Agricultural Marketing Resource Center
Value-added Agriculture Profile
Iowa State University

November 2008

Lesson #2: Sustaining a 'Home' on the Range: Alternative fuel usage on the Rocking Z Ranch case study

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Funding was provided, in part, by the Agricultural Marketing Resource Center.

[1]The authors prepared this case as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. The cooperation and contributions made by Zack and Patty Wirth are greatly appreciated.

Introduction

In many ways Zack and Patty Wirth are typical Montanans, especially in their ability to adapt to changing economic conditions. They own and operate the Rocking Z Ranch near Wolf Creek, Montana. Zack is the fourth generation of his family to live on the ranch, but unlike many fourth generation ranchers, he did not inherit the ranch. The historical ranch operation consisted of about 120 head of cattle but in the 1980s, some of the land had to be sold. After the land sale, the ranch was not an economically viable commercial operation. Therefore, Zack's father worked construction jobs to supplement ranch income. Zack and Patty's opportunity to operate the ranch occurred in 1992 when, with a combination of equity and debt, they purchased the ranch. Their plans for the ranch, however, were very different from those of previous generations. They intended to operate a guest ranch rather than a working cattle ranch. They replaced the cattle with recreational horses. Nonetheless, sustaining ranch profitability was going to be a challenge and would require evaluating many options that previous generations had never needed to consider.

Forage Assets on the Rocking Z Ranch

The ranch is fortunate to have plenty of summer pasture for the horses, with some extra grazing that could be rented to neighbors. However, winter feeding needs require more hay than the ranch is able to produce in the absence of irrigation. The ranch contains several flood-irrigated hay fields. Flood irrigation, however, is labor-intensive, and because it is inefficient, often drains the local creek. Zack had previously worked for an irrigation company and knew that sprinklers distributed water more efficiently than flood irrigation. In 2002, he started to seriously consider upgrading his irrigation system. His past work with center pivot, wheel line and big gun irrigation sprinkler systems gave him a good idea of what system might work best for his ranch. The size and shape of his hay fields quickly ruled out a center pivot. He eventually decided to purchase a big gun system.

The next issue was deciding on the type of pump needed to pressurize the big gun. The least cost option for many irrigators is to install an electric pump. Most of these pumps require three-phase power, which is not currently available at the Rocking Z Ranch. Zack contacted his local electric cooperative to ask about the installation of three-phase power. They informed him that the nearest three-phase power line was 11 miles from the Rocking Z, and the local grid system was already operating near its capacity. Obtaining a three-phase transmission line was going to be very expensive.

Zack began considering other options. He had heard that coal-fired boilers had been used in the past to generate electricity. However, these systems were never approved for commercial use. He also evaluated wood/wood chip-powered systems, but these systems required large quantities of wood, which diminished their feasibility.

Finally, he turned his attention to using a diesel engine to pressurize his irrigation system. The major concern about a diesel system involved the price of diesel fuel. In January of 2005, the price of diesel fuel was $1.96/gallon, but by October 2005 it had increased to $3.16/gallon. At these prices, Zack realized that it might be more economical to simply buy hay from the Fairfield area (about 70 miles away) than to upgrade his irrigation system.

As he was considering these possibilities, he heard about an Oregon producer who operated a Detroit Diesel engine on vegetable oil to power his irrigation system. This system requires minor modifications to a traditional diesel engine to allow it to operate on diesel fuel while the engine reached operating temperature before switching to vegetable oil as the fuel source. The engine switches back to diesel fuel a few minutes before shut down to purge the system. This type of system offered the potential of reduced fuel costs if vegetable oil was less expensive than diesel fuel.

