Cottonseed Flour Production: Economic Evaluation

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ABSTRACT

Estimating methods are described and results are presented on economic evaluation of processing glandless cottonseed into flour with by-products of oil, hulls, and fine meats. Processing was assumed to be conducted in three sizes of mills processing 100, 200, and 400 tons per day of seed for 300 days per year. Estimates were made of the prices of flour required to give discounted cash flow rates of return ranging from 0 to 25%. At 25% return the estimated prices of flour were 36 cents, 28 cents, and 25 cents per pound for the three sizes of mills.

INTRODUCTION

Cottonseed is one of the principal commercial oilseeds of the world. However, the proteinaceous solid from the seed is still used almost exculsively for animal feed instead of for human food because of the presence of the naturally occurring pigment in the kernels called gossypol. Development of varieties of seed whose kernels are nearly gossypol-free began in about 1959. Considerable progress has been made in developing varieties with good fiber properties as well as low gossypol seed (1). Low gossypol seed are called "glandless" because they are nearly free of discrete pigment glands which contain most of the gossypol in normal, glanded seed.

The food use potential of the new glandless seed was quickly recognized by researchers (2-4). In particular, investigators at the Food Protein Research and Development Center at Texas A&M University have tested the utility of glandless cottonseed products in many food applications (5-8). Considerable work has also been reported on various aspects of production of protein isolates and concentrates from glandless cottonseed flour (9-12). Among the potential food ingredients which can be made from glandless seed are nut-like kernels, flour, protein isolates, and protein concentrates (7,8,13,14).

Commercial use in food of products made from glandless cottonseed will depend upon establishment of at least one plant for commercial processing of glandless seed. The only known processing of glandless seed at present is production of kernels for use as nuts. This is a report on a preliminary economic evaluation of the production of glandless cottonseed flour. Flour manufacture was selected for study because it is a consumer product as well as the starting point for production of concentrates and isolates; glandless kernels could also be a product from a flour plant.

The economic evaluation was made by estimating the selling prices of flour required to produce discounted cash flow rates of return (DCFRR) ranging from zero to 25% for three sizes of mills to process 100, 200, and 400 tons of seed per day (24 hr) for 300 days per year. Evaluations required estimates of product yields, investment in new processing facilities, and operating costs.

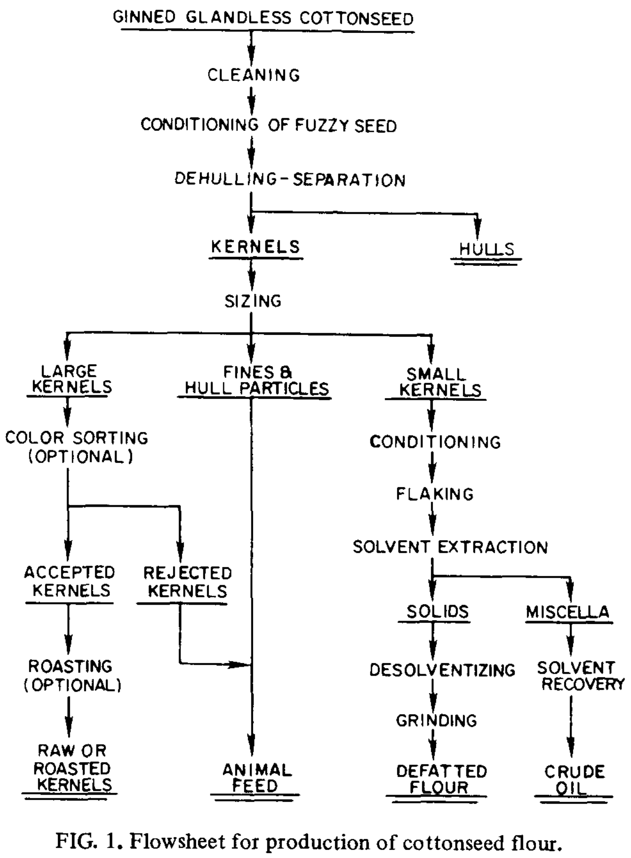

FIG. 1. Flowsheet for production of cottonseed flour.

PROCESS

Commercial processing of glandless seed into food quality flour would be quite similar to present commercial processing of seed for oil and meal (15). The principal difference would lie in designs and operating techniques to protect the flour from any kind of foreign matter or micro-bial contaminants, as well as from gossypol in glanded seed and hulls from the seed itself. Figure 1 is a flowsheet for production of glandless flour and edible kernels. It is based on considerable unpublished pilot plant experience at the Food Protein Research and Development Center. For this economic analysis, both large and small kernels were considered to go into flour production, and production of edible kernels was not included.

