ECONOMIC FEASIBILITY OF MANUFACTURING FUEL PELLETS FROM COTTON BYPRODUCTS

Greg Holt, USDA-ARS, Lubbock, TX;
James Simonton, International Textile Center, Lubbock, TX;
Ana Maria Canto, and Mario Beruvides; Texas Tech University, Lubbock, TX

Abstract

Waste or byproducts from cotton ginning facilities have not traditionally been considered a viable source of revenue but considered a cost liability. It was estimated that in the US, there were over 2.25 million tons of cotton byproducts generated each year across the cotton belt. Last year Texas produced 4,153,866 bales of upland cotton. From the bales produced, there was an estimated 750,000 tons of waste produced in the ginning process. The purpose of this research was to explore the cost feasibility of creating a fuel pellet operation utilizing gin byproducts from marketing, transportation, and manufacturing aspects. Economic analyses and modeling were conducted on the estimated costs and revenues to determine the feasibility of the project.

Introduction

For this research the waste stream generated by the cotton ginning process was the main focus. It is worthwhile to mention that cotton waste generation is not restricted to ginning but could also include, but not limited to, textile mill and cottonseed oil mill waste streams. This study is concerned with the most prevalent type of gin found on the High Plains of Texas and across the cotton belt, the Saw Gin, and the type of waste it generates. Previous work has investigated the possibility of utilizing gin by-products as livestock feed, gardening compost, and raw materials in asphalt roofing products. Still most of the waste generated by the gins has not been considered to have monetary value and it is discarded back onto the fields where it comes from as a soil additive (Holt et al., 2000a). Transforming cotton by-products from a liability to a source of income would be a positive strategy for cotton gins and producers alike.

In an attempt to convert cotton by-products into usable materials, the USDA developed a patented system known as the COBY (Cotton Byproducts) process (USDA, 2001). In the COBY process the byproducts from the ginning operation are treated with gelatinized starch and other additives, then they are further processed with heat and pressure. Processing cotton by-products into fuel pellets would provide a renewable resource of energy that is economically and ecologically sound (Holt et al., 2000a; PFI, 2001).

Fuel pellets are made up of biomass materials such as commonly grown plants and trees. Waste materials from trees like sawdust and ground wood chips are some of the components of the most common residential fuel pellets. Fuel pellets can be used in pellet burning fireplaces or furnaces for residential or industrial use and can be burned in almost any common industrial furnace.

The popularity of pellet stoves has increased in recent years. The Pellet Fuel Institute (PFI) reported a 14.7% increase in pellet consumption for the 2000-2001 heating season in comparison from the previous season (PFI, 2001). The regional distribution in the U.S for the past six years is shown on Table 1. Data in this Table indicate that nationally there has been a steady increase in demand for fuel pellets over the past six years. Some of the reasons for the steady sales of the fuel pellets are concerns for the environment, unseasonably cold winters, and increases in the price of natural gas and heating oil. Premium fuel pellets costs compare positively among common residential fuels like propane, electricity, and natural gas, (see Table 2).

Materials and Methods

The main objective of the study was to determine the feasibility of creating a fuel pellet manufacturing operation utilizing cotton gin by-products from marketing, transportation, and manufacturing related aspects. The cost analysis for the study was based on a single pellet mill operation located in close proximity to a high capacity cotton gin and centrally located to other gins. In order to address the objective of the study several assumptions were made: (1) there is a current demand for the product. (2) all pellets produced will be bagged (40 lbs per bag), (3) all pellets will be for the consumer market, (4) distribution will be limited to a five state area (Texas, New Mexico, Colorado, Missouri, and Kansas), (5) all production will be sold wholesale to existing distribution companies (6) there will be no long term warehousing of finished product, and (7) a strategic advantage will be gained by operating in the five state region selected. For this study, several key elements relating to the profitability and cost control of a fuel pellet manufacturing operation were identified and addressed. Such elements are: raw materials, machinery and facility layout, labor cost, and transportation.

