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THE ECONOMICS OF SMALL SCALE ALCOHOL PRODUCTION

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Introduction

The purpose of this paper is to provide a framework which a potential small scale ethanol producer could use to evaluate whether production is likely to be profitable on his farm. It will concentrate on the economic evaluation procedure and will include a set of calculations for an example alcohol plant.

While a few dozen small scale ethanol plants are in operation in the United States, they are of variable designs and few have been in operation long enough to provide a good basis for an economic evaluation. This author has found no published studies of the economics of small scale ethanol plants based on actual operating data. This is in direct contrast to most agricultural enterprises for which the USDA and colleges of agriculture have published many cost and return studies.

Several economic-engineering studies of small scale alcohol production have been published. These studies are based on the investment required to build an alcohol plant of some particular design, the cost of inputs to operate the plant and the value of products produced, assuming the plant operates the way it is supposed to. Whether these investments, operating costs, and income will turn into reality can be known only when plants of these designs are built and operated over a period of years.

Cost-Return Estimates and Worksheet

While all of the elements of the projected costs and returns budget are subject to uncertainty, the capital investment and related depreciation and interest (or amortization) are of particular concern. Because of economies of size (or diseconomies of small size) the capital investment for commercially built small scale ethanol plants, particularly those that are operated intermittently, can be quite large in relation to the amount of ethanol produced. This suggests that many potential small scale ethanol producers will need to try to keep investments down by using equipment already on the farm or low cost components that can be adapted to ethanol production.

Perhaps the best way to look at the costs and returns for ethanol production is to look at the input needs, products produced, and likely costs or value of each. The inputs required, in addition to the plant itself, are the feedstock, energy, labor, chemicals, repairs and maintenance, insurance and other costs such as taxes and marketing. The main product is ethanol and the byproduct is stillage.

The framework below (Table 1) provides blank spaces in which you can enter the estimated cost of inputs and value of by-products and tax credits that would apply to your proposed ethanol plant.

Budget for Example Plant

The estimates of the cost of producing alcohol presented here are based largely on estimates for a small on-farm ethanol plant presented in Small-Scale Fuel Alcohol Production prepared by the USDA with the assistance of Development Planning and Research Associates, Manhattan, Kansas. Many changes in the USDA data have been made to reflect information available to this author.

The distillation part of the plant will be operated 8 hours per day to produce 25 gallons of 190 proof alcohol per hour or 60,000 gallons per year if operated 300 days per year. An operator will be required 8 hours per day 6 days per week. Fermentation will continue unsupervised for 16 hours per day 6 days per week and 24 hours on the 7th day.

The example plant will use corn as a feedstock and the stillage will not be dried. While it is possible to obtain 2.5 gallons of alcohol per bushel of corn, some small scale plants are producing only about 1.7 gallons per bushel. The calculations presented here are based on 2.0 gallons of 190 proof alcohol per bushel of corn.

Amortization

Total investment in this plant was estimated by the USDA study to be $140,000. If this amount is amortized over 10 years at 15 percent interest, the annual payment would be $27,895 which is $.46 per gallon of 190 proof alcohol produced (Table 2). For your proposed plant, use the life and interest rate you believe are applicable.

Feedstock cost

Feedstock costs for various conversion ratios and prices of corn and wheat are shown in Table 3. At $3.40 per bushel of corn and 2 gallons of alcohol per bushel, the feedstock cost per gallon of 190 proof alcohol is $1.70. Part of this will be recovered as stillage value to be discussed later.

Energy cost

Electricity to operate the grinder, stirrers and pumps is estimated to be 0.5 kwh per gallon of alcohol. At $.06 per kwh, the cost would be $.03 per gallon of alcohol.

The cost of energy to fire the boiler for cooking and distillation will depend on the fuel used and the energy requirement per gallon of alcohol. The USDA estimate is 43,000 btu per gallon of alcohol; this may be lower than the energy required in most small scale alcohol plants but will be used in the example.

If the plant is fueled with No. 2 fuel oil containing 138,000 btu per gallon and the burner efficiency is 80 percent, 0.39 gallon fuel oil would be required per gallon of alcohol produced. At $1.10 per gallon of fuel oil, the fuel cost would be $.43 per gallon of alcohol produced. Other fuel sources such as coal or natural gas currently would be less expensive.

Labor

Labor at $5.00 per hour for 8 hours per day and 300 days per year would cost $12,000 per year or $.20 per gallon of alcohol produced.

