge. The data in Table 1 suggest that if you search for mad cows you will probably find them. But the number of undiscovered BSE cases in the U.S. is probably very small compared to the situation in Europe, given the limited use of animal products in U.S. cattle feed in past years. The U.S. government faces an interesting trade-off. If testing is not expanded, there is a small risk of cases going undetected and this presents a marketing problem. However, if testing is expanded, a few additional cases of BSE could appear and this also presents a marketing problem.

When the first case of BSE occurred in the United States, analysts believed that this incident would have a serious impact on the U.S. domestic beef market. Based on market reactions in Europe and Japan, a possible outcome in the U.S. would have been an excess supply of beef and lower domestic prices. So far, the overall market impact of BSE in the United States has been minimal. However, certain U.S. processors and exporters (selling to Japan for example) have suffered some economic losses.

While it is difficult to speculate about the long-term effects of BSE, the history of other food safety scares and impacts on consumer demand in the U.S. has shown these scares to be rather short-lived. Once media coverage of a food scare dies down, consumer demand picks up quickly. This is consistent with the mad cow scare in the U.S. Furthermore, U.S. beef producers are being sheltered by the restrictions on Canadian imports and they would like to continue to keep out Canadian cattle as long as the Japanese market is off limits for U.S. exporters.

The authors recommend the following sources for further information:

Buzby, Jean C. and Linda Detwiler. "BSE: Anatomy of A Crisis." Choices. Spring 2001: 41-45.

Leuck, Dale, Mildred Haley, and David Harvey. "U.S. 2003 and 2004 Livestock and Poultry Trade Influenced by Animal Disease and Trade Restrictions." ERS, USDA, LDPM-120-01. Washington DC, July 2004.

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United States General Accounting Office. Mad Cow Disease: Improvements in the Animal Feed Ban and Other Regulatory Areas Would Strengthen U.S. Prevention Efforts. GAO-02-183. Washington DC. Jan. 2002.

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Faculty Profile

Jeffrey M. Perloff is the chair of and a professor in the Department of Agricultural and Resource Economics, University of California at Berkeley. He received his Ph.D. in economics from the Massachusetts Institute of Technology in 1976. Jeff conducts research on agriculture economics, labor, trade, marketing, industrial organization, econometrics, and (with his wife) psychology.

Lien Tran and he studied migration by agricultural workers between types of jobs. Their work explains why predictions made when the 1986 Immigration Reform and Control Act was passed that granting people amnesty would induce most of them to leave agriculture were incorrect. Enrico Moretti and he studied how farmers use a variety of payment systems to encourage employees to work hard with relatively little supervision (*ARE Update* "Promoting Productivity," Jan/Feb 2004).

Recently, Ximing Wu, Amos Golan and Jeff have completed a study of how major federal and state redistribution and insurance policies and federal taxes affect wage inequality in urban and rural areas. Although government tax and transfer programs have similar qualitative effects in rural and urban areas, some policies are relatively more effective in reducing inequality in rural areas. Whereas adjusting the marginal tax rate on the lowest bracket or Earned Income Tax Credits has as an effect on equalizing income at least as large as in urban areas, the minimum wage only affects urban inequality, and government policies that increase GDP have larger effects in urban than in rural areas.

With Michael Ward, Jay Shimshack and J. Michael Harris, Jeff has examined how the introduction of private-label products in grocery stores affects pricing and promotion of national brands (*ARE Update*, "Price, Promotion and Differentiation Effects of the Private-Label Invasion," Jul/Aug 2002). Their findings reject the conventional wisdom that when private labels enter processed food and beverage industries, name-brand firms defend their brands by lowering prices, engaging in additional promotional activities, and increasingly differentiating their products.

Hayley Chouinard and Jeff have examined the effect of federal and state taxes on gasoline prices. They find that the federal gasoline tax falls equally on consumers and wholesalers, whereas state taxes fall almost entirely on consumers. The amount by which state taxes raise the price that consumers pay is greater in states that use relatively little gasoline.

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Most of Jeff's current research concerns retail pricing and consumer behavior at grocery stores. He is engaged in a series of studies on the effect of milk marketing orders (and other milk related laws), sales, and private labels. Working with Hayley Chouinard, Jeff LaFrance (Berkeley) and others, he is studying the effects of fat or sugar taxes on consumption—a hot policy issue.

In addition, he has consulted with state and federal government agencies on topics ranging from dumping cases, antitrust cases (including some related to the California energy crisis), employment and welfare issues, to taxes. He is a fellow of the American Agricultural Economics Association and is a member of the National Bureau of Economic Research Board of Directors.