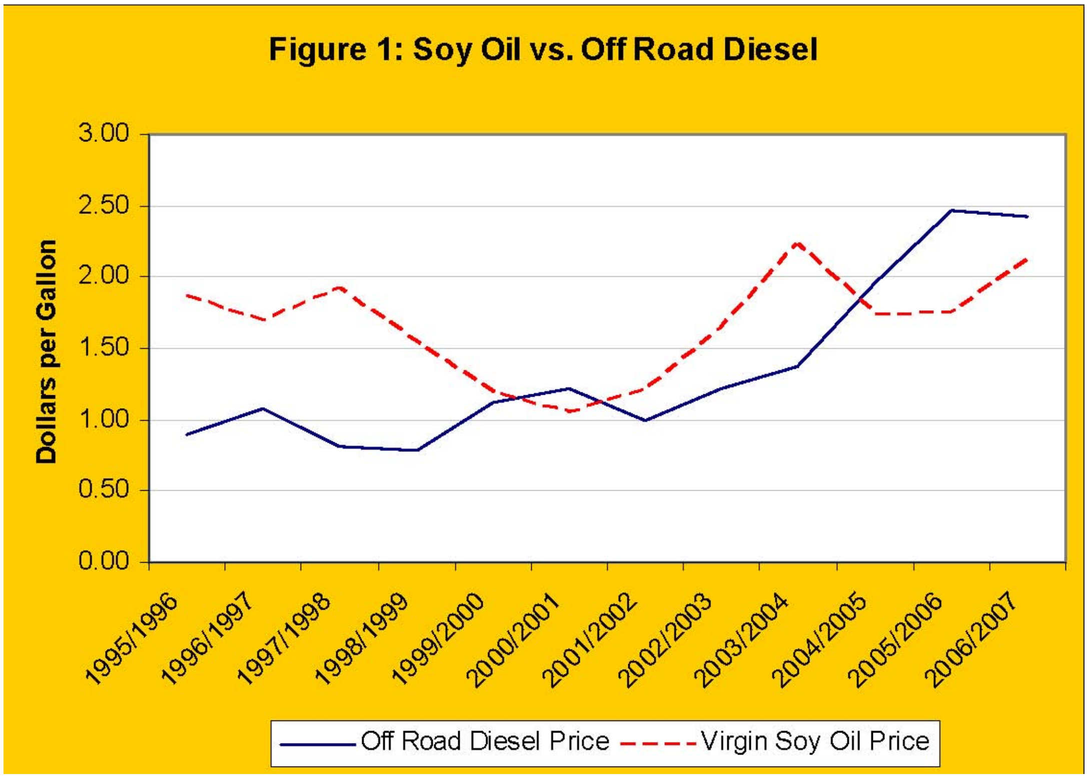
Zack had two options for obtaining vegetable oil. He could purchase vegetable oil from an oilseed processor or find a source of used vegetable oil. Soybean oil is the most abundant vegetable oil produced in the United States. However, the per gallon price of soybean oil (with a Midwest delivery point) has been lower than that of diesel fuel in only two of the past five years (Figure 1). In 2007, soybean oil was approximately $2.12/gallon (in the Midwest) and local off-road diesel fuel was $2.42/gallon.

Zack needed at least 1,500 gallons of oil each year to run the diesel engine in most years, and as much as 3,000 gallons in some years. Another option was to purchase vegetable oil that did not meet human food standards (off-specification oil) from oilseed processors. Such oil usually sells at a discount to food-grade oil. He contacted an oilseed crushing facility in Culbertson, MT and found that they occasionally sell off-specification oil. However, they could not guarantee a steady supply. Another option was to obtain used vegetable oil from regional restaurants. These supplies were likely consistent but only available in small amounts from any single location. He found a company in Hayden, ID that collected used restaurant oil, filtered it and sold it in large quantities for approximately $1.57/gallon in 2007. Zack, however, would have to transport it from Hayden to the Rocking Z. He could mount a 1,500 gallon tank on a trailer and make 1 or 2 trips each year. Although the 600-mile trip would likely cost between $200 and $400, he would save nearly $1,000 for each 1,500 gallons of diesel fuel replaced with vegetable oil. This was enough to convince him that he should continue with the plan.

Using Vegetable Oil for Irrigation

The irrigation system upgrade was estimated to cost nearly $120,000. To offset these costs, Zack applied for and received an EQIP cost-sharing grant of $55,000 in 2004. The system was completed in 2006. The EQIP project was based on a diesel-powered engine and did not include any additional equipment to allow the system to operate on vegetable oil. Modifications were needed to use vegetable oil, including installing a preheating system, several oil storage tanks, fittings, concrete and a building to house the system. These costs totaled around $20,000. Therefore, Zack applied for a Conservation Innovation Grant from the National Resources Conservation Service (NRCS). The program offered cost-sharing opportunities for farmers and ranchers to adopt innovative conservation approaches. Zack's project qualified for a $9,700 grant.

The system includes a John Deere diesel engine that is started on traditional diesel fuel. As the engine heats, some of the heat is transferred to the vegetable oil tank by way of an Arctic Fox heat exchange system. The engine begins to burn vegetable oil once the oil has been heated to 160 degrees. To avoid fuel line blockage, the systems switches to diesel fuel as the engine is shut down to purge fuel lines of as much vegetable oil as possible. Zack found that continually



operating the pump for 7 days seemed to be a good operating procedure. Rather than shut the engine down every 12 to 24 hours, he simply moves his sprinkler to another area. The biggest problem with the system had nothing to do with the engine or the fuel being used. The main problem was that the big gun was not reliable. Eventually, he returned the big gun to the manufacturer and purchased a wheel line sprinkler, which was ready for use in 2008.

Using Biodiesel on the Rocking Z

Irrigation uses a significant amount of fuel on the Rocking Z Ranch. The other major use of diesel fuel, however, involves operating four diesel tractors. While researching alternative fuels for use in the irrigation system, Zack began considering the possibility of modifying his tractors to run on alternative fuel. The main problem with the use of vegetable oil for powering his irrigation system occurred during start up and shut down of the diesel engine. The solution was to preheat vegetable oil, arrange for the purging of fuel lines during shut down and minimize the number of startup/shut down cycles. This approach, however, is generally not feasible for tractors. Another drawback to directly using vegetable oil in tractors was that he would need to modify four diesel tractor engines rather than a single irrigation engine. Zack discovered that converting vegetable oil into biodiesel obviates most of these problems.

