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THE ECONOMICS OF FORAGE HARVESTING IN ARIZONA

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by

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On many Arizona farms forage harvesting is a major operation. Investments in machinery for this task may climb to $10,000 or $15,000 on a single farm. Many Arizona feeders and dairymen lay out sums equal to this just to pay their custom harvesting bill.

There have arisen, in recent years, several new developments in forage harvesting. Some of these have been: green chopping, where the pasture is hauled to the cattle; dry chopping, where hay is chopped and handled entirely with machines, and various innovations in the method of ensiling crops.

Considerable uncertainty exists as to the relative costs of these different methods of harvesting forage. The fact that some forage is harvested green and has a very high water content makes an evaluation of yield and cost difficult. This is primarily due to the custom of valuing forage on an alfalfa hay basis.

This research project was undertaken to determine the costs of different harvesting methods. In conjunction with this, an attempt was made to describe the types of harvesting that exists in the state and their connection with various types of livestock production.

Methodology

In the early phases of the project it was hoped that a survey of a large number of operating farmers who were using the various harvesting methods could be accomplished. However, it was found that farmers in general did not keep accurate enough records to give even a general idea as to the actual costs, by item, of the various harvesting methods used.

As a consequence, the method used was the case study approach. Farmers who used the various methods and were willing to cooperate were asked to keep actual cost data on their particular operation. These were the operating costs only -- fuel, oil and grease, labor and repairs, wire, etc.

There were three farmers who kept green chop records, three who kept bailing records, two who kept dry chop records and two who kept ensilage records. These various records were then combined to give one set of figures for the operating costs and capacity per hour of the various machines and methods.

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From a survey of 19 farmers in the Salt River Valley, information concerning estimated life of machines, the various machines required, and other annual cost information was gathered.

A survey of dealers in the Phoenix area in October, 1955, provided data as to the cost of new machines at that time in that area.

A survey conducted early in 1956, with 50 dairymen and 32 cattle feeders replying, yielded information as to the relative importance of forage harvested by particular methods to each type of livestock production.

Objectives

The general objectives of this study are to:

1. Compare the costs of alternative methods of forage crop harvesting for various sizes of operations.

2. Compare the capital investment, labor, and machine requirements for alternative harvesting methods.

3. Analyze the connection between the way in which the forage crop is to be used (fed to dairy cows, steers, or sold) and the harvesting method or combination of methods used.

4. Establish guides to help individual farmers decide the most efficient method or methods of harvesting and using forage for their particular situation.

I. Method of Harvest by Type of Enterprise

Forage utilization is shown by enterprise for dairying and cattle feeding in Table 1. These data indicate that cattle feeders used relatively more baled hay (62 per cent of total forage fed) than did dairymen (only 44 per cent of total forage fed). On the other hand, green chop was a more popular type of forage with dairymen than with cattle feeders. It accounted for 22 per cent of total forage fed by dairymen compared to only 2 per cent of total forage fed by cattle feeders. Ensilage was more popular with both dairymen and cattle feeders than green chop, with cattle feeders showing the most respect for ensilage as a forage crop. This ensilage was primarily made from sorghum.

The main reason for the higher use of green chop by dairymen than by feeders is that green forage is an essential part of the milk producing ration. Since green chop is merely pasture in the feed bunk, this shows why more of it is used by dairymen than by cattle feeders. Cattle feeders expressed the view that green feed is too "washy" for a finishing ration for beef animals. Since the green feed is only handled once, a considerable amount of labor is believed to be saved and this accounts for less hay being fed by dairymen than by cattle feeders. This larger use of green feed by dairymen has also reduced the ensilage use by these same farmers.

Table 1. Forage Utilization by Dairymen and Feeders in the Salt River Valley, 1955.

Type of livestock	Number of replies	Hay			Green Chop			Ensilage		
		Number feeding hay	Tons of dry matter fed	Per cent of total	Number feeding green chop	Tons of dry matter fed	Per cent of total	Number feeding	Tons of dry matter fed	Per cent of total
Dairy cows	50	48	12,750	22	31	5,137	66	47	11,035	31
Beef cattle	32	32	45,934	78	12	2,618	34	30	25,072	69
Total	82	80	58,683	100	43	7,755	100	77	36,107	100

Source: Mail questionnaires to Arizona dairymen and cattle feeders. There were 383 schedules mailed and 82 returned representing a 21.4 per cent response

II. Investments Required

The minimum investment in machinery required to harvest forage crops varies from about $4,500 to $10,500 depending upon the methods used and whether power take-off or auxiliary-engine machines are used.

Table 2 shows a schedule of the machines required and the minimum investment in those machines for the particular method of harvest. It is quite evident that the investment is less where only one method of harvest is used than where methods of harvest are combined, such as baled hay and green chop or baled hay and ensilage. Of course, the farmer is able to reduce the amount invested by buying only the machine he uses most and hiring a custom operator for the other operations. The amounts in Table 2 are for new machines and could be reduced by purchasing used machines. Purchases of used forage harvesting machines is not extensive in Arizona. Most of these machines are worn out when traded in and do not constitute salable pieces of merchandise for further use. The farmer takes a considerable chance when he purchases a used hay baler or forage harvester.

There are no power take-off or twine balers listed in Table 2. According to census figures, in 1954 only 8 per cent of the hay baled in Arizona was tied with twine balers into rectangular bales. 1/ The reasons for this are evident when one examines the hay industry in Arizona. Much of the hay produced in Arizona is moved sometimes several times and for long distances. Twine-tied bales do not survive this movement in good shape. Many bales break and are wasted.

Power-take-off balers are not popular because of their smaller capacity than auxiliary-engine-powered machines. Before the introduction of the "live" power take-off, it was difficult to match tractor ground speed with the capacity of the baler. Probably the large majority of the power-take-off balers in the state are twine-tie balers.

The investment in tractors has not been included because most farmers will not purchase any additional tractors to accomplish the forage harvesting job. Therefore, in any decision as to investment, the tractor will not be a consideration since that investment has already been incurred.

It must be borne in mind that the amounts in Table 2 are new dealer list prices.

Table 3 shows representative dealers' list prices for each machine and the annual costs attached to them.

1/ Bureau of the Census, 1954 Census of Agriculture, Vol. 1, Part 30, U. S. Department of Commerce, Washington, 1956.

Table 2. Minimum Initial Investment Required in 1957 for Various Combinations of Harvesting Methods.

