Evaluation of Processing Alternatives to Saw Delintering of Cottonseed[1]

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ABSTRACT

Results are presented on economic evaluations of several alternative processes to saw delintering. Comparisons were made in terms of yields and quality of products, and processing costs. Comparisons of net monetary returns per ton of seed, and discounted cash flow rates of return showed no alternative processes to be attractive with linters selling at $0.04/lb or above. However, at a break-even linters price of $0.03/lb, hulling of undelintered seed and dilute sulfuric acid delintering were quite attractive alternatives. Hulling of undelintered seed was likewise attractive because of low processing energy requirements and low atmospheric emissions and workroom dust and noise.

INTRODUCTION

Saw delintering of cottonseed has been a standard technique in the cottonseed oil mill industry for many years. This operation is performed to prepare the seed for hulling and the separation of kernels and hulls before extraction of oil from kernels (meats). In recent years, some segments of the industry have been considering alternative ways of processing seed. The reasons for interest in alternatives include the difficulty and expense of bringing the saw delintering operation into complicance with Environmental Protection Agency standards on dust emissions, and with Occupational Safety and Health Act standards on guarding of machines and on workroom dust and noise. Other reasons for interest in alternative processes are the low prices and limited demand for the linters removed from the seed, in times of continual increases in all categories of production costs.

Six alternative processes were studied. These were abrasive delintering, hulling seed without delintering, dilute sulfuric and gaseous HCl acid delintering, solvent extracting rolled whole seed, and enzymatic delintering.

Wamble (1) published a brief description of saw delintering which is useful to those who are not familiar with this process. Much general information on saw delintering has been presented through many years in the *Oil Mill Gazetteer.* Perdue and Clark (2) published data on operating costs. Verdery (3) has published an operating manual on this process which includes considerable operating cost data.

Abrasive delintering is a new process which has been described only briefly in published reports. However, it is presently employed in several oil mills (4). Commercial hulling of undelintered seed is practically unknown in the U.S.; however, different ways of doing this are suggested by Verdery (5). Dilute sulfuric acid delintering is a new process developed by Cotton Inc., primarily for planting seed. One commercial planting seed plant has been reported to be in operation (6,7). Gaseous HCl delintering applied to commercial production of planting seed is not a new process. Use of this process for oil mill purposes was first proposed by Ridlehuber (8). Hay (9) described a continuous pilot plant trial of this process. Clark and Wamble (10) described an investigation of the process of "solvent extraction of oil from cottonseed prior to the removal of linters and treatment of the residue to effect separation of meal, hulls, and linters." No prior description of enzymatic delintering is known.

ESTIMATED YIELDS, QUALITIES OF PRODUCTS, AND COMPARATIVE GROSS RETURNS

As a basis for estimating yields of products, the average yields from cottonseed processing for the U.S. during the period 1948-1962 were selected (11). Essentially all delintering during this period was by use of saw linters. These yeidls were assumed to be those which could be experienced using the saw delintering process on some given quality of cottonseed, followed by solvent extraction of oil from meats. Estimates were prepared of deviations which could be expected (if any) from these yields by the alternative processes, if they were operated on the same kind of seed. The results of these estimates are shown in Table I.

Saw delintering employs machines called linters. ("Linter" is a term that is used to describe the machine that removes the short fibers from the seed. These short fibers are called "linters.") A linter usually has 176 12 in. diameter saws mounted on a shaft and arranged so that the saws

[1]Presented at the AOCS meeting in New Orleans, April 24, 1976.

TABLE I

Estimates of Comparative Yields of Products for Alternative Processes (lb/T)

Process	Oil	Meal[a]	Hull	Linters	Hull fiber	Total[b]
Saw delintering	332	930	455	181		1898
Abrasive delintering	332	930	455	181		1898
Hulling undelintered seed						
41% meal	329	921	572		76	1898
50% meal	329	745	824			1898
Acid delintering with sulfuric acid	332	930	561	102[c]		1925
Acid delintering with gaseous HCl	332	930	561	81[d]		1904
Extracting whole seed	318	910	670			1898

[a]When protein in meal is not specified, 41% meal is the basis.
[b]Difference between these figures and 2000 represents losses.
[c]Hydrolyzed linters plus ammonium sulfate
[d]Hydrolyzed linters plus ammonium chloride