Raw Materials

A local gin provided actual production data for the study. During the 2001 crop year, the gin production was 55,000 bales of cotton with an average processing rate of 50 bales per hour. Previous studies have estimated that non-field cleaned cotton will yield about 700 to 800 pounds of waste per bale and field cleaned cotton about 300 to 350 pounds per bale (Holt, 2000b). Based on this, it was projected that during the 2001 ginning season the gin produced approximately 29 million pounds (14,500 tons) of waste.

The projected quantity of waste generated during the 2001 season was based on the gins estimate that their producers were split 50/50 between field cleaned and non-field cleaned harvesting methods. An average of 525 pounds was used for the amount of waste produced per bale of cotton ginned. It is important to mention that not all waste is recoverable or utilizable for this type of product. It has been estimated that approximately 80% of the waste generated by the ginning process can be used for the pellet operation (Holt, 2000a).

Machinery and Facility Layout

The size of the facility constructed to house the pellet mill operation was determined based on the capacity of the machinery selected. The construction will consist of a metal building on concrete slab. It was estimated that changes related to machinery configuration, size, or production capacities would affect the layout and cost of the operation. The pellet mill operation will be situated adjacent to the current gin operation to facilitate the use of the gin's waste disposal system to supply the fuel pellet operation.

Insta-Pro International in addition with other suppliers provided the information utilized on the selection of the equipment and technologies for the study. Three Insta-Pro model 9800 extruders were selected to give production capacity versatility. Each extruder has a capacity of 9800 pounds per hour. Insta-Pro estimates that the throughput of each extruder will be approximately 50% of its rated capacity for this type of waste. The real capacity could be slightly higher or lower depending on the extruder's ability to handle the waste produced by the gin. The remaining equipment was sized at 75% of their rated capacity to handle the output of the extruders. This type of design enables the operation to scale back extruders in times of low gin trash production and scale up when the waste production increases. The pellet mill daily production rate was set at approximately 70% of the anticipated average waste production of the gin (21,000 lbs. per hour). Table 3 presents a general description of the capital equipment used for the study. It was deemed to be uneconomical to attempt to match the waste throughput of the gin since the amount could vary from 12,000 to 37,000 pounds of waste per hour depending on the content of the waste stream. Figure 1 gives a depiction of the flow of materials through the entire process.

Labor Cost

Labor for this operation will use a combination of full time temporary contract labor and full time permanent positions. The ginning industry has traditionally used full-time temporary employees to work during the ginning season only. After completion of the ginning season, these employees move on to other employment opportunities.

Direct labor included laborers, forklift operators, front-end loader operators, and lead men for each shift. These employees were considered as full-time temporary contract labor for the duration of the pellet-manufacturing season. Some full-time permanent employees were included such as a manager and foreman. It was important to have these as permanent positions so that a level of operational expertise could be maintained. These people would be used to train or retrain employees each year and would work to develop sales and marketing for the company.

Transportation

Previous studies have shown that finished product transportation cost would be a limiting factor for cotton by-product fuel pellet operations. In the same way it has been shown that end product destination and mode of transportation are key elements in determining the feasibility of a fuel pellet operation located on the High Plains of Texas, (Simonton et al., 2002; Holt et al., 2002). To address these concerns, three different transportation options were examined: shipment by rail, commercial carrier, and independent trucking along with multiple destinations for each.

On the transportation issues the primary areas of focus for this study were transporting the finished products to the distribution points. Since cotton producers pay for the transport of their own crops to the gin there are no direct transportation cost absorbed by the gin. After the waste has been converted to pellets and bagged, the product will be shipped to one of several potential markets. Three potential markets in the central and mountain regions have been identified as Albuquerque, NM, Denver, CO, and Kansas City, KS. These cities were selected as distribution hubs, due to the popularity of wood pellet products in these areas. The pellet product can be transported to the three potential cities by different routes with their corresponding cost rates. The cost varies in relationship to the distance traveled in each route. The initial cost system was set up with the general assumption that the fuel pellets would be shipped in equal proportions to three different destinations.