	Method	Equipment	1957 Investment[a]
1.	Baling	(a) 1 baler (aux. eng.), 1 mower, 1 rake, and 3 racks.[b]	$ 5,312
2.	Baling and green chopping	(a) 1 baler (aux.-eng.), 1 mower, 1 rake, 3 racks, 1 forage chopper, (PTO), and 1 self-unloading wagon	9,848
		(b) same as (a) except aux.-eng. chopper	10,658
3.	Custom baling and hauling; green chop program	(a) 1 forage chopper (PTO), 1 self-unloading wagon	4,536
		(b) same as (a) except aux.-eng. forage chopper	5,346
4.	Baling and silage program (could also be a green chop program)	(a) 1 baler (aux.-eng.), 1 mower, 1 rake, 1 forage chopper (PTO--1 row), 3 racks and 1 self-unloading wagon	9,848
		(b) same as (a) except aux.-eng. chopper	10,658
5.	Custom baling and hauling; silage program (could also be a green chop or chopped hay program)	(a) 1 forage chopper (1 row, PTO) with green cutter bar, and pickup attachments, 1 self-unloading wagon	5,560
		(b) same as (a) except aux.-eng. forage chopper	6,370
6.	Field chopping dry hay and ensilage program	(a) 1 forage chopper (1 row, PTO) with pickup and direct cut row attachment; 1 self-unloading wagon, 1 mower, and 1 rake	5,890
		(b) same as (a) except aux.-eng. forage chopper	6,700

a/ These are new prices based on a survey of dealers in Phoenix, Arizona. No tractors are included.

b/ Racks are flat bed, 4-wheel trailers.

Table 3. Forage Harvesting Equipment - Representative Prices and Annual Fixed Costs.

Machine	Price	Annual Costs				
		Est.life	Deprec.[a]	Int.	Ins.	Taxes	Total
Mower	$ 389	7	$ 49	$ 12	$ 3	$ 5	$ 69.00
Side-del. rake	567	7	73	17	3	8	101.00
Baler(auto-wire aux.-eng.)	3,456	6	519	104	16	49	688.00
Forage harvester[b] (aux.-eng.)	2,970	6	443	89	15	43	590.00
(PTO)	2,160	6	324	65	11	32	432.00
Grass cutter bar attachment	630	6	94	19	3	8	124.00
Pickup attachment	400	6	60	12	3	5	80.00
Self-unloading wagon	2,376	5	437	71	11	32	551.00
Rack wagons (flat bed,4-wheel)	300	18	15	9	2.50	5	31.50

a/ Straight line method with 10 per cent salvage value.

b/ With row crop head.

Costs General

The costs of farm machinery operation fall into two broad types. The first is the variable or operating costs. For each method these costs are listed and include operator labor, maintenance labor, fuel, oil and grease, and repairs. The amounts for each method will be discussed in the following section. These costs vary with use. More gasoline is used for two tons of baling than for one. Operating cost per ton or per acre is a set amount, but the total operating cost will be twice as much for 40 acres of hay as for 20 acres.

The second type of costs is the fixed costs. They are costs which do not change with output and include depreciation, interest on investment, insurance, and taxes. As an example, the depreciation on a tractor for a year is approximately the same whether the tractor is used two weeks or two months. Therefore, fixed costs per unit of output are less the more the machine is used. Cost advantages come through the spreading of these fixed costs over more units of work.

The combination of operating and fixed costs then represents the total cost of operation. In this study they represent all costs except the fixed cost of tractor operation. These tractor costs were excluded because in most instances they will be present whether forage is harvested or not.

Cost by Method

Baling: When hay is baled, naturally it must first be mowed and raked. This becomes part of the cost of baling hay. Table 4 shows costs of mowing hay by the acre and by the ton. These costs are set up first with labor figured at $1 per hour and then alternatively at 75 cents per hour. This change in labor rates reduces the cost 9 cents per acre or 7 cents per ton for the mowing operation.

The cost of raking hay with a side-delivery rake is shown in Table 5. These costs are figured in the same manner as those for mowing (see Table 4). When labor rates of $1 per hour and 75 cents per hour were used there was a difference of 9 cents per acre or 7 cents per ton in the total cost of raking. In both the mowing and raking, a rate of three acres per hour is used. This may be high for some farmers and low for others. However, it is a realistic rate, even though it may not represent the rate common to every farmer.

Table 4. Cost for Mowing Hay in Relation to Tonnage Harvested Annually.

Inputs	Cost per acre				Cost per ton			
	Tonnage handled annually				Tonnage harvested annually			
	100	250	500	750	100	250	500	750
Operating Costs								
Labor	$ .34	$ .34	$ .34	$ .34	$ .27	$ .27	$ .27	$ .27
Maintenance labor	.04	.04	.04	.04	.03	.03	.03	.03
Fuel	.10	.10	.10	.10	.08	.08	.08	.08
Grease & oil	.01	.01	.01	.01	.01	.01	.01	.01
Repairs	.08	.08	.08	.08	.06	.06	.06	.06
Total oper. costs	0.57	0.57	0.57	0.57	0.45	0.45	0.45	0.45
Fixed Mower Costs								
Depreciation	.63	.25	.14	.11	.50	.20	.10	.07
Interest	.15	.06	.03	.03	.13	.05	.02	.02
Insurance	.03	.01	.01	.01	.03	.01	.01	.01
Taxes	.05	.02	.02	.02	.05	.02	.01	.01
Total fixed costs	0.86	0.34	0.20	0.17	0.71	0.28	0.14	0.11
Total Costs (Labor $1 per hr.)	1.43	0.91	0.77	0.74	1.16	0.73	0.59	0.56
Total Costs (Labor 75¢ per hr.)	1.34	0.82	0.68	0.65	1.03	0.66	0.52	0.49

Source: 1956 Cost records of 10 cooperating Arizona farmers.

Table 5. Cost of Raking Hay in Relation to Tonnage Harvested Annually.

Inputs	Cost per acre				Cost per ton			
	Tonnage harvested annually							
	100	250	500	750	100	250	500	750
Operating Costs								
Labor	$ .34	$ .34	$ .34	$ .34	$ .27	$ .27	$ .27	$ .27
Maintenance labor	.04	.04	.04	.04	.02	.02	.02	.02
Fuel	.10	.10	.10	.10	.08	.08	.08	.08
Grease & oil	.01	.01	.01	.01	.01	.01	.01	.01
Repairs	.05	.05	.05	.05	.04	.04	.04	.04
Total opera. costs	0.54	0.54	0.54	0.54	0.42	0.42	0.42	0.42
Fixed rake costs								
Depreciation	.93	.37	.19	.13	.72	.29	.15	.10
Interest	.23	.09	.04	.03	.18	.07	.03	.02
Insurance	.03	.01	.01	.01	.03	.01	.01	.01
Taxes	.10	.04	.02	.01	.08	.03	.02	.01
Total fixed costs	1.29	0.51	0.26	0.18	1.01	0.40	0.21	0.14
Total Costs (Labor $1 per hr.)	1.83	1.05	0.80	0.72	1.43	0.82	0.63	0.56
Total Costs (Labor 75¢ per hr.)	1.74	0.96	0.71	0.63	1.36	0.75	0.56	0.49

Source: 1956 Cost records of 10 cooperating Arizona farmers.