TABLE II

Comparison of Gross Returns for Alternative Processes for Product Prices Shown ($/T)[a]

	Oil ($0.20/lb)	Meal ($120/T)	Hulls ($40/T)	Linters or hull fiber	Total gross return
Saw delintering	66.40	55.80	9.10	7.24[b]	138.54
Abrasive delintering	66.40	55.80	9.10	7.24[b]	138.54
Hulling undelintered seed					
41% meal	65.80	55.26	11.44	2.81[c]	135.31
50% meal	65.80	51.76[d]	16.48		134.04
Acid delintering with dilute sulfuric acid	66.40	55.80	11.22	4.08[c]	137.50
Acid delintering with gaseous HCl	66.40	55.80	11.22	2.84[c]	136.26
Extracting whole seed	63.60		68.80[g]		132.40

[a]Published prices in November 1975 in *Monthly Cotton Linters Review* and *Chemical Marketing Reporter.*
[b]Linters priced at $0.04/lb.
[c]Hull fiber priced at $0.037/lb for 68% cellulose.
[d]Meal priced at $138.95/T.
[e]Hydrolyzed linters plus ammonium sulfate priced at $0.04/lb.
[f]Hydrolyzed linters plus ammonium chloride priced at $0.035/lb.
[g]Combined value of meal plus hulls-meal.

rotate into a roll of seed. The short fibers on the seed are cut by the saws which feed the fibers into an air stream for conveying to cleaning and then baling. When seed are sufficiently delintered, they fall out of the linter.

Abrasive delintering employs machines which abrade the linters from the seed, producing delintered seed which are essentially no different from saw delintered seed. Abrasive linters are usually employed for second cut (second stage) delintering following first cut saw delintering. Yields and quality of oil, meal, and hulls are not different than from saw delintered seed. Linters yields and quality may differ slightly from saw delintered seed; however, in as much as inquiries in the industry uncovered no basis on which to estimate any important differences, the assumption was made for this study that there would be none. Prices of products and returns from sale of products would be the same as for saw delintering. Table II shows the prices employed and the comparative gross returns from all processes.

Hulling undelintered seed would affect yields of oil and meal because some kernels would be lost in the fuzzy hulls. These losses were estimated to be 1.5% of the weight of fuzzy hulls, and yields of oil and meal were reduced accordingly. This level of losses was estimated to be attainable in practice, on the basis of considerable work with this process at the Oilseed Products Division, using half size commercial machinery. Production of meats (kernels) low in hull content, and consequent production of high protein meal, was judged to be the only practical way to operate if seed were not delintered. All of this meal might be able to be sold as high protein meal, such as 50% protein, or some or all of it might be diluted with hull bran and sold at the standard 41% protein. Yields were calculated for both of these situations, and these are shown in Table I. Hull bran can be produced by defibrating hulls, which also produces hull fiber. Hull fiber is listed in Table I as a product. Quality and price of oil and 41% meal would be the same as standard (with saw delintering). Hull fiber would have a slightly lower value than standard linters. A price of $138.95 per ton was calculated for 50% protein meal, based on 41% protein meal at $120/T and hulls at $40.00/T. Fuzzy hulls might need some compacting treatment such as pelleting or baling. However, the value of hulls in Table II was based on loose, bulk hulls. The cost of pelleting hulls was estimated to be $3.20 per ton of hulls. This cost would be expected to be recovered through a higher selling price, and thus the adjusted return per ton of seed would be unchanged.

The use of dilute sulfuric acid for oil mill delintering was first proposed by Cotton Inc. engineers. It is essentially the same process as is now operating to produce planting seed. Cleaned seed are sprayed with dilute acid amounting to ca. 1 to 1½% of the weight of the seed. The water diluting the acid merely serves as a carrier for the acid to allow it to be distributed uniformly over the seed, and not enough water is used to wet the seed down to the hull. Then the water is dried off by hot gases, leaving concentrated acid on the seed. This embrittles the linters which are removed by abrasion as the seed are tumbled in the dryer. The linters are suspended in the drying gas stream and are removed from it. The degree of delintering can be controlled by the amount of acid used, the temperature of heating, and the time of abrasion after the water is removed.

A process for continuously delintering seed with gaseous HCl would be similar to the one using dilute sulfuric acid.

