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

By

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Objectives:

After completion of this lesson, the students will be able to:

1. Describe the biodiesel topics of this lesson by business strategy, business supply and substitution of resources, and market.
2. Describe why ranchers would establish a biodiesel enterprises for their own use.
3. Identify and describe opportunities that exist for biodiesel processing on production operations in the future.

Materials/References Needed:

Sustaining a 'Home' on the Range: Alternative Fuel Usage on the Rocking Z Ranch**.** Joel Schumacher, Cole Arthun and Gary W. Brester, Dept of Economics and Agricultural Economics, Montana State University, Bozeman, MT.

What is Biodiesel?, http://www.unh.edu/p2/biodiesel/

Biodiesel: A Primer. David Ryan, NCAT Energy Specialist, http://attra.ncat.org/attra-pub/PDF/biodiesel.pdf

Making Biodiesel**.** Celeste Peltier, http://www.humboldt.edu/~ccat/biodiesel/makingbiodiesel/celesteSP2001/makebiod.pdf.

Visual Masters (VM):

VM-1 PPT Incorporating Lessons on Biodiesel into the Science Classroom, http://www.unh.edu/p2/biodiesel/media/NHSTA05.ppt.

VM-2 PPT Biodiesel http://www.aspousa.com/proceedings/powerpoint/Biodiesel%20-%20Jeff%20Probst.ppt.

VM-3: PPT 3 Biodiesel production Economics. University of Idaho, http://www.uiweb.uidaho.edu/bioenergy/Feild2fuel_cda06/Haines_Montana_Economics_Summer%202006.pdf

VM-4: PPT 4 Biodiesel for the CEBC. Kate Wilbanks and Dr. Susan Stagg-Williams, University of Kansas, http://www.cpe.engr.ku.edu/reu/2004posters/wilbanks2.ppt.

Interest Approach: http://www.pacfuel.com/historybd.htm

Rudolf Diesel patented his high-compression internal combustion engine in 1882, and in 1900, he demonstrated his compression ignition engine at the World's Exhibition in Paris. In that prototype engine he used peanut oil, the first biodiesel. Vegetable oils were used until the 1920s

when an alteration was made to the engine, enabling it to use a residue of petroleum diesel. Although the diesel engine gained worldwide acceptance, biodiesel did not. With superior price, availability, and government subsidies, petroleum diesel quickly became the fuel of choice for the diesel engine.

In the mid 1970s, fuel shortages revived interest in developing biodiesel as an alternative to petroleum diesel. However, as the petroleum market was increasingly subsidized, biodiesel was again relegated to a minority "alternative" status. This political and economic struggle continues to limit the impact of the biodiesel industry today.

Now, increasing concerns about the potential of global climate change, declining air and water quality, and serious human health concerns are inspiring the development of biodiesel, as a renewable, cleaner-burning diesel alternative. Biodiesel is made from recycled vegetable oil and various feedstock (e.g., soy beans). As part of an active carbon cycle, biodiesel feedstock production reduces the buildup of greenhouse gases, and in turn, global warming.

Many fleet operators have made the switch to biodiesel, yet biodiesel consumption accounts for less than one percent of the total diesel fuel consumption in the United States. Additional industries seeking cleaner alternatives to sulfur-emitting diesel include transit bus fleets, heavy-duty truck fleets, airport shuttles, marine and national park boats and vehicles, mining, the military and many more. This case study chronicles the startup of a Montana oilseed (camelina) business whose customers are primarily individuals who use the oil to make biodiesel.

Student Activity:
When student numbers are sufficient, divide students into groups. Students should be instructed to:

- Read the biodiesel study assigned to their group.
- Where appropriate, divide the reading of the assigned biodiesel case study among their group.
- Each member is to provide an overview of his/her assigned reading to the group.
- Review and answer the questions related to their case study.
- Develop a clear, concise summary for the biodiesel topic assigned.
- Develop the profile on notebook paper. Use the backside of this paper to write the final version of the group's answers and a profile of the wind generation topic assigned. Write the profile in bullet form.
- Use PPTs and WWW reference to instruct students on related aspects of biodiesel that apply chemistry, biology and economics.