The cost of operating a baler is shown in Table 6. These costs are arranged similar to mowing and raking costs and include an extra operating cost item of wire. When labor rates of $1 per hour and 75 cents per hour are applied to the labor hours used per ton, the costs are differentiated by 20 cents per ton in favor of the lower labor rate.

These costs are representative for an automatic wire-tie baler with an auxiliary engine. Included in labor cost, in addition to the operator's wages, are the wages of a man to ride a trailer or sled. This man stacks the bales in piles of from 20 to 30 bales for easier loading to wagons or trucks and delivery to stack or roadside.

Wire was figured at $10.67 per roll and estimated to tie 11 tons of hay per roll, thus the resulting wire costs of 97 cents per ton in Table 6.

Table 6. Cost Per Ton for Baling Hay (Auxiliary-Engine -- Automatic Wire-Tie) in Relation to Tonnage Harvested Annually.

Inputs	Tonnage Harvested Annually					
	250	500	750	1000	1200	1500
Operating Costs						
Labor	$ .80	$ .80	$ .80	$ .80	$ .80	$ .80
Maintenance labor	.02	.02	.02	.02	.02	.02
Fuel	.26	.26	.26	.26	.26	.26
Grease & oil	.03	.03	.03	.03	.03	.03
Repairs	.31	.31	.31	.31	.31	.31
Wire	.97	.97	.97	.97	.97	.97
Total operating costs	2.39	2.39	2.39	2.39	2.39	2.39
Fixed Baler Costs						
Depreciation	2.07	1.03	.69	.52	.43	.35
Interest	.41	.21	.13	.10	.09	.07
Insurance	.06	.03	.02	.02	.01	.01
Taxes	.18	.09	.06	.05	.04	.03
Total fixed costs	2.72	1.36	.90	.69	.57	.46
Total baling costs	5.11	3.75	3.29	3.08	2.96	2.85
Hauling (Custom)	1.75	1.75	1.75	1.75	1.75	1.75
Total cost baling & hauling (labor $1 per hr.)	6.86	5.50	5.04	4.83	4.71	4.60
Total cost baling & hauling (labor 75¢ per hr.)	6.66	5.30	4.84	4.63	4.51	4.40

Source: 1956 Cost records of 10 cooperating Arizona farmers.

It was impossible to obtain accurate data on the cost of hauling and stacking the hay since many growers hire this job done by a custom firm. Therefore, the custom rate of $1.75 per ton was charged for hauling and stacking.

Green Chopping: In Table 7 are the costs associated with the green chop method. This table contains data for both power take-off and auxiliary-engine powered harvesters. The tonnages shown here are wet weight.

Table 7. Cost Per Ton for Green Chopping (Chopping, Hauling and Feeding) in Relation to Tonnage Harvested Annually.

Inputs	Tonnage Harvested Annually											
	500		750		1000		1250		1500		2000	
	PTO	Aux.eng.	PTO	Aux.eng.	PTO	Aux.eng.	PTO	Aux.eng.	PTO	Aux.eng.	PTO	Aux.eng.
	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.
Operating Costs												
Labor	.63	.58	.63	.58	.63	.58	.63	.58	.63	.58	.63	.58
Maintenance labor	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12
Fuel	.28	.30	.28	.30	.28	.30	.28	.30	.28	.30	.28	.30
Grease & oil	.02	.03	.02	.03	.02	.03	.02	.03	.02	.03	.02	.03
Repairs to chopper	.11	.12	.11	.12	.11	.12	.11	.12	.11	.12	.11	.12
Repairs to wagon	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
Total oper. costs	1.22	1.21	1.22	1.21	1.22	1.21	1.22	1.21	1.22	1.21	1.22	1.21
Fixed Chopper Costs												
Depreciation	.65	.88	.43	.59	.32	.44	.26	.35	.22	.29	.16	.22
Interest	.13	.18	.09	.12	.07	.09	.05	.07	.04	.06	.03	.04
Insurance	.02	.03	.01	.02	.01	.01	.01	.01	.01	.01	.01	.01
Taxes	.06	.08	.04	.05	.03	.04	.02	.03	.02	.03	.01	.02
Wagon depreciation	.87	.87	.58	.58	.44	.44	.35	.35	.29	.29	.22	.22
Interest	.15	.15	.10	.10	.07	.07	.06	.06	.05	.05	.04	.04
Insurance	.02	.02	.02	.02	.01	.01	.01	.01	.01	.01	.01	.01
Taxes	.06	.06	.04	.04	.03	.03	.03	.03	.02	.02	.02	.02
Total fixed costs	1.96	2.27	1.31	1.52	0.98	1.13	0.79	0.91	0.66	0.76	0.50	0.58
Total Cost (labor $1 per hr.)	3.18	3.48	2.53	2.73	2.20	2.34	2.01	2.12	1.88	1.97	1.72	1.79
Total Cost (labor 75¢ per hr.)	2.99	3.31	2.34	2.56	2.01	2.17	1.82	1.95	1.69	1.80	1.53	1.62

Source: 1956 Cost records of 10 cooperating Arizona farmers.

The operating costs of an auxiliary-engine machine are $1.21 per ton or one cent less than the cost of the power take-off machine. This is the result of larger capacity of the engine-powered machine which reduces labor charges per unit of output. Total cost of operating the machines shows the auxiliary-engine machine is more expensive to operate than the power take-off due to higher fixed costs. If a large enough tonnage is harvested the engine-powered machine will be less expensive as the fixed costs are spread over more units of output.

Where the two labor rates are used, it is found that a reduction in labor rate from $1 per hour to 75 cents reduces the total cost of the power take-off machine 19 cents per ton and the cost of the auxiliary-engine machine 17 cents per ton. This illustrates an important point, that where large amounts of labor are used there are greater savings to be made by reducing the labor rate.

In order to feed green feed efficiently, the grower must have some sort of self-unloading wagon. Operating and annual costs of one wagon are included in the costs of green chopping. Some farmers may have more than one wagon, in which case their costs would be higher than those listed here.

Row Ensilage: Table 8 shows the cost of harvesting row ensilage. The term "row ensilage" is used instead of grass or pasture ensilage and is meant to include primarily sorghum and corn crops. All the costs are included from cutting through filling the trench with the exception, of course, of fixed tractor costs.

The main difference in the factors determining ensilage costs from those used in green chop are the greater capacity per day in ensilage harvest and the use generally of a less expensive set of wagons. Ordinarily cotton trailers are used in hauling ensilage. These are less expensive to operate than a self-unloading wagon. The same basic harvesting machine is used as in green chop with the addition of a row attachment.

The cost of operating both power take-off and auxiliary-engine powered machines is shown in the table. Again the operating costs of the engine-powered machine are less, due to greater capacity and, therefore, lower labor charges.

When the two labor rates of $1 per hour and 75 cents per hour were used, the power take-off machine costs were reduced by 18 cents per ton, while the auxiliary-engine machine costs were reduced by only 15 cents per ton. This again shows that if labor is plentiful and cheap it is economical to substitute labor for machinery. In this table, if the labor rate was increased to more than $1 per hour, the difference in cost per ton between the power take-off and auxiliary-engine machines would narrow due to the greater amount of labor used with power take-off machines.