Receiving, storage, and cleaning of seed would be essentially the same as present practice. Conditioning of seed to increase the yield of coarse kernels would be desirable if seed were low in moisture. A live steam treatment has been described (16). Hulling of undelintered seed would be practiced because this facilitates production of hull-free kernels. (17,18).

One fraction produced during the hulling step would be a mixture of inseparable hull and kernel particles. These "fine meats" would be a by-product (17). Fuzzy hulls have low bulk density making them difficult to store and transport. Therefore, pelleting of hulls might be practiced (18).

Hull-free kernels would be conditioned, flaked, and solvent extracted by conventional means. Meal would be desolventized and stripped of hexane without condensing stripping steam in the meal (19). Meal would be gound into flour. All of the technology for processing glandless seed is known and available in commercial machinery although some of the details would have to be worked out during the design and start up of a specific new plant.

TABLE I

Estimated Annual Production of 100, 200, and 400 TPD Glandless Cottonseed Flour Mills

	Size of mill, TPD and annual crush, tons		
	100	200	400
	30,000	60,000	120,000
Products		Product yields (1000 lb)[a]	
Trash and loss	3,060	6,120	12,240
Hulls	25,350	50,700	101,400
Fine meats	4,650	9,300	18,600
Oil	8,670	17,340	34,680
Flour	18,270	36,540	73,080

[a]Yields per ton: foreign matter and losses, 102; hulls, 845; fine meats 155; oil 289; flour 609.

TABLE II

Estimated Returns from By-Products for 100, 200, and 400.TPD Glandless Cottonseed Flour Mills[a]

	Size of mill, TPD		
Product	100 Annual return $	200 Annual return ($)	400 Annual return ($)
Hulls	570,375	1,140,750	2,281,500
Fine meats	204,600	409,200	818,400
Oil	2,080,800	4,161,600	8,323,200
Total return	2,855,755	5,711,550	11,423,100

[a]Calculated from yields in Table I and the following prices per pound: hulls $0.0225; fine meats $0.044; oil $0.24.

YIELDS AND ANNUAL RETURNS FROM SALES

By-products from processing glandless seed into flour would be oil, hulls, and fine meats. Yields of these would depend upon the composition of the seed (20) and the efficiency of the processing operations. Table I shows yields which were selected from a combination of published figures (21) and unpublished composition and processing data. Any consistent set of yields could have been used. The effects of changes in yield could be calculated by the methods in this report. Yields per ton of seed were translated into annual yields for the three plant sizes. Glandless seed supplies adequate for these rates were assumed to be available.

Annual returns from sale of by-products in Table I are shown in Table II. Returns from sale of flour are not shown because the price of flour was the objective of the calculations. Prices for oil and for hulls were selected from published values (22,23) for these commodities for glanded seed. Oil and hulls from glandless seed might earn slightly higher prices because of lower color and higher linters content, but this possibility was not considered in the prices selected.

Fine meats could be processed for oil and meal by a screw press operation separate from the flour process. However, for this study the fine meats were assumed to be sold to an oil mill for the value of the oil, meal, and hull components less 1.1 times the estimated costs of processing.

CAPITAL INVESTMENTS

Data for use in estimating capital investment requirements for the flour mills were obtained from several published and private sources. Most of the costs for production facilities, including some installation costs, were obtained from equipment manufacturers. Costs of support facilities came from manufacturers, from cost estimating publications (24-26), and from revisions of previous oil mill cost estimates (27,28). Revisions of any data which were not current (July, 1977) were made by use of U.S. Department of Labor Wholesale Price Indexes (29). Costs estimated in these various ways are presented in Table III.

PRODUCTION COSTS

Estimated annual production costs are shown in Table IV for the three sizes of mills.

Lubbock, Texas, was used as a basing point for rates on taxes, natural gas, water, electricity, and hourly labor (30). This city is in the heart of a large cotton growing area with conditions favorable for glandless seed (1).

Insurance rates for workmen's compensation, property, seed, and products were supplied by an insurance industry source (Chaffe, K., private communication).

Property taxes were calculated by application of a tax rate of $2.28/$100 of value to the entire investment cost including land but not including the seed inventory. The rate included all city, county, and state taxes, adjusted for assessments as percentages of market value (30).

Straight line depreciation for 25 years with no salvage was applied to all depreciable assets. Use of the same depreciation rate for all assets simplified calculations.

Labor and material costs for maintenance of facilities were estimated as 5% of total capital investment minus land, as suggested by industry sources. In addition, maintenance for hull pelleting machinery was estimated as $0.15 per ton of seed.