Questions:

1. **What were Zack and Patty's plans for the Rocking Z ranch near Wolf Creek, Montana?**

Answer: *Their plans for the ranch were not the same as the previous generations' plans. Their plan to make the ranch a viable operation was to open a guest ranch and replace the cattle with horses. Making the ranch profitable was going to be a challenge and would require evaluating many options that previous generations had never even thought about.*

2. **What were Zack's considerations regarding the upgrade of his irrigation system?**

Answer: *His past work with center pivot, wheel row and big gun irrigation systems gave him a good idea of what system might work best for the ranch. The size and shape of his hay fields quickly ruled out a center pivot system. He eventually decided to purchase a big gun system. This equipment was installed and ready for use in 2007.*

3. **What was the main barrier to installing a big gun irrigation system for Zack's hay field?**

Answer: *Most of these pumps require three-phase power, which isn't currently available at the Rocking Z Ranch. He contacted his local electric cooperative to ask about getting three-phase power. They informed him the nearest three-phase power was 11 miles away and because the transmission line to the area was already nearly maxed out, it would require a major upgrade to the entire distribution system in the area to bring three-phase power to the ranch. It was going to be prohibitively expensive to install three-phase power, which ruled out an electric pump.*

4. **What did Zack identify as a substitute for three-phase power?**

Answer*: In 2005, he turned his attention to a diesel-engine-powered system. The major concern about a diesel system was the price of diesel. In January of 2005 the price of diesel was $1.96 per gallon, but by October it was $3.16 per gallon. Zack was concerned that at the higher price it might be cheaper to simply buy hay from the Fairfield (about 70 miles away) area than to upgrade his irrigation system to increase the ranch's hay production. As he was considering these possibilities, he heard about an Oregon man who operates a Detroit Diesel engine on vegetable oil to power his irrigation system. The basic idea of a vegetable oil system is to make some minor modifications to a traditional diesel engine, then operate the engine on diesel fuel while the engine heats up and then switch from diesel to vegetable oil. The fuel is then switched back to diesel a few minutes before shut down to purge the system. This type of system offered the potential of reduced fuel costs over operating the engine on diesel fuel.*

5. **What were Zack Wirth's options for obtaining oil to be used in his diesel engine?**

Answer: *He could contact a company that processes oilseeds and buy new oil or try to find a source of used vegetable oil. Soybean oil is the most abundant vegetable oil produced in the United States, although Montana does not produce soybeans. Comparing the price per gallon of*

soy oil prices (with a Midwest delivery point) with the price of off-highway diesel shows that only in about half of the last ten years has soybean oil been less expensive than diesel. Soybean oil price in 2007 was approximately $2.12, which was about 30 cents cheaper than off-highway diesel fuel.

Another option was to purchase off-specification oil (oil that didn't meet human food standards) from oilseed processors. The oil he had inquired about was for food-grade oil, but he wondered if off-specification oil ever became available at a discounted price. He contacted the oilseed crushing facility in Culbertson and found out that from time to time they did have off-specification oil, but they couldn't guarantee they would have some available when he needed it.

Another option he had heard about was to drive around to restaurants to pick up their used oil. But at 15 to 50 gallons at each location, this wasn't going to be cost effective since he lived so far from a large town. He needed to find either a large business that used lots of oil or a company that could supply him with larger quantities of oil. He found a company in Hayden, Idaho that collected used oil, then filtered it and resold the oil in larger quantities. They were selling oil for approximately $1.57 in 2007. This was 55 cents cheaper than virgin soy oil and 86 cents less than off-highway diesel but Zack would have to pick it up.

6. What were Zack's financial considerations when looking to upgrade to a big gun irrigation system?

Answer: *To utilize a big gun system was estimated to cost nearly $120,000. An EQIP cost sharing grant was applied in 2004 for to offset the cost the improvements. The application was approved for $55,000. The system was completed in 2006. This project was based on a diesel-powered engine and did not include any additional equipment to allow the system to operate on vegetable oil. To modify the new system to operate on vegetable oil would cost around $20,000, which was another big expense for the Rocking Z Ranch. The $20,000 would pay for a preheating system, several oil storage tanks, fittings, concrete work and a building to house the system. To offset the cost of this project, an application was submitted to the Conservation Innovation Grant program from the NRCS (National Resources Conservation Service). This program offers cost-sharing opportunities for farmers and ranchers to adopt innovative conservation approaches. The project qualified the project for a $9,700 grant to help offset the cost of the system. 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 exchanger system.*

7. What was the biggest problem that Zack experienced with his diesel power system?

Answer*: The main problem was with the big gun that had been purchased. Rather than attempt to fix the big gun and possibly run the risk of another season of hassles, the big gun was returned to the company and more reliable wheel row equipment was purchased for 2008.*

The irrigation system was only part of the ranch's total diesel expenses. The other major use for diesel was for operating the diesel tractors. While researching the irrigation system, he began to consider if the possibility of reducing the ranch's diesel costs further by modifying his tractors to

run on vegetable oil. The main problem with the vegetable oil irrigation system was during start up and shut down of the engine.