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An Alternative Natural Beef Production System: A Differentiation Strategy for California Producers and Packers

by
Ricardo Vernazza Paganini

This article demonstrates that a natural beef production system that emphasizes grazing on rangeland and irrigated pastures can be more profitable, given current prices, than the conventional production system that emphasizes grain-fed beef. The article recognizes several impediments to widespread adoption of natural production systems but suggests that such systems may provide niche markets in California for both producers and packers.

Beef cattle remain one of California's most important agricultural products, ranking fifth in 2001 at $1.35 billion in value of production, behind dairy, grapes, nursery products and lettuce. In most countries, beef is produced on pasture, utilizing available forage resources and the ruminants' ability to convert this inedible material to human food. Historically, this was true in the U.S. as well, at least up until World War II. At that time, the development of the feedlot industry led to increased reliance on feed grains to maximize the quantity and quality of beef.

Grain-fed beef production systems are considered more profitable and successful in producing the type of beef quality desired by U.S. consumers. Consumers' preferences generally have been associated with high-marbled steaks, grain-fed flavor and highly tender beef. Moreover, consumers expect beef to have white fat that typically occurs with grain feeding. However, the concepts of environmentally friendly production systems, animal welfare and chemical-free food are rapidly changing the demand for beef. An increasing proportion of the U.S. population is concerned with the use and preservation of natural resources as well as with the human handling and treatment of farm animals. Many consumers are willing to pay higher prices for products that have been produced applying environmentally friendly practices. A study in 2000 found that, out of 1400 survey respondents, 38 percent were willing to pay a 10 percent premium on natural beef while 14 percent would pay a 20 percent premium.

The demand for organic and natural food is growing rapidly, yet market share still remains quite small. In the United States, total retail sales of organic foods rose steadily from about $1 billion in 1990, to $3.3 billion in 1996 and up to $7.8 in 2000. This increase continues the streak of industry growth equal to 20 percent or more annually since 1990.

In this context, a natural beef production system could represent a market differentiation strategy for increasing the profitability of producers. In a market dominated by conventional beef, an early adopter of this production system may experience above-average profit in the short run. Such production systems, based mainly on pastures, rather than on concentrated animal feeding units, would be perceived by consumers to be more environmentally acceptable.

To investigate this potential opportunity, I developed a cost-benefit economic model to evaluate and compare an alternative beef production system (Natural Grazing System–NGS) with a more traditional one (Intensive Production System–IPS).

The Empirical Model

The model contrasts both systems from a profit standpoint, assessing production, cost and revenue functions. The general production information and coefficients used in the development of the model were taken from a prior study which addressed the systems from a production standpoint. The feeding strategy is the main difference between the two systems. Production characteristics of the IPS resemble a finishing operation in California commonly referred as calf-fed production system. Animals are bought from a cow-calf ranch at weaning time (spring), placed in a feedlot facility, and fed for a 6-month period with a corn-based ration until slaughter. On the other hand, animals in the alternative NGS are purchased and placed on irrigated pastures for the summer period, then on native rangelands until May of the following year and finally sent to the feedlot for a 90-day period.

The data used to develop the model were actual production data gathered during a three-year period. This provides a detailed and realistic quantification of the production parameters including live weight production output, initial and final body weight, grazing period, stocking rates, days on feed, average daily gain

Table 1. Performance Coefficients

Parameters		Production System NGS	IPS
Initial body weight	kg/head	238	238
Rangeland grazing phase	days	274	-
Average daily gain	kg/head/day	0.557	-
Irrigated pasture grazing phase	days	122	-
Average daily gain	kg/head/day	0.484	-
Feedlot phase	days	94	188
Average daily gain	kg/head/day	1.55	1.23
Dry matter intake	kg/head/day	11.95	8.19
System throughput rate	%	56	95
Production output	kg/head/year	332.2	445.7

The term "natural" is used throughout the article to refer to a production system that is more "environmentally friendly" relative to those systems where animals spend the majority of the growing and finishing phase in confinement and consuming grain-fed diets. The "natural" term, as it is used here, also differs from the concept of organic beef production which faces more stringent rules as well as governmental and agency regulations.

and dry matter intake. The length of the production period varied between systems, with the purchase-to-slaughter period taking 385 and 650 days in the IPS and NGS, respectively. Production, revenue and cost functions estimated in this analysis account for these differences. The performance data are presented in Table 1.

The cost function addressed all relevant costs that differ among systems, such as purchase price of the feeder, cost of leasing both the rangeland and irrigated pastures, yardage costs, health and implants costs, and price of the ration (Table 2).

Steer price for the IPS is a market price for fat animals from the USDA Livestock Market Information Center. On the other hand, the NGS was allowed to receive a premium price due to its recognition as an environmentally friendly production system.