Table 8. Cost Per Ton for Harvesting Row-Ensilage in Relation to Tonnage Harvested Annually.

Inputs	Tonnage Harvested Annually											
	500		750		1000		1500		2000		3000	
	PTO	Aux.eng.	PTO	Aux.eng.	PTO	Aux.eng.	PTO	Aux.eng.	PTO	Aux.eng.	PTO	Aux.eng.
	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.	dol.
Operating Costs												
Labor	.59	.50	.59	.50	.59	.50	.59	.50	.59	.50	.59	.50
Maintenance labor	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12
Fuel	.14	.15	.14	.15	.14	.15	.14	.15	.14	.15	.14	.15
Grease & oil	.02	.03	.02	.03	.02	.03	.02	.03	.02	.03	.02	.03
Repairs to chopper	.11	.12	.11	.12	.11	.12	.11	.12	.11	.12	.11	.12
Repairs to wagons	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
Total oper. costs	1.04	0.98	1.04	0.98	1.04	0.98	1.04	0.98	1.04	0.98	1.04	0.98
Fixed Chopper Costs												
Depreciation	.65	.88	.43	.59	.32	.44	.22	.29	.16	.22	.11	.15
Interest	.13	.18	.09	.12	.07	.09	.04	.06	.03	.04	.02	.03
Insurance	.02	.03	.01	.02	.01	.01	.01	.01	.01	.01	.01	.01
Taxes	.06	.08	.04	.05	.03	.04	.02	.03	.01	.02	.01	.01
Wagon depreciation	.08	.08	.06	.06	.04	.04	.03	.03	.02	.02	.02	.02
Interest	.06	.06	.04	.04	.03	.03	.02	.02	.02	.02	.01	.01
Insurance	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
Taxes	.03	.03	.02	.02	.01	.01	.01	.01	.01	.01	.01	.01
Total fixed costs	1.04	1.35	0.70	0.91	0.52	0.67	0.36	0.46	0.27	0.35	0.20	0.25
Total Costs (labor $1 per hr.)	2.08	2.33	1.74	1.89	1.56	1.65	1.40	1.44	1.31	1.33	1.24	1.23
Total Costs (labor 75¢ per hr.)	1.90	2.18	1.56	1.74	1.38	1.50	1.22	1.29	1.13	1.18	1.06	1.08

Source: 1956 Cost records of 10 cooperating Arizona farmers.

Dry Chopping Hay: The cost of dry chopping hay is shown in Table 9. Costs for both power take-off and auxiliary-engine machines are figured. The machine is a forage harvester with a pick-up attachment. The operating costs are greater for the power take-off machine because it has smaller capacity and, therefore, requires a higher amount of labor. Certain items such as fuel and repairs are higher for auxiliary-engine machines because of the extra engine and the more complicated drive machinery associated with the auxiliary-engine.

When 750 tons are harvested annually and the labor rate is $1 per hour, the auxiliary-engine machine is the most economical method of harvest. However, when a labor rate of 75 cents per hour is used, the power take-off machine is the cheaper because of the reduction in rate being applied to more hours of labor for the power take-off machine. The reduction in the hourly labor rate from $1 to 75 cents caused a reduction of 67 cents per ton in the cost of the power take-off harvester while the auxiliary-engine costs were reduced by only 58 cents per ton.

It should be remembered that these costs in Table 9 cover only chopping, hauling and stacking and do not include mowing and raking. These costs must be added to the costs in Table 9 to get the cost of the entire operation, since the hay is mowed and windrowed as though it were being prepared for a baler.

This chopping has been tried by some farmers in the Salt River Valley when the hay has moisture content of approximately 30 per cent and then it is dried in the stack by means of forced air and sometimes heat. However, the feasibility of this method has not yet been determined. It requires additional costs, supposedly to be offset by a higher quality hay.

The cost advantage of this dry chopping method over baled hay will be discussed in a later section.

Ownership of Machines

Mow--Rake: Figure 1 shows in graphic form the separate and combined costs of mowing and raking hay with a 7-foot power mower and tractor-drawn side delivery rake. The graph shows the data from Tables 4 and 5. The dark curved lines are total cost lines for each operation and the top line represents the combined cost of both operations when read on the left axis.

The straight line labeled "Custom Rate" shows the common custom rate for that operation. If a farmer has an annual tonnage equal to or greater than the tonnage where the custom rate line intersects the total cost line he can afford to own the machine otherwise he would be ahead to hire his work done. In this case about 125 tons justifies the ownership of a mower and a rake.

Table 9. Cost Per Ton for Dry Chopping Alfalfa Hay in Relation to Tonnage Harvested Annually. a/

Inputs	Tonnage Harvested Annually					
	250		500		750	
	PTO	Aux.-eng.	PTO	Aux.-eng.	PTO	Aux.-eng.
	dol.	dol.	dol.	dol.	dol.	dol.
Operating Costs						
Maintenance labor	.11	.12	.11	.12	.11	.12
Labor	2.56	2.21	2.56	2.21	2.56	2.21
Fuel	.30	.38	.30	.38	.30	.38
Grease & oil	.06	.06	.06	.06	.06	.06
Repairs to chopper	.12	.14	.12	.14	.12	.14
Repairs to wagons	.06	.06	.06	.06	.06	.06
Total oper. costs	3.21	2.95	3.21	2.95	3.21	2.95
Fixed Chopper Costs						
Depreciation	1.30	1.77	.65	.89	.43	.59
Interest	.26	.36	.13	.18	.09	.11
Insurance	.04	.06	.02	.03	.01	.02
Taxes	.13	.17	.06	.09	.04	.06
Wagon depreciation	.06	.06	.03	.03	.02	.02
Interest	.04	.04	.02	.02	.02	.02
Insurance	.01	.01	.01	.01	.01	.01
Taxes	.02	.02	.01	.01	.01	.01
Total fixed costs	1.86	2.49	0.93	1.26	0.63	0.84
Total Cost (labor $1 per hr.)	5.07	5.44	4.14	4.21	3.84	3.79
Total Cost (labor 75¢ per hr.)	4.40	4.86	3.47	3.63	3.17	3.21

Source: 1956 Cost records of 10 cooperating Arizona farmers.

a/ Includes all costs except annual fixed costs for tractors involved and covers chopping, hauling and stacking, does not include costs for mowing and raking.