8. What was Zack's solution to this problem?

Answer: *The solution for this problem for the irrigation pump was to let it run for days at a time, but for a tractor that solution didn't seem as appealing. Another drawback to using vegetable oil in the tractors was that he would need to convert four diesel tractors instead of just one engine as with the irrigation system. Zack's idea to get around this problem was to convert the vegetable oil into biodiesel for use in the tractors.*

9. Describe the basic process that Zack used to produce biodiesel on his ranch?

Answer: *Biodiesel is produced during a process called transesterification. The transesterification process requires three inputs: vegetable oil, a catalyst and alcohol. The process produces two products: glycerin and biodiesel. The basic proportions for this 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. The glycerin is of little value for small producers. Zach received a permit from the Montana Department of Environmental Quality to add the glycerin produced from the operation to the manure pile.*

10. What advantages does biodiesel have over straight vegetable oil? Drawbacks?

Answer: *Biodiesel is a much thinner (lower viscosity) fuel than vegetable oil. The lower viscosity allows biodiesel to be used in a traditional diesel engine without preheating the fuel as is required with vegetable oil. The lack of required engine modifications needed to use biodiesel is a huge advantage over vegetable oil in many cases. Another positive attribute of biodiesel is that it can be blended with traditional diesel in any proportion and the user can switch back and forth between diesel and biodiesel at any time.*

Drawbacks--*Biodiesel gels at a higher temperature than number two diesel fuel. This often limits winter use of biodiesel in Montana. To reduce this problem, biodiesel used in the winter is blended with higher amounts of number two diesel, stored in heated tanks or cold flow additives are employed. Even after these steps are taken, biodiesel still does not perform as well as diesel fuel in the winter.*

11. How much biodiesel did Zack produce in 2007 and what are his plans in future years?

Answer: *Zack produced approximately 900 gallons of biodiesel in 2007. All of the fuel was consumed on the ranch, and in 2008 he plans to produce 1,500 gallons of biodiesel.*

12. What is the biggest concern for small-scale biodiesel producers? What was Zack's biggest problem with biodiesel?

Answer: *Fuel quality. The biodiesel sold commercially is required to meet a set of standards designed by the American Society for Testing and Materials (ASTM). The cost to have a lab*

perform the required tests to determine if a fuel sample meets ASTM specifications can cost over $1,000. The cost of the testing leaves most small-scale producers uncertain about the actual quality of their fuel.

The cold flow properties of biodiesel have created some problems on the Rocking Z Ranch. When the temperature drops to 5 to 10 degrees above zero, the biodiesel has tended to gel enough to cause problems in the tractors.

Because most of his diesel use is during the summer, this doesn't reduce the total savings to the ranch by a large amount.

13. Besides the cost of the oil, what other variable costs did the Wirth's incur when producing biodiesel on the ranch?

Answer: *The price of methanol and catalyst are also important to 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 he purchased cost $248 ($4.51 per gallon). Producing 100 gallons of biodiesel requires about 20 gallons of methanol so this increase in price has increased his production costs by over $0.50 per gallon. Catalyst is also required to produce biodiesel. Catalyst can be purchased in 50-pound bags for $90 ($1.80 per lbs.). At this price, catalyst adds less than $0.10 per gallon to the cost of the biodiesel produced. These two costs contribute to the cost of the biodiesel and the financial viability of the biodiesel operation.*

14. How would you assess the market for meal during the first year of Zack's business?

Answer: Unfortunately, camelina is a relatively new crop, and its meal does not have regulatory approval to be sold as animal feed in Montana. Several groups including Montana State University are researching the value of feeding camelina meal to cattle, goats, fish and poultry. The brightest prospects appear to be its use as a source of omega-3 that may be transferred to meat obtained from such animals. Such research may be useful in obtaining regulatory approvals. However, this process takes time, which is at premium for any business but especially a new business. To speed the process, many companies involved with camelina have agreed to join a consortium to develop a single application for approval.

15. What questions does Zack ponder as he considers future decisions regarding his business?

Answer*: Were these the right thing to do? The results of the first few years look promising but will they prove to be successful over the long term?*

All indications point to yes, but like trying to predict the weather, they both agree that only with the passage of time will the final outcome become clear.

Conclusion:

The main focus of this lesson is the successes, challenges and opportunities of processing biodiesel that is consumed on a ranch for use in tractors and an irrigation power unit (John Deere diesel engine). Through examining this case study of biodiesel processing operations and ranch business decisions, students can learn through real-life examples about biodiesel processing from an individual producer who took the initiative to reduce fuel costs for his ranching operation.