Biodiesel is produced by a process called transesterification. Transesterification requires three inputs: vegetable oil, methanol and a catalyst. The process produces two products: glycerin and biodiesel. The basic proportions for the process are 80 parts vegetable oil, 17.5 parts methanol and 1-3 parts catalyst. This process produces 80 parts of biodiesel and 15-20 parts of crude glycerin. Glycerin is of little value to small producers and its disposal can be a problem. Environmental regulations limit disposal options in some cases, but Zach applied for and received a permit from the Montana Department of Environmental Quality to add his glycerin to a manure pile. The manure pile decomposes glycerin to the point where it causes few if any environmental concerns. Biodiesel has a much lower viscosity than vegetable oil, which allows it to be used in a traditional diesel engine without preheating. Use of biodiesel does not require engine modifications. Biodiesel can also be blended with traditional diesel fuel in any proportion, which allows for fueling flexibility.

Biodiesel has some disadvantages relative to traditional diesel. Traditional diesel has a lower gel point than biodiesel. Hence, biodiesel is often blended with higher proportions of traditional number 2 diesel, stored in heated tanks or coupled with flow additives during winter months. But even after these steps are taken, biodiesel still does not perform as well as traditional diesel fuel in the winter.

Zack decided to buy an 80-gallon biodiesel processor from a manufacturer in Colorado (EZ Biodiesel) for $3,300 to further reduce his fuel expenses. Although the processor was sold as a turnkey operation, some startup expenses were incurred. Additional tanks, fittings and barrels were purchased for $2,900. To help offset these equipment costs, Zack received a $3,000 grant from the National Center for Appropriate Technology. The processor was installed in an old calf warming room of an open-faced shed. The room had a good roof, heat and a cement floor. To improve the safety of Zack's operation, methanol is stored outside the processing room in a well-ventilated area of the shed. Each 80-gallon batch of biodiesel requires about 90 minutes of labor. The 90 minutes are not consecutive, so Zack uses timers as reminders to move the production process to its next step. Biodiesel is stored in a 300-gallon plastic fuel tank. The tank was initially elevated and gravity was used to fuel vehicles. However, gravity did not provide enough pressure to force the fuel through a standard fuel filter. Consequently, Zack installed an electric fuel pump and produced approximately 900 gallons of biodiesel in 2007. All of the fuel was consumed on the ranch. He plans to produce 1,500 gallons of biodiesel in 2008.

Fuel quality is a concern for small-scale biodiesel producers. Commercially-sold biodiesel is required to meet American Society for Testing and Materials (ASTM) standards. The laboratory costs of ASTM specification testing can exceed $1,000 per batch. This cost is often prohibitive for small-scale producers and increases the uncertainty regarding fuel quality. Some less expensive tests are available but are much less accurate than laboratory testing. To date, Zack has not attributed any mechanical engine failures with his equipment to fuel quality problems.

The cold flow properties of biodiesel have created some problems on the Rocking Z Ranch. When the temperature drops to 5-10 degrees above zero, biodiesel tends to gel. Several companies manufacture additives to improve the cold flow properties of diesel fuel. Zack has tried several of these products, but none seem to significantly improve the cold flow problems of biodiesel. Zack requires small amounts of fuel during the winter, so he uses traditional diesel fuel in his tractors during cold weather.

The cost of vegetable oil is only part of the total cost of producing biodiesel. The price of methanol and catalyst also affect the profitability of the operation. Zack purchases methanol by the barrel (55 gallons). The first barrel he purchased cost $88 ($1.60 per gallon), but the most recent barrel cost $248 ($4.51 per gallon). Twenty gallons of methanol are required to produce

100 gallons of biodiesel. The price of methanol has increased his biodiesel production costs by over $0.50 per gallon. Catalyst can be purchased in 50-pound bags for $90 ($1.80 per pound). At this price, catalyst contributes less than $0.10 per gallon to the cost of the biodiesel.

The Future of the Rocking Z

After Zack and Patty wave goodbye to another group of guests that quickly became friends, they enjoy a cup of coffee on the front porch and take in the beautiful valley views. Over the next hour, they will reflect on their favorite aspects of ranch life, their decision to operate a guest ranch and their future. Much of their success has resulted from dramatic changes in the definition of a “ranch.” Their decisions to use vegetable oil and biodiesel as alternative fuels are just one aspect of these changes.

Planning for the future involves a careful evaluation of past decisions. Was their decision to use vegetable oil and biodiesel as alternative fuels logical? Have these decisions contributed to the success of the Rocking Z? Could Zack’s labor be used in a more efficient endeavor? As Zack’s timer sounds, he pushes himself out of his chair and starts walking toward the calf warming room to move another batch of biodiesel toward its final production process.