A property insurance rate of $0.52 per $100 for fire and extended coverage was applied to the total capital investments minus land, sewers, fencing, fire protection facilities, roads, and railroad tracks.

Administration costs were estimated from lists of positions and salary or wage rates for all office and laboratory personnel. Payroll charges were added to the total salary and wage costs on the basis of 7% retirement, 5.85% social security (OASI), and 0.43% workmen's compensation insurance. Office overhead for communications, supplies, travel, etc., were added through the use of multipliers which ranged from 1.4 to 2.4. These were applied to the

TABLE III

Estimated Capital Investment Requirements for 100, 200, and 400 TPD Glandless Cottonseed Flour Mills

	Size of mill, TPD		
	100	200	400
Production facilities	$1000	$1000	$1000
Seed receiving and storage	919	1,188	2,350
Cleaning and hulling	445	707	1,304
Solvent extraction	1,453	2,137	3,258
Flour manuf, and storage	495	780	1,157
Hull pelleting and storage	217	277	432
Subtotal	3,529	5,089	8,501
Support facilites			
Office, lab, and mach. shop	296	385	518
Railroads	78	94	179
Roads and parking	16	19	30
Fire protection	217	228	234
Sewers and fences	89	100	167
Elect. power substation	13	18	31
Steam generation	91	121	170
Land	31	45	98
Subtotal	831	1,010	1,427
Total	4,360	6,099	9,928
Contingency (15%)	654	915	1,489
Total capital investment	5,014	7,014	11,417

TABLE IV

Estimated Annual Production Costs for 100, 200, and 400 TPD Glandless Cottonseed Flour Mills

	Size of mill, TPD		
	100	200	400
Fixed costs	($)	($)	($)
Depreciation	199,320	278,760	451,720
Taxes	141,395	197,795	321,226
Property insurance	23,495	33,567	55,136
Administration	191,171	248,017	423,791
Total fixed costs	555,381	758,139	1,251,873
Variable Costs			
Seed	4,500,000	9,000,000	18,000,000
Interest on seed	157,505	315,010	630,020
Labor	473,131	522,276	607,417
Electricity	97,200	178,200	324,000
Water	3,300	6,600	13,200
Steam	46,620	93,240	186,480
Repairs, labor and supplies	253,650	357,450	582,650
Packaging supplies	39,000	78,000	156,000
Solvent	19,200	38,400	76,800
Seed and product insurance	11,813	23,625	47,249
Quality control	33,000	33,000	33,000
Total variable costs	5,634,419	10,645,801	20,656,816
Total production costs	6,189,800	11,403,940	21,908,689
Total cost per ton of seed	$206.33	$190.07	$182.57

total salary and wage costs including payroll charges (28).

Similarly, production labor costs including supervisory personnel were estimated from lists of positions and pay rates. Payroll charges were added on the basis of 7% retirement, 5.85% social security, and 14.18% workmen's compensation insurance.

Procurement of cottonseed was assumed to cost $150 per ton including transportation and any other costs not included under administrative costs. This price for seed was about $25 to $50 per ton higher than the price paid by oil mills for glanded seed in 1976 (23).

Based on estimated rates of seed receipts, the maximum quantity of seed in storage for an annual operating season was estimated to be two-thirds of the requirements. This quantity of seed was estimated to be in storage for four months after which the seed inventory declined to zero at the monthly processing rate. These estimates of seed inventory were employed to calculate interest charges on money borrowed to purchase seed and to calculate insurance costs on seed stored. Interest on average monthly seed inventories was calculated at 9% of the value of seed at $150 per ton. Insurance was calculated at $0.63 per $100 of value.

Fire and extended coverage insurance on flour, hulls, and oil were calculated for year-long inventories of seven day's production of each, at rates of $0.66 (flour and hulls) and $0.22 (oil) per $100 of value.

Electric power rates including fuel adjustments were rounded to $0.03 per kilowatt hour. Electric power requirements were estimated to be 89 kwh per ton of seed for the 400 TPD mill for all uses combined. Smaller operations are usually less efficient because losses are greater percentages of the total. Therefore, power per ton of seed for 100 and 200 TPD was assumed to be 20% and 10% greater than for 400 TPD.

TABLE V

Estimated Selling Prices for Glandless Cottonseed Flour vs. Rate of Return and Size of Mill[a]

	Size of mill and selling price of flour		
% DCFRR[b]	100 TPD ($/lb)	200 TPD ($/lb)	400 TPD ($/lb)
0	0.18	0.16	0.14
10	0.25	0.20	0.18
20	0.32	0.26	0.23
25	0.36	0.28	0.25

[a]Sales costs not included.
[b]After income taxes paid.