Yields of oil and meal from both acid processes were estimated to be the same as for saw delintering. Yields of hulls were based on leaving ca. 7% residual linters on hulls, which was judged to be sufficient removal to allow a satisfactory separation of kernels and hulls to be made. Yields of linters were based on the linters removed, plus estimates of ammonium sulfate or ammonium chloride produced by neutralizing the acid with ammonia. The qualities of oils and meals from seed samples treated with dilute sulfuric acid or with gaseous HCl were evaluated. Solvent extracted oils from treated seed were compared with oils from saw delintered control seed from the same lot on the basis of colors of refined oil and of refined-and-bleached oil (12). Meal qualities were judged largely by percentages of nitrogen soluble in 0.02 N NaOH (13). On the basis of limited data from only a few seed samples, oils and meals from both acid processes were judged to be equivalent in quality to these products from control seed.

The necessity for treating delintered seed with ammonia to neutralize residual acid was not determined. Sulfuric acid treated seed have low acidity ($<0.01\%$) after partial delintering. Either with or without ammonia treatment, hulls from both acid processes were assumed to be usable for cattle feeding. Hulls, as well as linters, containing ammonium sulfate or ammonium chloride, were judged to be suitable for feed on the basis of work by Crookshank et al. (14) involving these two chemicals as feed additives. Hulls were assumed to have the same value as standard hulls.

TABLE III

Estimates of Partial Production Costs for Processing Cottonseed in a 400 TPD Mill

Variable costs	Quantity	Units	Rate/unit ($)	Cost ($)	Cost/lb of linters($)[a]
		Saw Delintering			
Variable costs					
Operating labor (including handling baled linters)	0.46	man/hr	3.26	1.50	
Electric power					
Operating	58.	kwh	0.013	0.75	
Repairs					
Labor	0.06	man/hr	3.96	0.24	
Materials	0.60	$	1.0	0.60	
Bale coverings	181.	lb	0.00326	0.59	
Subtotal of variable costs				3.68	0.0203
Fixed Costs					
Property taxes	0.42	$	1.0	0.42	
Property insurance	0.30	$	1.0	0.30	
Amortization	1.00	$	1.0	1.00	
Subtotal of fixed costs				1.72	0.0095
Total of variable and fixed costs				5.40	0.0298
Costs for dust abatement					
Power	8	kwh	0.013	0.10	
Repairs				0.03	
Property taxes and insurance	1.98	$	0.04	0.08	
Amortization[b]	1.98	$	0.1213	0.24	
Subtotal for dust abatement				0.45	0.0025
Total of variable and fixed costs including dust abatement				5.85	0.0323
		Mixed Saw and Abrasive Delintering			
Variable costs					
Operating labor (including handling baled linters)	0.34	man/hr	3.26	1.11	
Electric power					
Operating	87	kwh	0.013	1.13	
Repairs					
Labor	0.08	man/hr	3.96	0.32	
Materials	0.11	$	1.0	0.11	
Bale coverings	181	lb	0.00326	0.59	
Subtotal of variable costs				3.31	0.0183
Fixed costs					
Charges on old machinery					
Taxes	0.21	$	1.0	0.21	
Insurance	0.15	$	1.0	1.15	
Amortization	0.50	$	1.0	0.50	
Charges on new machinery					
Taxes and insurance	5.16	$	0.04	0.21	
Amortization[b]	5.16	$	0.1213	0.63	
Charges on dust abatement					
Taxes and insurance	1.34	$	0.04	0.05	
Amortization[b]	1.34	$	0.1213	0.16	
Subtotal of fixed costs				1.91	0.0106
Total of variable and fixed costs				5.22	0.0289

[a]Cost per ton divided by 181 lb of linters per ton.
[b]Amortization in 14 years at 8% interest.

Linters from different processes were calculated to have different nitrogen contents, and therefore they were priced at $0.04 and $0.035/lb for sulfuric acid and HCl processed seed, respectively. These prices were somewhat less than the price of corn or milo with which they might compete at $0.05/lb.

The yield of oil from rolled whole seed was estimated to be 14 lb/T less than standard because of reduced retention time of solids in the extractor. Reduced time would be brought about by the ca. 65% increase in weight of solids and 270% increase in volume of solids as compared with rolled meats containing enough hulls to produce 41% protein meal. The solids after solvent extraction can be separated into meal and hulls, which, however, are somewhat different than meal and hulls from saw delintered seed. Rather than attempting to price these unconventional products, the combined value of meal and hulls was estimated to be the same as the value of meal and hulls from saw delintered seed.