Model Development and Analysis

To evaluate the economic feasibility of building and operating a cotton byproduct processing plant, a spreadsheet model was developed and analyzed using Crystal Ball Software (Crystal Ball, 2000). Since changes in costs of materials, labor, supplies, transportation, and other variables occur and can have a significant affect on the feasibility of a project, twenty-five variables were assigned distributions with ranges deemed appropriate based on research and experience.

Results and Conclusions

The forecasting model used for the economic analysis performed 50,000 iterations adjusting each variable with a predefined distribution range. Data used to determine the break-even selling price per bag was based on market information gathered from the Fuel Pellet Institute and other similar organizations. When manufacturing and transportation costs are taken into consideration the break even selling price per bag for fuel pellets being trucked and shipped by rail is $2.03 and $1.79, respectively.

An analysis was performed to examine the break-even waste quantity at a selling price of $2.50 per 40 lb bag delivered. In the analysis it could be seen that as waste quantity is reduced the operation's ability to cover cost is inhibited. The actual break even waste quantity occurs at 4305 tons of waste. This equates to 20,500 bales of cotton that average 525 pounds of waste per bale. The break-even bale quantity is significant since the worse crop year this gin has experienced in the last 25 years was 21,000 bales. The average output for this gin is 55,000 bales or 11,550 tons of waste generated. The cost per bag difference between 11,550 tons (55,000 bales) of waste generated and 9,450 tons (36,000 bales) is about $0.073 more per bag. The reason for the small difference in the cost per bag is due to the structure of the business. The cost system reflects the pellet mill's operation that is designed to generate most expenses only when it is running.

Since transportation costs are key to the total cost of the product an analysis was performed to determine if the cost of the product would be sensitive to a change in freight charges. The analysis used incremental values that represented values from a 30% decrease to a 50% increase in freight cost. An increase in trucking freight cost is more significant because of the limited capacity of each truckload, 1,100 bags. While a change in rail freight cost is distributed over 5,000 bags. This would indicate a need to shift the shipping allocation more heavily toward rail. The results of this comparison are contained in Figure 2.

By approaching this project as an enhancement to a current operation, a Minimum Attractive Rate of Return (MARR) was not predetermined. However, it was established that the minimum Return on Investment (ROI) was to be at least 15%. The cost system was developed in Excel spreadsheets and was used to examine factors that influenced the sensitivity of critical areas such as cost and profits. One such area was the relationship between finished product transportation and the amount of waste available for the pellet operation. Rates of returns were calculated using the future value of the capital cost if the money was simply invested for 10 years. These values were used as benchmarks. The waste generated, in the form of thousands of bales ginned, was manipulated until the profits matched the benchmark values. This allowed a comparison to be made that showed how many bales needed to be processed in order to meet the various return rates.

With 15% return on investment, as a minimum standard, transporting finished product by truck did not appear to be a viable option. For trucking to be viable the long-term interest rate on capital cost had to be 6% or below. Using rail as the primary transportation is less sensitive to a change in interest rate and was found to meet the required ROI even at an interest rate of 16%.

Using the information contained in this study it does appear that a fuel pellet operation can be a profitable development. Treasury Bills returns about 3.84% on a 10-year investment (as of November 14, 2002). The stock market historically returns approximately 10 to 12% (Coe, 2002; Stuhlreyer, 2002; and Wibel, 2002). Based upon the assumptions and values used in the forecast model, the ROI of 15% would have a 29.95% and 54.4% chance of certainty if transporting the product to market by truck or rail, respectively. To be able to achieve the optimal transportation cost a combination of truck and rail will most likely be used.

It is believed that the ROI can be further improved by examining capital cost for the project. The capital costs estimates were considered to be conservative in nature. Narrowing the estimates to quotable amounts could result in an improvement of the overall ROI of the project. It is important to note that pricing contained in this study is for budgetary estimation only and is not intended as quotable amounts.

