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COST COMPARISON BETWEEN CLEAR LIQUIDS AND SUSPENSION FERTILIZERS

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Many fluid fertilizer manufacturers have indicated interest in suspension fertilizers as a way to reduce plant-nutrient costs to the farmer. Potentially the cost of mixing, transporting, and applying a given amount of plant nutrients should be less as suspensions than as clear liquids since suspensions can be made in higher-analysis grades. Questions frequently asked are: "How much can be saved by producing suspensions?" "Is the saving sufficient to justify changing mixing and application equipment so that the suspensions can be mixed and applied easily?"

This is an attempt to answer such questions.

The most popular way of making clear liquids is by cold-mixing a base solution, 10-34-0 or 11-37-0, with urea-ammonium nitrate solution, potash, and water. Surveys indicate that more than 65 percent of the liquid mixed fertilizers in this country are produced by cold-mixing. Low plant investment, ease of production and handling, and economy of operation are major reasons for the popularity of the cold-mixing process.

The conventional cold-mix plant for producing clear liquids can easily be altered to produce suspension mixtures. It is necessary only to provide for more intensive mixing in the mix tank, for the screening of potash, and for agitation of suspensions that are stored.

Figure 1 shows a typical cold-mix plant which produces suspension mixtures from TVA's 12-40-0 base suspension, urea-ammonium nitrate solution, potash, and water. It also can be used to produce clear liquid mixtures. The following analysis compares various costs for clear and suspension mixtures made in such a plant. Seven widely different ratios were used. Formulations for each ratio are shown in Table 1.

Raw-Materials Costs

Materials costs are computed for three retail locations in the United States: Albany, Georgia; Springfield, Illinois, and Seattle, Washington. Costs of materials used are indicated in Table 1.

Cost of the 11-37-0 is based on TVA's spring 1969 price. It was assumed that the price of 12-40-0 per unit of plant food would be the same as the price of 11-37-0 per unit of plant food, plus the cost of clay in the 12-40-0. This should be a safe assumption, since the two products are made in the same TVA

plant. TVA is now pricing 12-40-0 slightly below this price to facilitate market introduction.

Commercial prices are used for urea-ammonium nitrate solution and potash. In some of the formulations it was assumed that clay in addition to that supplied by the 12-40-0 would be added during mixing. This supplemental clay is added to insure that the mixture will have a sufficient clay content to keep the salts in suspension.

Total delivered cost for raw materials for each ratio of clear liquids and suspensions is shown for each location in Table 2.

#### Investment Costs

The total investment cost for a cold-mix suspension plant was assumed to be the same as for a cold-mix liquid plant. The suspension plant would require more sophisticated mixing equipment, but this additional cost would be offset by a lower storage cost per unit of plant food with suspensions.

#### Fixed and Operating Cost

Fixed and operating cost is considered to be all the cost, except the raw-materials cost, incurred in mixing the fluid fertilizers. It includes such items as labor, depreciation, taxes, utility charges, and return on investment. Table 3 shows the fixed and operating cost at three annual production rates for a fluid fertilizer cold-mix plant and the operating cost per ton of fertilizer. Fixed and operating cost per ton at various levels of production is plotted as a curve in Figure 2. This was used to determine the fixed cost per ton of nutrients for both suspensions and clear liquids, which cost is shown for each ratio in Table 4.

It was assumed that 4,000 tons of clear liquids would be produced annually. An equivalent tonnage of suspension grades, also shown in Table 4, was calculated on the basis of the plant-nutrient content of each type of product. Fixed cost per ton of plant nutrients was calculated from this table and data in Figure 2. In each case the fixed cost is less for suspensions; except for high-nitrogen nonpotash grades, it is substantially less than for clear liquids.

#### Transportation Cost

The cost of transporting fluid fertilizers from the plant to the farm was calculated from data shown in Figures 3 and 4. Data for both curves was obtained from surveys of the fluid fertilizer industry. Figure 3 shows the average length of haul for a plant producing 4,000 tons annually to be about 27 miles. Figure 4 shows that the transportation cost for this distance averages about \$2 per ton of product. Transportation cost per ton of plant

nutrients was calculated from this figure and the tons of grade per ton of plant nutrients. These costs are shown for each grade in Table 4.