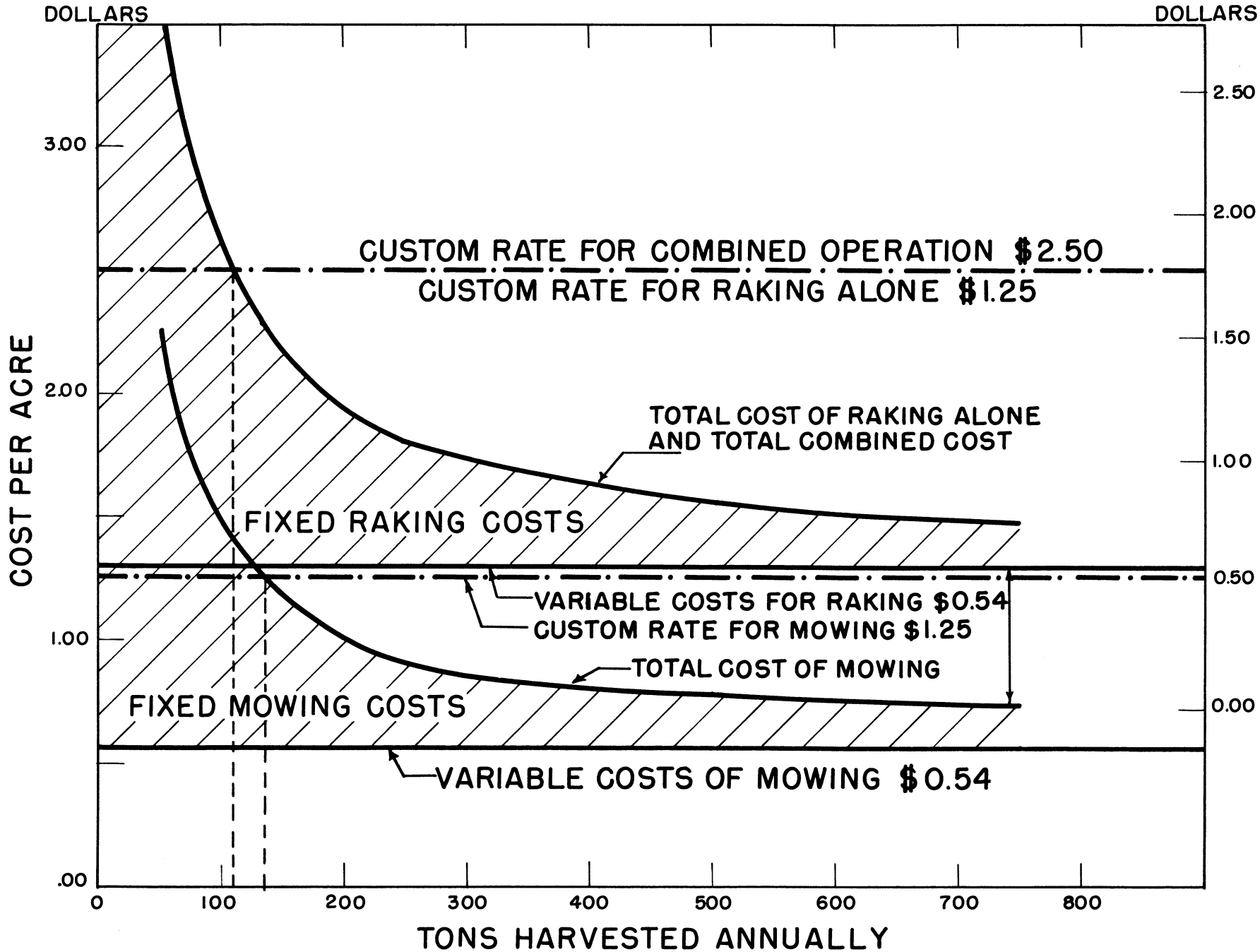

FIGURE 1.- MOWING AND RAKING HAY. COST PER ACRE, CENTRAL ARIZONA 1957.

Hay Baler: Figure 2 gives the details of the cost of operating a hay baler which are associated with the size of operation. The lower unhatched part of the graph represents the variable or direct costs of $2.39 per ton and this is the same regardless of the volume harvested. The cross hatched section of the graph represents the fixed or indirect costs and these diminish per ton as the tonnage harvested increases. The addition of the variable and fixed costs together gives the total cost per ton which is represented by the dark curved line and this decreases as the tonnage harvested increases. As was shown for mowers and rakes a custom rate line of $4.50 per ton is drawn in. This intersects the total cost line at about 325 tons annual harvest. Any grower who has a tonnage equivalent to or larger than 325 tons can justify the ownership of a baler of the type covered in this study. For tonnage of less than 325 tons, the farmer would be ahead to hire a custom operator to do his baling.

Row Ensilage: The cost of harvesting row-ensilage (sorghum and corn) is shown in Figure 3 for both power take-off and auxiliary-engine powered machines. This graph shows the data from Table 8. The variable or operating costs are the unhatched lower portion and are $1.04 per ton for the power take-off machine. This is the result of slightly more labor being used with a power take-off machine.

The total costs then are shown by the heavy curved lines and show that as the scale increases the cost of the two machines come closer together. This is caused by the spreading of the higher annual cost of auxiliary-engine machines over more tons of output.

The most common custom rate reported was $2.25 per ton for chopping, hauling and packing. The line entitled custom rate shows the relationship of the custom rate to the cost of operating a machine on a farm. For auxiliary-engine powered machines the custom rate line intersects the total cost line at about 540 tons and for the power take-off it intersects at about 415 tons. These tonnages indicate the points where ownership of a forage harvester for ensilage purposes only is justified. At tonnages less than these the farmer should either purchase a smaller machine or hire the harvesting done by a custom operator.

Comparison of Costs by Methods

The only way to compare the costs of various methods is to put the crops on some common denominator basis. Here total digestible nutrients (TDN) has been used as the common denominator.

Table 10 and Figure 4 show the relationship of the various methods on a cost per hundredweight of TDN basis. The three scales of production have been used to show the influence of scale on the cost of the operation.