Bench scale, batch type tests were performed to make an evaluation of the concept of delintering cottonseed using an enzyme cellulase. The enzyme used was *Trichoderma viride*. It was found that immersion of seed in a solution of this enzyme would indeed loosen the linters so they could be rubbed off the seed between the fingers. A wetting agent in the solution was necessary in order to achieve uniform action on the seed. Immersion time for effective linter removal was 120-150 min at 77 F (25 C). Shorter times did not loosen the fibers enough; longer times resulted in excessive softening of the hulls. Seed with damaged hulls became very soft during immersion. Because of the necessity for complete immersion of the seed for such a long time, incorporation of this means of delintering into an otherwise conventional cottonseed oil mill process did

TABLE IV

Estimates of Partial Production Costs for Hulling Undelintered Seed in a 400 TPD Mill

	Costs per ton of seed for			
	Quantity	Units	Rate/unit ($)	Cost ($)
41% Protein in Meal Produced				
Variable costs				
Labor defibrating, baling hull fiber	0.076	man/hr	3.26	0.25
Electric power				
Hulling-separating addition	3.1	kwh	0.013	0.04
Defibrating, dust control	16.6	kwh	0.013	0.22
Repairs, materials, and labor				
Hulling-separating addition	1.356	$	0.04	0.05
Defibrating, dust control	1.361	$	0.04	0.05
Bale coverings for hull fiber	76	lb	0.00326	0.25
Subtotal of variable costs				0.86
Fixed costs				
Charges on old machinery[a]				
Taxes	00.21	$	1.0	0.21
Insurance	0.15	$	1.0	0.15
Amortization	0.50	$	1.0	0.50
Charges on new machinery				
Taxes and insurance				
Hulling-separating	1.356	$	0.04	0.05
Defibrating, dust control	1.361	$	0.04	0.05
Amortization[b]				
Hulling-separating	1.356	$	0.1213	0.16
Defibrating, dust control	1.361	$	0.1213	0.17
Subtotal of fixed costs				1.29
Total of variable and fixed costs				2.15
50% Protein in Meal Produced				
Variable costs				
Electric power				
Hulling-separating	3.1	kwh	0.013	0.04
Repairs, labor, and materials				
Hulling-separating	1.356	$	0.04	0.05
Subtotal of variable costs				0.09
Fixed costs				
Charges on old machinery[a]				
Taxes	0.21	$	1.0	0.21
Insurance	0.15	$	1.0	0.15
Amortization	0.50	$	1.0	0.50
Charges on new machinery				
Taxes and insurance				
Hulling-separating	1.356	$	0.04	0.05
Defibrating, dust control	0.247	$	0.04	0.01
Amortization[b]				
Hulling-separating	1.356	$	0.1213	0.16
Defibrating, dust control	0.247	$	0.1213	0.03
Subtotal of fixed costs				1.11
Total of variable and fixed costs				1.20

[a]One-half of fixed costs on old machinery from saw delintering.
[b]Amortization in 14 years at 8% interest.

not appear to be feasible. Such a delintering process might be feasible in conjunction with an aqueous process for processing cottonseed similar to some which have been described (15).

ESTIMATED PARTIAL PRODUCTION COSTS

Processing costs for processes which might be substituted for saw delintering were called" partial production costs" because they covered only part of the total cost of processing seed into products. Partial production costs were estimated for all of the alternative processes including saw delintering. The estimates are shown in Tables III-V, which summarize the estimates in terms of quantities, units, rate/unit, and cost, for mills processing 400 tons of seed per day, operating 250 days per year. Investment costs were divided by 100,000 to give the quantity figures shown in the tables for "charges on new machinery." "Charges on old machinery" were one-half of the taxes, insurance, and amortization charges for saw delintering (Table III).

The table of partial production costs for extracting whole seed is not shown because this process was judged to be the least attractive alternative process. However, the total partial production cost for this process is shown in Table VI.

Estimated costs for saw and abrasive delintering were based largely on data supplied by industry sources. First cut delintering with saw linters was assumed to be retained with abrasive delintering. Costs for dilute sulfuric acid delintering were based on data supplied by Cotton, Inc. Costs for the other processes were estimated from the elements of the processes.