Natural gas rates in Lubbock were estimated to result in steam costs of $2.10 per 1000 pounds. Steam requirements were estimated to be 740 pounds of steam per ton of seed for all sizes of mills.

Water requirements for steam generation, cooling tower makeup, and sanitary use were estimated to be 300 gallons per ton. The cost rate was $0.35/1000 gallons.

Hexane solvent costs to make up losses were estimated at one gallon per ton of seed and a delivered cost of $0.64 per gallon.

Packaging supplies included bags for all flour and for one-third of the hulls produced, at $0.15 per bag.

Costs of in-plant chemical laboratories and personnel were included under investment and administrative costs. Supplies for laboratory operation were included under quality control costs along with estimated costs for microbiological control through commercial laboratories.

ECONOMIC EVALUATION

Discounted cash flow rate of return (DCFRR) was chosen for the economic analysis because it considers investment costs and the time value of money as well as sales income and production costs. It provides investors with criteria to use in making decisions among alternative investments. DCFRR is defined as the interest rate which makes the present worth values of cash inflows for a project equal to present worth values of cash outflows (31). Defined another way, DCFRR is the rate of return earned on an unrecovered investment with a cash flow repayment schedule which makes the unrecovered investment equal to zero at the end of the life of the investment. (32).

For this study we wanted to calculate the prices of flour which would be required for different DCFRR of 0, 10, 20, and 25%. The data in Tables I through IV supplied all of the information needed except the price of flour, for calculation of undiscounted annual cash flows using the equation, $A = (S - C)(1 - t) + D - I$, where A = annual net cash flow or return after income tax; S = annual sales; C = annual costs including depreciation; D = annual depreciation; t = income tax rate (decimal); I = investment in facilities or working capital. With the price of flour unknown, S = sales of by-products, plus X times the annual production of flour, where X was the unknown price of flour. An income tax rate of 0.5 was used.

Present value (also called present worth) analysis then was used to determine the present value of future money receipts and disbursements for each year of project life. This used the equation, $P = A (1/(1 + i)^n$, where P = present value, A = annual cash flow, i = rate of return desired, n = number of years from beginning of the project life, $1/1 + i)^n$ = present worth factor available in published tables in many references (32). At the end of the project life the undepreciated value of the facility was assumed to be sold for 100% of undepreciated value, and working capital was assumed to be recovered through sale of inventories. These cash flows were also converted to present values in the final year. The sum of present values for receipts less present values for disbursements over the life of the project was employed to calculate the unknown value of the flour. This method is described in detail with worked examples by Herbert and Bisio (31).

The project life is not necessarily the same as the depreciable life of the assets. For new or high risk ventures, the project life may be relatively short. A 12-year project life was chosen. This was divided into 2 years for design and construction and 10 production years. The investment cost was assumed to be equally divided between the two construction years, with no cash inflow during this period.

Table V shows the sales prices calculated for flour with four different DCFRR for the three sizes of mills.

At 25% DCFRR, changes in net income from whatever cause, resulted in a uniform $0.04 per pound change in selling price of flour for each $25 per ton change in income, up or down.

DISCUSSION

This report has described how estimates were made of the selling prices of glandless cottonseed flour at different levels of production and different rates of return on investment. Sales costs were not included and these might amount to between 15 and 30% of the total value of sales (33). Using the high figure of 30% of sales would make the selling price be $0.30/lb for flour from a 400 TPD mill at 20% DCFRR.

The results of the estimates would have been different if different input data had been used. Obviously anyone contemplating production of cottonseed flour should make his own estimates of profitability. Estimates should be made of how the price of flour or the profitability might change through the potential range of items making up the factors in the annual cash flow equation.

Changes in net income could be brought about by changes in seed prices with other input data remaining unchanged, by the aggregate of changes in many or in all of the production costs, or by changes in production costs coupled with changes in sales returns. Some of the specific situations which might be studied are the following:

1. effect of variations in yields of flour as a result of different seed composition;
2. changes in prices for oil or other by-products;
3. insufficient market for flour, requiring sale of product for animal feed;
4. increased capital investment costs due to inflationary factors or design changes;
5. unexpected start up problems;
6. increased production costs due to higher seed prices, higher energy costs, etc;
7. insufficient supplies of seed, with consequent low production of glandless flour;
8. processing of other oilseeds during part of a season;
9. revenue from sale of raw or roasted kernels.

ACKNOWLEDGMENTS

This work was supported by the Natural Fibers and Food Protein Commission of Texas. Many individuals in the cottonseed processing industry and in firms serving the industry provided information and/or advice.

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[Received March 2, 1978]