Chemicals

Enzymes, yeast, acids, bases and other chemicals have been estimated by the USDA to cost $.22 per bushel of corn. At 2.0 gallons of alcohol per bushel of corn, the chemical costs would be $.11 per gallon of alcohol.

Maintenance, insurance, other

Maintenance costs were estimated by the USDA to average four percent of the equipment cost which is $.07 per gallon of alcohol.

Insurance, including fire, liability, and workmen's compensation is estimated to cost $.03 per gallon of alcohol.

A tax bond will be required at a cost of about $.01 per gallon of alcohol. Real estate taxes have been estimated at $.01 per gallon.

Total cost

Total annual cost, before deducting byproduct value and alcohol tax credits, is estimated in the example to be $183,295 for the 60,000 gallon per year plant or $3.05 per gallon.

Byproduct credit

The value of stillage could vary widely depending on the amount of alcohol produced per bushel of corn and on how the stillage is utilized.

Stillage value should be computed on an opportunity cost basis. That is, the value of the stillage should be equal to the cost of the nutrients that would be replaced by the nutrients in stillage. If 2.6 gallons of alcohol are produced per gallon of corn, the dried distillers grains and solubles (DDGS) produced in a plant that dries the stillage to 10 percent moisture will contain about 28 percent protein. If the wet stillage, with greater than 90 percent moisture, would replace purchased DDGS in the diet and the dry matter in wet stillage was worth as much as the dry matter in DDGS, the calculation of the value of wet stillage would be quite straightforward. For stillage from most farm stills, the calculations will be more complicated for at least three reasons: (1) Problems in feeding stillage with over 90 percent water will make the dry matter in wet stillage worth less than the dry matter in DDGS, (2) On most farms, there are cheaper sources of protein and energy than purchased DDGS and (3) A plant that produces less than 2.6 gallons of alcohol per bushel of corn will result in more stillage dry matter per bushel of corn because not all the starch is converted to sugar and then to alcohol but the stillage will have a lower percentage protein content.

It is estimated here that about 24 lbs. of DDGS equivalent with 20 percent protein will be produced per bushel of corn if the conversion ratio is 2.0 gallons of alcohol per bushel of corn. First, let's assume that if the stillage is fed wet (over 90 percent moisture) the nutrients will have the same value as those in ingredients the farmer would feed if he did not operate the alcohol plant. Two nutrient sources considered are mixtures of (1) soybean meal and corn and (2) urea and corn with the same protein content as the stillage would have if dried to 10 percent moisture. Mixture (1) would require 73 pounds of shelled corn and 27 pounds of 50 percent soybean oil meal. The cost of the mixture with corn at $3.40 per bushel and SOM 50 at $250 per ton would be $7.81 per cwt.

73 lbs. corn @ $.0607/lb.	=	$4.43
27 lbs. SOM @ .125/lb.	=	3.38
		$7.81 per cwt.

If each bushel of corn yields 24 lbs. of DDGS equivalent, each gallon of alcohol is accompanied by 12 lbs. of DDGS equivalent. At $.0781 per lb., the byproduct value is about $.94 for each gallon of alcohol produced. Mixture (2) would require 96 lbs. of corn and 4 lbs. of urea for a cost of $6.33 per cwt. with corn at $3.40 per bushel and urea at $250 per ton. The byproduct value would be about $.76 per gallon of alcohol.

Each of these estimates is probably high because it will be difficult if not impossible to obtain the same nutrient value from wet stillage as from ingredients fed at usual dry matter levels. The byproduct value used here is 50 percent of the average of the corn-SOM and corn-urea based values or $.42 per gallon of alcohol produced.

Tax Credits

Three Federal tax credits may be available to the owner and operator of a small scale alcohol plant: (1) regular investment credit, (2) business energy investment credit and (3) an alcohol credit for each gallon of alcohol produced. New York State investment credit may also be available.

The regular and business energy investment credit are each 10 percent of the eligible investment. Probably not all of the $140,000 will be eligible but if it is, the Federal investment credit would be $28,000. The NY investment credit of 4 percent would be $5,600 if the entire plant is eligible. Many farmers would not be able to use these credits immediately because their tax bills are not large enough. If the credits are used soon after the plant is built, they can be converted to a per gallon basis by amortizing them over 10 years and dividing by 60,000 gallons per year. The amortization factor for 10 years at 15 percent is $199.25 per $1,000.