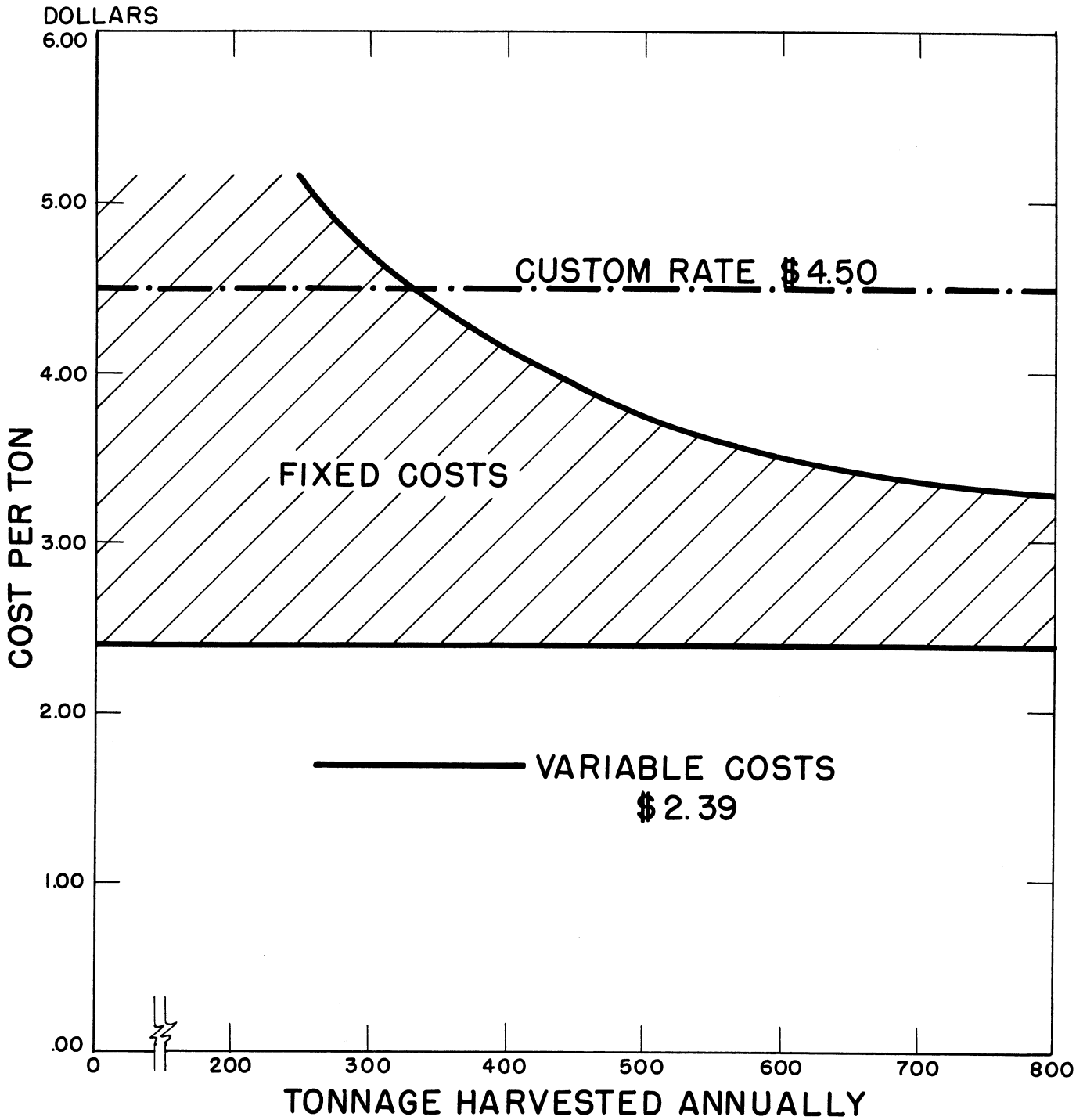

FIGURE 2.- BALING HAY. COST PER TON, CENTRAL ARIZONA 1957.

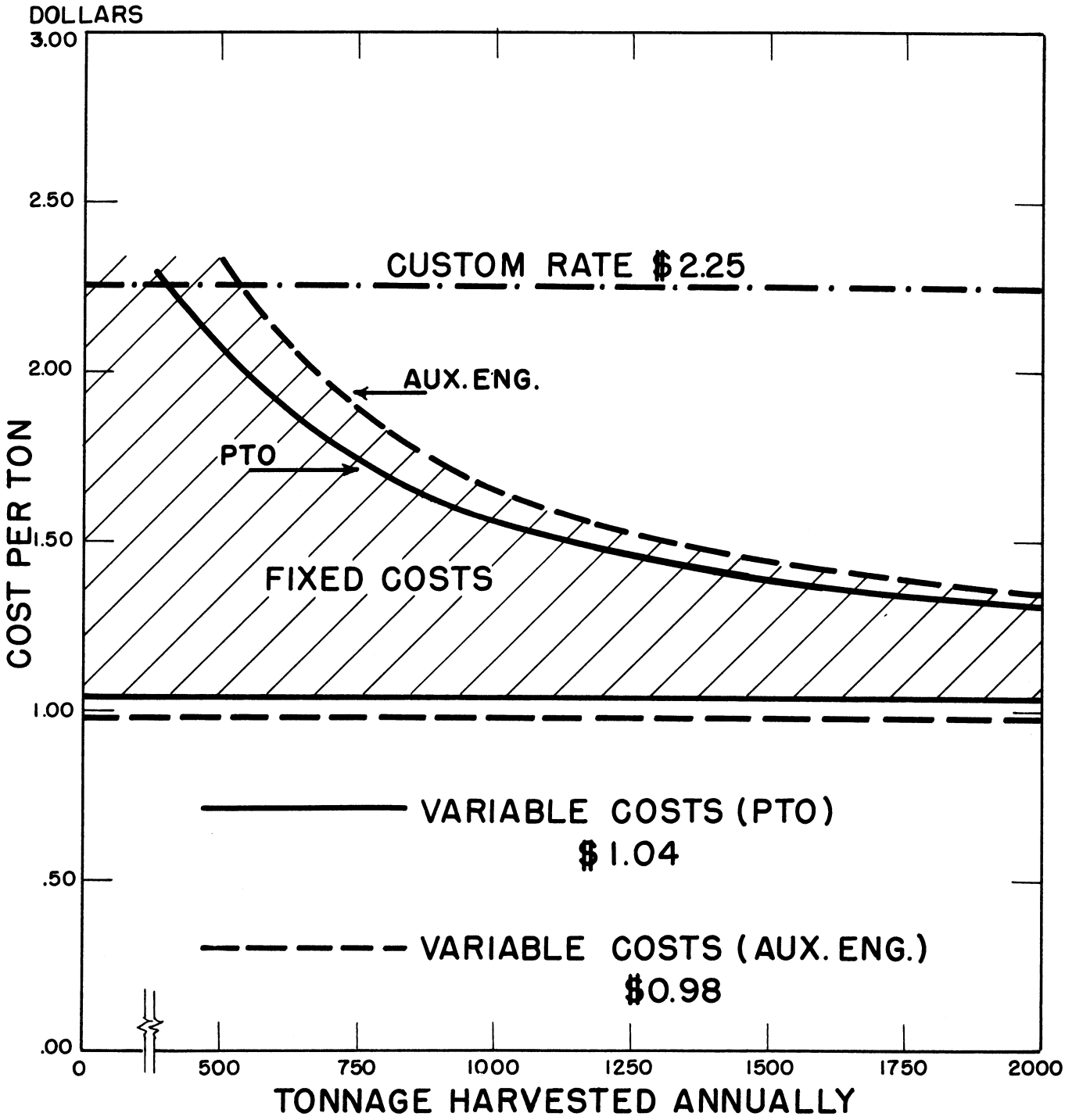

FIGURE 3.- ROW- ENSILAGE. COST PER TON, CENTRAL ARIZONA 1957.

Table 10. Harvest Cost Per Hundredweight of Total Digestible Nutrients.