Disclaimer

Use of a trade name, propriety product or specific equipment does not constitute a guarantee or warranty by the United States Department of Agriculture and does not imply approval of a product to the exclusion of others that may be suitable.

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Tables

Table 1. Fuel pellet distribution in U.S. in tons

Region	2000-2001	1999-2000	1998-1999	1997-1998	1996-1997	1995-1996
U.S. Pacific	204,000	235,500	231,000	236,000	228,000	262,000
Mountain	121,000	89,000	120,000	108,000	108,000	123,000
Central	43,000	17,500	31,000	49,000	36,000	19,000
Great Lakes	26,000	19,100	27,000	22,000	45,000	36,000
Northeast	197.000	147,000	135,000	154,000	143,000	107,000
Southeast	63,000	62,000	58,000	49,000	49,000	39,000
Total	654,000	570,100	602,000	618,000	609,000	586,000

Table 2. Fuel cost comparison (PFI, 2001)

Fuel	Price ($)	Cost Per Million BTU's of Usable heat ($)
Premium Wood Pellets – 6% moisture, 8200 BTUs/lb 80% efficiency	160 per ton	12.20
Electricity – 3415 BTUs/ kwh, 95% efficiency	0.10 per KWH	30.80
Propane – 90,000 BTUs/gal 80% efficiency	1.40 per gallon	30.80
Oil #2 – 138,000 BTUs/gal 80% efficiency	1.20 per gallon	10.86
Natural Gas – 100,000 BTUs/therm 80% efficiency	1.00 per MCF	12.50
Coal – 12,000 BTUs/lb 75% efficiency	160.00 per ton	8.88
Firewood – 20 MM BTUs 65% efficiency	130.00 per cord	10.00
Note: Efficiency Rating is based on newer modern appliances. Older heating appliances may be far less efficient therefore increasing cost per MMBTU.		

Table 3. Capital equipment list for the project.

Item	Quantity	Description	Unit Price ($)	Unit Total ($)	Total ($)
1	1	External Feed Hopper	25000	25000	
2	2	Condensers	8500	17000	
3	1	Live Bottom Hopper	25000	25000	
4	1	Screw Conveyor	5141	5141	
5	1	Live Bottom Feeder Bin w/ Leveling Screw	15625	15625	
6	2	Belt Conveyor	6778	13556	
				Sub-total	101,322
7	3	Insta Pro Extruders	173250	519750	
8	3	Cotton Feeders for Extruder	10025	30075	
9	3	Spare Parts Kit for Extruder (optional)	6250	18750	
10	1	Box Dryer	125000	125000	
11	1	Landers Pellet Mill	161188	161188	
12	1	Cleated Belt Conveyor	12233	12233	
13	1	Pellet Cooler	46351	46351	
14	1	Vibro Screening Conveyor	10381	10381	
15	1	Rerun Screw Conveyor	5189	5189	
				Sub-total	928,917
16	1	Bag Dump Station w/ dust filter	9375	9375	
17	1	Screw Feeder	2813	2813	
18	1	Bucket Elevator w/ Service Platform	4918	4918	
19	1	Surge Bin w/ Support Stand and Gate	1744	1744	
20	1	Screw Feeder	2813	2813	
21	2	Volumetric Feeders for Load Cells	9375	18750	
22	1	Tandem Wylie tanks	6000	6000	
23	3	Additive Spray Systems	1600	4800	
24	1	Pump and Piping for starch system	9000	9000	
25	1	Warehouse	43000	43000	
26	1	Starch Silo (Used)	100000	100000	
27	1	Bin Cluster	50000	50000	
28	1	Bagging Scale	174663	174663	
29	1	Bag Sealer	39938	39938	
30	1	Bag Kicker	6072	6072	
				Sub-total	473,886
			Machine Total		1,504,125
			Cost/sq. ft		
		Building	10.75		35,475
		Machine Installation and Start-up			250,000
		Machine Electrical Installation			225,00
		Miscellaneous and Startup Cost			150,412
Total Cost					2,165,013