$33,600 investment credit x $199.25/$1,000 = $6,695/year

$6,695 ÷ 60,000 gpy = $.11 per gallon of alcohol

There is a federal alcohol credit of $.40 per gallon of 190 or greater proof alcohol produced ($.30 per gallon for proof between 150 and 190). For the example plant, the credit would be 60,000 gal. x $.40 = $24,000 per year.

Net cost, after byproduct and tax credits

In the example, the cost of $3.05 per gallon would be reduced by the byproduct credit of $.42, the investment credits of $.11 and the alcohol credit of $.40 per gallon for a net cost of $2.12 per gallon of alcohol produced. Keep in mind that the net cost could vary widely depending on the value of the byproduct and whether the investment credit could be used soon after the plant was constructed.

Value of alcohol produced

The value of alcohol produced will depend on the cost of the fuel it replaces or the price at which it can be sold. Most New York farmers would not be able to use 60,000 gallons per year in their farm businesses.

When placing a value on the alcohol, keep in mind that it contains about 76,000 Btu. per gallon compared to about 116,000 for gasoline and 138,000 for diesel fuel.

Effect of cost and price changes and inflation

Costs for the various inputs used in the example were approximate for early 1981. Some costs such as interest rates and corn prices could be lower in the future. Inflation will likely result in increased costs over time but also increases in the value of the ethanol produced. Because energy prices are likely to increase more rapidly than other costs, a year-by-year analysis of the costs and returns for ethanol production over the next 10 years would be likely to make an ethanol plant investment look like a better investment than in the example presented here.

Summary

You are encouraged to make a careful analysis of the likely production costs and ethanol and byproduct values for your situation before proceding with construction.

Table 1. Worksheet for estimating your ethanol production costs

Item	Notes	Total Annual Cost	Cost per gallon
Amortization	______________	$______	$______
Feedstock	______________	______	______
Electricity	______________	______	______
Other Energy	______________	______	______
Labor	______________	______	______
Chemicals	______________	______	______
Maintenance	______________	______	______
Insurance	______________	______	______
Other	______________	______	______
TOTAL		$______	$______
Byproduct	______________	(______)	(______)
Net Cost before tax credits		$______	$______
Tax credits:			
Federal and NYS investment credits		(______)	(______)
Federal alcohol credit		(______)	(______)
Net cost after tax creidts		$______	$______

Table 2. Estimated cost of producting ethanol in a small scale plant (60,000 gpy) See text for explanation of estimates

Item	Notes	Total annual Cost	Cost per gallon
Amortization	$140,000 @ 15%, 10 years	$27,895	$ .46
Feedstock	Corn $ $3.40/bu.	102,000	1.70
Electricity	0.5 kwh/gal @ 6¢/kwh	1,800	.03
Other energy	Fuel oil @ $1.10/gal	25,800	.43
Labor	8 hrs./day @ $5.00, 300 days	12,000	.20
Chemicals	$.22 per bu. of corn	6,600	.11
Maintenance	4% of equipment investment	4,200	.07
Insurance		1,800	.03
Other	Tax bond, real estate taxes	1,200	.02
TOTAL		$183,295	$3.05
Byproduct		(25,200)	(.45)
Net Cost before tax credits		$158,095	$2.63
Tax credits:			
Federal and NYS investment credits		(6,695)[1/]	$(.11)
Federal alcohol credit		(24,000)	(.40)
Net cost after tax credits		$127,400	$2.12

[1/] $6,695 is the annual equivalent of $33,600 Federal and NYS investment credit amortized over 10 years at 15 percent interest.

Table 3. Feedstock cost per gallon of ethanol for corn or wheat at various prices and conversion ratios

Price per bushel of corn or wheat	Gallons of alcohol per bushel of corn or wheat			
	1.7	2.0	2.3	2.5
$2.00	$1.18	$1.00	$ .87	$ .80
2.20	1.29	1.10	.96	.88
2.40	1.41	1.20	1.04	.96
2.60	1.53	1.30	1.13	1.04
2.80	1.65	1.40	1.22	1.12
3.00	1.76	1.50	1.30	1.20
3.20	1.88	1.60	1.39	1.28
3.40	2.00	1.70	1.48	1.36
3.60	2.12	1.80	1.57	1.44
3.80	2.24	1.90	1.65	1.52
4.00	2.35	2.00	1.74	1.60
4.20	2.47	2.10	1.83	1.68
4.40	2.59	2.20	1.91	1.76
4.60	2.71	2.30	2.00	1.84
4.80	2.82	2.40	2.08	1.92