To make the economic analysis as widely applicable and realistic as possible, a historical price database (1973-2002) in constant dollars (2002 year-basis) was developed instead of using feeder, steer and corn prices for the particular years of the experiment. Since a clear and consistent price decrease was observed, the average of the last 15 years, rather than the complete series, was considered more likely to resemble current and future price conditions.

Once the model was developed, profit functions were contrasted to find the minimum price premium required by NGS to make both systems equally profitable.

The Outcome

Profit comparison between systems suggested that for the Natural Grazing System to be competitive in terms of profitability, it does not need to receive a price premium. Both systems were found to be equally profitable when the price received by the NGS was 4.1 percent lower than the IPS. Even though live weight production (kg /head) in a per year basis was increased by 34 percent in the IPS, total variable costs were also increased by 52 percent. Among the factors explaining the higher variable costs, ration costs (corn) climbed by 73 percent.

Therefore, these figures suggest that for an average market price scenario, such as the one used in our analysis, the NGS would result in higher net margins per head. Moreover, the existence of market demand conditions allowing NGS animals to receive a price premium should assure a higher profit in that system. Economic comparisons between organic and conventional beef production systems commonly state that in order for the organic system to be attractive for beef producers it should capture a price premium. This is due to the fact that organic beef production faces increased costs of production such as regulation and certification expenses. However, this did not hold true for the natural grazing system.

These results suggest that the more extensive grazing production system appears to be more cost effective than the system for conventional beef. Such a statement seems paradoxical, given that most ranchers produce conventional beef. I suggest three explanations as to why the natural production system has not been commonplace in California. First, U.S. consumers have been reluctant to eat low-marbled steaks that have grassy flavor and yellow fat—all attributes associated with beef produced under grazing systems. Furthermore, consumers' perceptions toward beef quality in the main U.S. export destinations—Japan and South Korea—have followed the same pattern.

A second aspect is associated with what we may call the "dominant role of beefpackers." Processing companies have well understood consumers' behavior and thus have been reluctant to market grass-fed beef, offering no incentives to producers to develop this type of production. Moreover, scale economies have been a driving factor in the beefpacking industry. This trend has been characterized by technological change at the slaughtering and processing level that have sped up, standardized and made the overall process more efficient. Furthermore, the advantages of increasing returns to scale are observed provided that the plant's capacity is fully utilized and a constant flow of homogeneous product is processed. In this context, the grazing systems would supply a different product, and, for any given plant, comprise a small proportion of its total annual slaughter. An increased reliance on weather conditions would also increase supply variability from these systems. The aforementioned factors have and probably will continue to pose a limitation to the development of this type of production system.

Table 2. Cost and Production Coefficients

		Production System	
Parameters		**NGS**	**IPS**
Leasing rangeland pastures	$/head/day	0.186	-
Rangeland rate	$/hectare/year	31	-
Stocking rate	hectares/head	2.19	-
Irrigated pasture leasing rate	$/head/day	0.59	-
Yardage cost	$/head/day	0.04	0.04
Health and implants costs	$/head	27.4	19.4
Purchase price of the feeder	$/kg live weight	2.31	2.31
Price of the ration	$/kg	0.101	0.101
Price of the corn	$/kg	0.12	0.12
Price of other supplements	$/kg	0.027	0.027
Corn in diet	%	80	80
Supplement in diet	%	20	20
Total Variable Costs (TVC)	$/head/year	457	695

A third issue is the fact that even though potentially the NGS could be more profitable, the availability of land at competitive prices may restrict its adoption. Average agricultural real estate land values in California have risen from just $450/acre in 1970 up to $2910/acre in 2001.

Thus, the NGS is unlikely to become the dominant production system of California, but it may be developed as a niche marketing strategy. Beef produced under the NGS could be marketed as a specialty targeting two different consumer segments:

- The environmentally concerned population who is willing to buy beef raised under more environmentally friendly conditions.

- Latinos, who account for 34 percent of total California population, are known to be heavy beef eaters and to have positive perceptions of grassy flavor and leaner beef with yellow fat. In this respect, a study in 2000 using an experimental auction market procedure found that San Francisco consumers preferred grass-fed Argentinean type beef.

In summary, the natural grazing system could be a profitable alternative for California ranchers provided that appropriate programs and marketing agreements are developed with the beefpackers. This may also be a competitive strategy helping smaller beefpacking firms to stay in business.

For additional information on this study, the author recommends the following reading:

Sainz, R. and R. Vernazza. "Alternative Beef Production Systems: Performance and Carcass Traits of Calf-Fed, Short- and Long-Yearling Steers." ***Journal of Animal Science.*** 2004, No 82: 292-297.

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