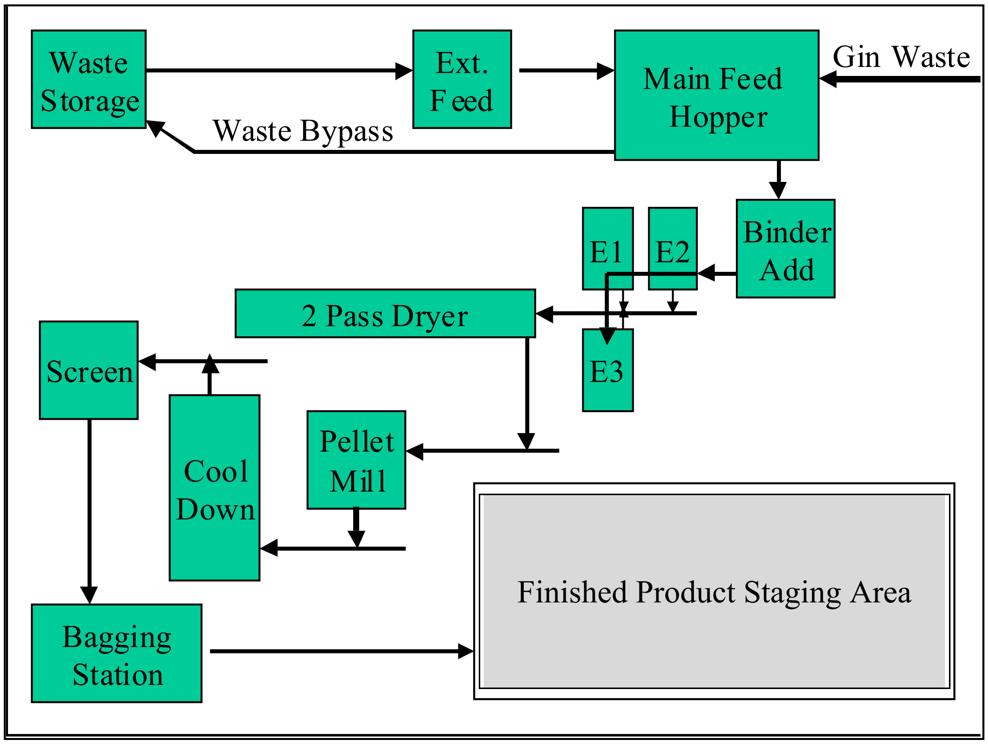

Figure 1. Pellet Mill Machine Flow Diagram

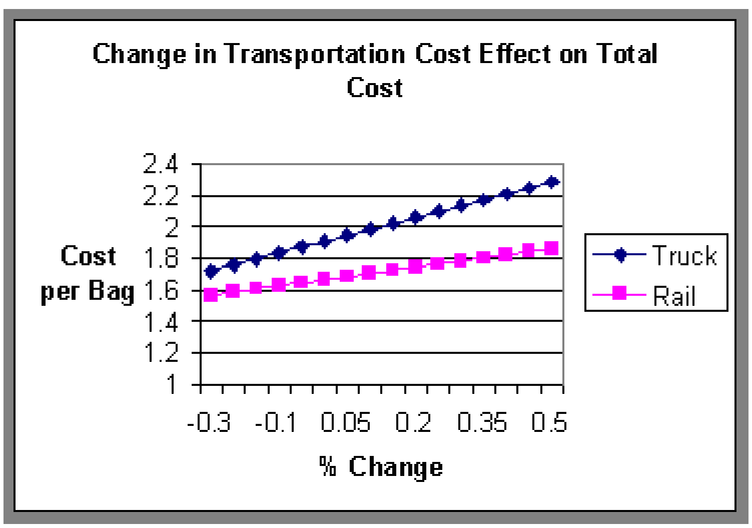

Figure 2. Change in Transportation Cost Effect on Total Cost ($)