COMPARISONS OF ALTERNATIVE PROCESSES

The estimated comparative monetary returns from sale of products from the alternative processes were called

TABLE V

Estimates of Partial Production Costs for Delintering Seed with Acid in a 400 TPD Mill

		Per ton of seed		
	Quantity	Units	Rate/unit ($)	Cost ($)
Delintering with Dilute Sulfuric Acid				
Variable costs				
Operating labor	0.18	man/hr	3.26	0.59
Electric power				
Delintering seed	15.9	kwh	0.013	0.21
Pelleting linters	2.2	kwh	0.013	0.03
Repairs, labor, and materials	4.0	$	0.08	0.32
Sulfuric acid	21.5	lb	0.028	0.60
Anhydrous ammonia	7.	lb	0.15	1.05
Natural gas	0.27	Mft^3	1.50	0.41
Paper bags for pellets	1.02	cwt	0.30	0.31
Subtotal of variable costs				3.52
Fixed costs				
Charges on old machinery[a]				
Taxes	0.21	$	1.0	0.21
Insurance	0.15	$	1.0	0.15
Amortization	0.50	$	1.0	0.50
Charges on new machinery				
Taxes and insurance	4.0	$	0.04	0.16
Amortization[b]	4.0	$	0.149	0.60
Subtotal of fixed costs				1.62
Total of variable and fixed costs				5.14
Delintering with Gaseous HCl				
Variable costs				
Operating labor	0.18	man/hr	3.26	0.59
Electric power				
Delintering seed	15.9	kwh	0.013	0.21
Pelleting linters	2.0	kwh	0.013	0.03
Repairs, labor, and materials	4.0	$	0.08	0.32
Gaseous HCl	4	lb	0.30	1.20
Anhydrous ammonia	2	lb	0.15	0.30
Natural gas	0.18	Mft^3	1.50	0.27
Paper bags	0.81	cwt	0.30	0.24
Subtotal of variable costs				3.16
Fixed costs				
Charges on old machinery[a]				
Taxes	0.21	$	1.0	0.21
Insurance	0.15	$	1.0	0.15
Amortization	0.50	$	1.0	0.50
Charges on new machinery				
Taxes and insurance	4.0	$	0.04	0.16
Amortization[b]	4.0	$	0.149	0.60
Subtotal of fixed costs				1.62
Total of variable and fixed costs				4.78

[a]One-half of fixed costs on old machinery from saw delintering.
[b]Amortization in 10 years at 8% interest.

"gross returns," and they are shown in Table II. When the partial production cost is subtracted from the gross returns, the difference can be called "adjusted return." Comparison of adjusted returns per ton of seed is one way to compare alternative processes. This is done in Table VI, where the gross returns and the adjusted returns are shown for linters prices of $0.04/lb (weighted average of first cut and second cut linters). The comparison of adjusted returns was made for linters prices of $0.05 and $0.03/lb as well, to show how sensitive the adjusted returns are to changes in prices of linters. The adjusted returns shown are close enough together that changes in the magnitudes of some of the cost items (such as labor rates and electric power rates) may also change the relative relationships of the alternative processes. This means that anyone contemplating a conversion from saw delintering to an alternative process should prepare his own careful estimates of the comparative gross returns and partial production costs.

The data in Table VI show that saw delintering becomes comparatively less profitable as the price of linters sinks to the cost of production, which was estimated to be $0.03/lb (Table III). At this price, relative profitabilities were: hulling of undelintered seed-50% meal and 41% meal, sulfuric acid, abrasive, HCl, and saw.

The best alternative process is difficult to select merely on the basis of adjusted returns because the magnitude of the investment cost and income taxes are not adequately considered. "Discounted cash flow rate of return" (DCFRR) takes into consideration investment costs and the time value of money, as well as sales income, production costs, and income taxes (16). DCFRR is rate of return after income taxes have been paid. For evaluating a converison in this study, it could be applied only to a process which showed a greater adjusted return than the saw delintering process.