Method	Power	Hay Equivalent in Tons Harvested Annually [a]		
		250 Tons	500 Tons	750 Tons
Dry chopping [b]	PTO	$ .64	$ .53	$ .49
Dry chopping	Aux.-eng.	.68	.54	.49
Baling [b]	Aux.-eng.	.82	.67	.63
Green chopping	PTO	.82	.61	----
Green chopping	Aux.-eng.	.87	.64	----
Ensilage	PTO	.52	.41	----
Ensilage	Aux.-eng.	.57	.42	----
Average		$ .70	$ .55	$ .53

[a] TDN in alfalfa hay divided by TDN in alfalfa green chop and grain sorghum ensilage. To obtain actual tonnages of green chop and ensilage multiply by 3.4 and 2.8 respectively.

[b] Mowing and raking costs included for appropriate scale.

The most expensive method here is green chop at a scale of 250 tons of hay equivalent annually or about 850 tons of actual green chop. With an auxiliary-engine machine the cost is 87 cents per hundredweight of TDN for this scale of operation. Unless the farmer can expand his scale of green chopping alfalfa he would be ahead to use a baler or to chop the hay dry and possibly use some ensilage for succulence in the ration. At larger scales of operation, however, green chopping would compare favorably with baling and possibly with dry chopping if any extra value can be attached to green chop for its quality.

For a beef feeder who prefers hay, if he can arrange his operation to use chopped hay and finds that the animals will eat it readily, chopping is the most economical method of handling hay. Of course, if the feeder must buy hay or transport it long distances, then baling is the only practical alternative he has.

It is not possible to say what is best for every farm, feedlot or dairy. The farmer must use the information given here and make a decision as to which gives the best method or combination of methods for his particular situation. Certainly there are farms where one method is the most economical and gives the best results. However, others must have a combination of methods to maximize income and production from the business.

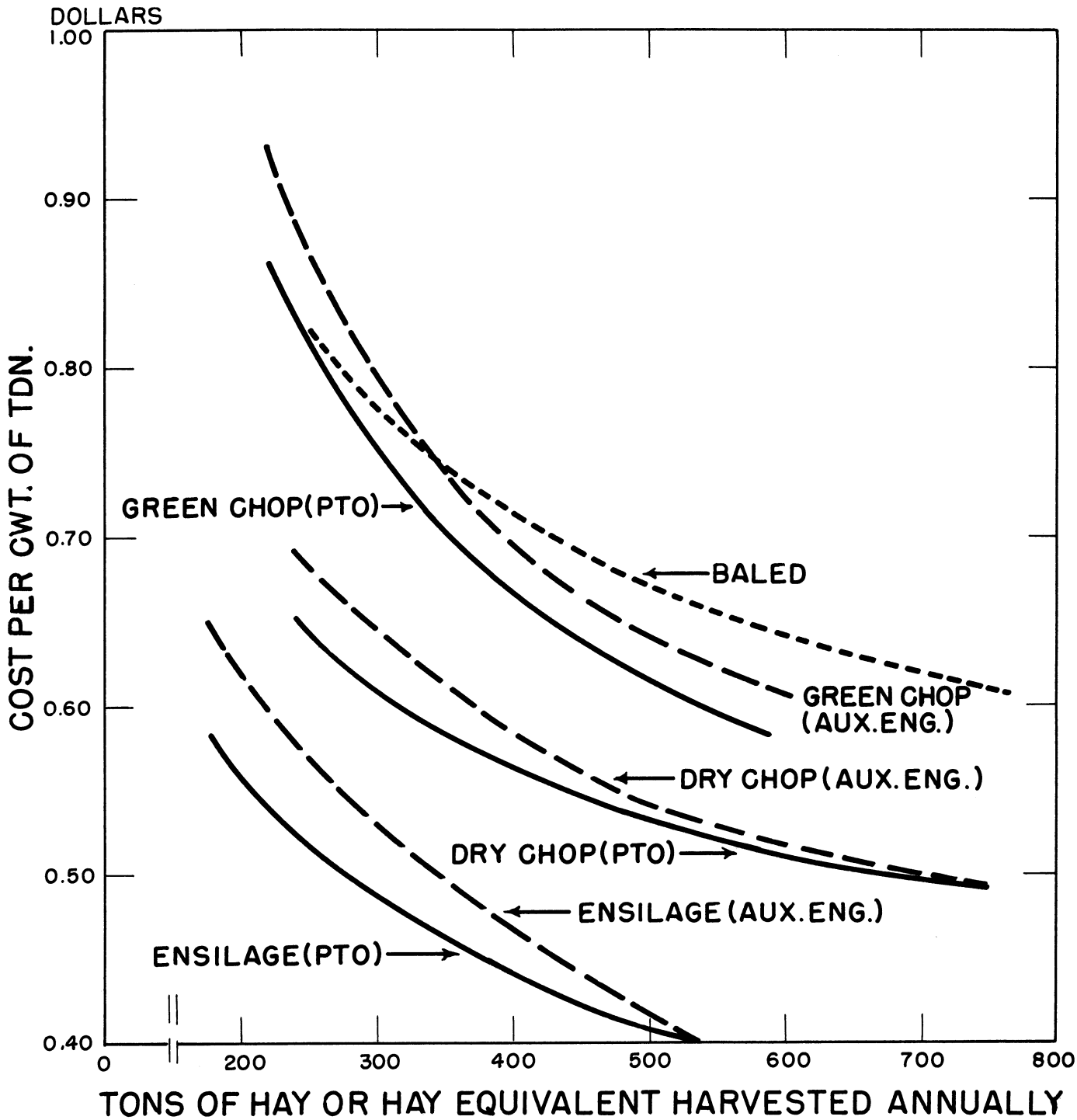

FIGURE 4.-HARVESTING METHODS. COST PER CWT. TDN, CENTRAL ARIZONA 1957.

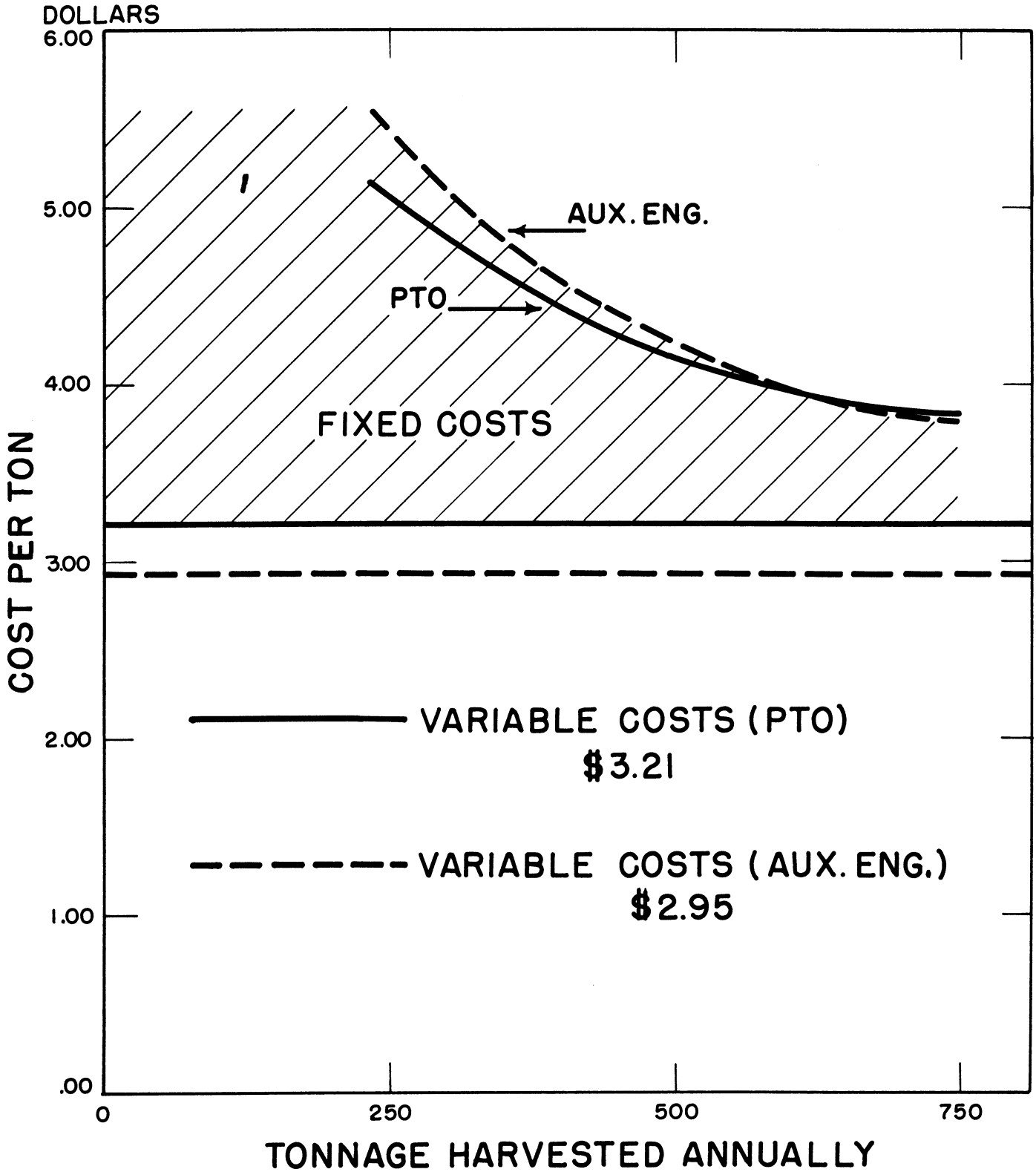

FIGURE 5.- DRY CHOPPING HAY. COST PER TON, CENTRAL ARIZONA 1957.

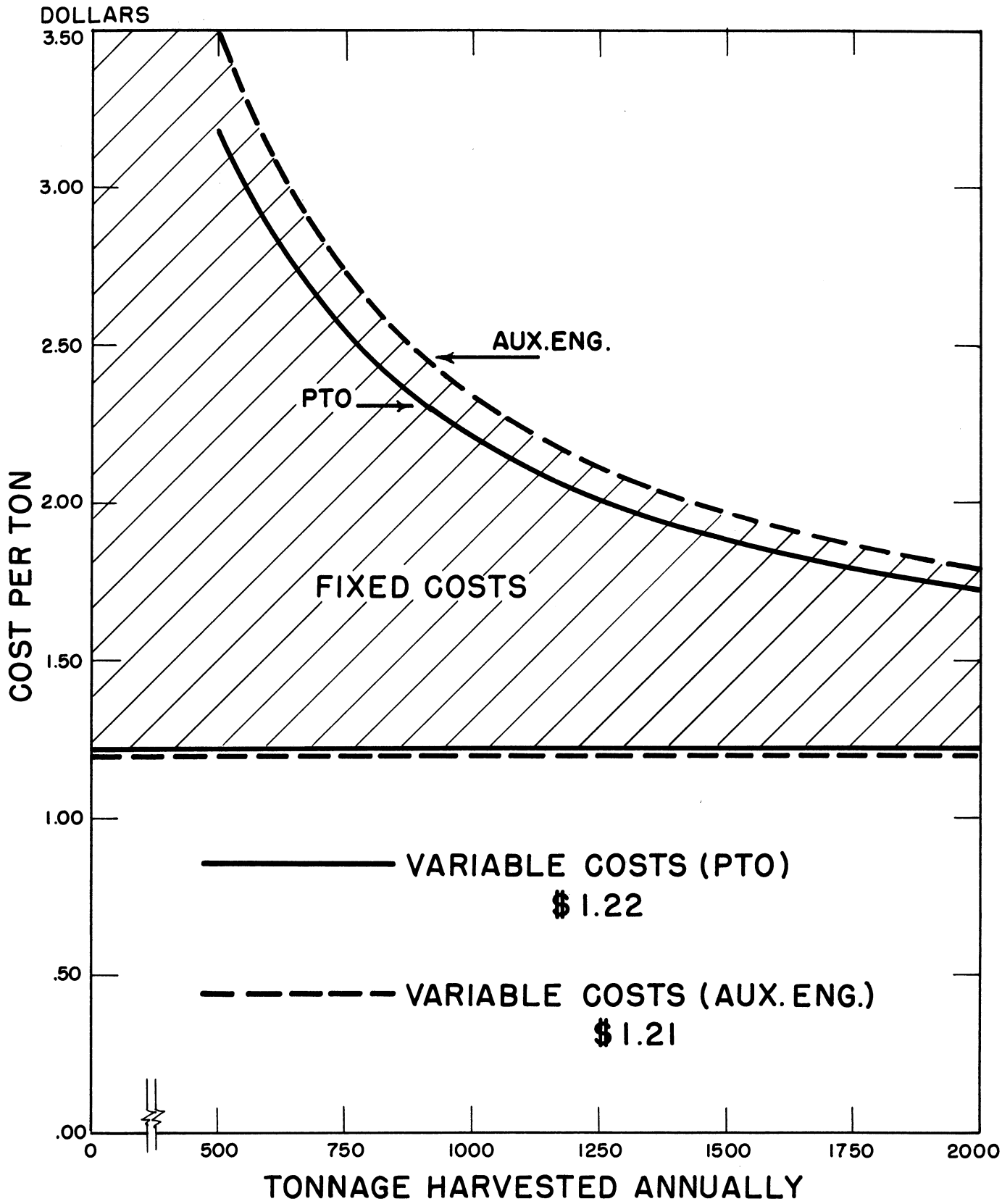

FIGURE 6.–GREEN CHOPPING HAY. COST PER TON, CENTRAL ARIZONA 1957.