For calculation of DCFRR, the assumption was made that each conversion to another process was made before investment of the $198,000 in dust abatement facilities for saw delintering. Simplifying assumptions were: investments were made at one time; straight line depreciation was used on new investment, with zero salvage; annual sales and partial production costs were constant; income tax rate was

TABLE VI

Comparison of Gross Returns, Partial Production Costs, and Adjusted Returns at Linters Price of $0.04/lb Compared with Adjusted Returns for Linters Prices of $0.05 and $0.03/lb

Process	Total gross return ($)	Partial production cost ($)	Adjusted return for linters price of: $0.04/lb ($)	$0.05/lb ($)	$0.03/lb ($)
Saw delintering	138.54	5.85	132.69	134.50	130.88
Abrasive delintering	138.54	5.22	133.32	135.13	131.51
Hulling undelintered seed					
41% protein meal	135.31	2.15	133.16	133.92	132.40
50% protein meal	134.04	1.20	132.84	132.84	132.84
Sulfuric acid delintering	137.50	5.14	132.36	132.36	132.36
HCl acid delintering	136.26	4.78	131.48	131.48	131.48
Extracting whole seed	132.40	2.70	129.70	129.70	129.70

48%. Estimated investment costs for conversion were taken from Table III-V. They are shown along with DCFRR in Table VII.

No conversions appeared attractive at a linters price of $0.04/lb. However, hulling of undelintered seed and sulfuric acid delintering became attractive at a linters price of $0.03/lb.

Energy required to conduct a process is an especially important factor at the present time. Estimates of fossil fuel requirements for the alternative processes are presented in Table VIII. Estimates in terms of fossil fuel penalize processes with large electrical energy requirements; however, this seems to be the most meaningful comparison. The data in Table VIII show hulling of undelintered seed with production of 50% protein meal to have by far the lowest fuel requirement. The possibility exists that boiler flue gases could be utilized to displace some of the natural gas energy required by the acid delintering processes. If all of the natural gas energy were eliminated, the fossil fuel energy requirement would decreased by more than one-half.

Workroom dust and noise are considerations in selection of a process, although probably they are of secondary importance to economic factors. All of the proposed alternatives are judged to create less workroom dust in the delintering area; however, abrasive and acid delintered seed may create more dust in the hulling area. Sulfuric acid delintering is considered to be more desirable than HCl because of the lesser tendency for release of irritating and toxic gases to the atmosphere. Workroom noise should be less for alternative processes than for saw delintering, without engineering noise controls. Noise controls should be more easily applied to alternatives than to saw delintering.

All of the alternative processes, except abrasive delintering, produce products which are somewhat different from

TABLE VII

Estimated Investment Costs and Discounted Cash Flow Rates of Return (DCFRR) for Conversions from Saw Delintering to Alternative Processes

Alternative process	Investment ($)	DCFRR with linters price of $0.04/lb	$0.03/lb
Abrasive	650,000	6.7%	6.7%
Undelintered seed			
41% protein	271,700	5.0%	30.1%
50% protein	160,300	0	56.0%
Sulfuric acid	400,000	0	22.8%

TABLE VIII

Comparison of Estimated Gross Energy Requirements for Alternative Delintering Processes

Process	Energy form and equivalent fossil requirement (BTU per ton of seed)[a] Electric kwh	Electric Btu[b]	Stream Btu[c]	Natural gas Btu[d]	Acid and ammonia Btu[e]	Total Btu
Saw	66	792				792
Abrasive	90	1080				1080
Undelintered seed[f]						
41% protein	20	240				240
50% protein	3	36				36
Acid-sulfuric	18	216		270	142	628
Acid-Hcl	18	216		180	58	453
Whole seed[f]	8	96	406			502

[a]Multiply BTU figures shown by 1000 to give uncoded values.
[b]BUT includes estimated losses in generation and transmission, resulting in a converison factor of 12,000 BTU/kwh.
[c]Conversion factor was 1230 BTU/lb steam corresponding to 140 lb steam with 65% boiler and distribution efficiency.
[d]Conversion factor was 1000 BTU per cubic foot of gas.
[e]Conversion factors were 90 BTU, 4483 BTU, and 20,024 BTU per lb of sulfuric acid, anhydrous HCl, and anhydrous ammonia, respectively, combined electrical and fuel energy. These factors were calculated from data supplied by others (17,18).
[f]Power for pelleting hulls was not included.

conventional ones. This is not considered to be a disadvantage in the longer term, and in the case of hulling of undelintered seed, production of high protein meal may be an advantage in some areas because this meal can more readily be used for nonruminant feeds.

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