#### Application Cost

Application tests made at TVA indicate that a simple type of application equipment such as that shown in Figure 5 can be used to broadcast suspensions. This is essentially the same type of equipment used to broadcast clear liquids. Other data indicate that the equipment cost for applying suspensions in the row is about the same as that for applying clear liquids. Therefore, it is assumed that the investment cost in equipment for the application of clear liquids is the same as the investment cost in equipment for the application of suspensions. Application tests at TVA indicate that suspensions produced from 12-40-0 base suspension can be applied by equipment that has essentially the same investment cost as that of equipment used to apply clear liquids.

Table 5 shows application cost data for typical liquid application equipment. It shows the fixed and operating cost for this equipment at various seasonal throughput and application rates. It was assumed that 400 tons of fertilizer would be applied per year. Figure 6, which shows the application cost per ton of product at different application rates, was plotted from data in Table 5.

It was assumed that 100 pounds of plant nutrients per acre would be applied. This figure was converted to pounds of fertilizer per acre by the use of the plant-nutrient concentration of each grade. The application cost per ton of product at this calculated application rate of pounds per acre was obtained from Figure 6. Then the total application cost per ton of plant nutrients was calculated. This value is shown in Table 4.

#### Cost of Refilling Nurse Tanks and Applicators

It was assumed that fertilizers would be applied to 50 acres per day and that 20 minutes would be required to refill the nurse tank and applicator tank. It was assumed that clear liquids would weigh 10 pounds per gallon and suspensions 12 pounds per gallon. From this data the number of refills and their cost were calculated (Table 4).

#### Summary

Table 6 gives a summary of the total cost of mixing, transporting, and applying one ton of plant nutrients as a clear liquid and as a suspension at a rate of 100 pounds of plant nutrients per acre. In each instance the total cost of producing, transporting, and applying suspensions is less than for clear liquids. The cost difference ranges from \$20.06 for a 1:3:3 ratio to \$0.84 for a 2:1:0 ratio. Average cost difference for all ratios was \$9.86. This saving is significant and indicates that in most instances the use of suspensions is

economically desirable. However, it is appropriate to mention that even though suspensions have some economic advantages over clear liquids the suspensions are somewhat more complicated than the clear liquids. For this reason personnel experienced in the mixing and application of fluid fertilizer should be employed in the marketing of suspension fertilizers. Also, some precautions should be taken to agitate suspension mixtures in storage. These precautions are not necessary for clear liquids.

#### Other Considerations

This study was based on new plants. It was assumed that each plant would be designed to match production requirements. Many operators, however, find it difficult to meet the fertilizer demand in the rush period, because most of them have a short fertilizer season. Operators of clear liquid plants who have this problem will find it highly desirable to change to the production of suspensions, since the plant-nutrient content of suspensions is usually about twice that of clear liquids.

If assumptions of this study were changed so that the suspension and clear liquid plants produced the same annual tonnage of fertilizer, the difference in fixed cost per ton of plant nutrients would be considerably greater in favor of suspensions. For example, if the plants had an annual throughput of 4,000 tons per year for both the suspensions and clear liquids of the 1:1:1 ratio, the fixed cost per ton of plant nutrients would be \$18.89 for the suspension plant (compared with \$31.64 based on the previous assumption). With this fixed cost, the total cost difference between clear liquids and suspensions would be \$27.52 per ton of plant nutrients (compared with \$16.00 based on the earlier assumption). Therefore, if an operator of a clear liquid plant is having difficulty in meeting sales requirements during the fertilizer season, it could be highly advantageous for him to change to the production of suspensions.

Table 1

Formulations With 11-37-0 Base Solution

<u>Ratio</u>	<u>Grade</u>	<u>Pounds Per Ton of Product</u>			<u>Water</u>
		<u>11-37-0</u>	<u>32-0-0</u>	<u>0-0-62</u>	
1:1:1	8-8-8	432	352	258	958
1:2:2	5-10-10	541	127	323	1009
1:3:1	7-21-7	1135	47	226	592
1:3:3	3-9-9	486	20	290	1204
2:1:0	22-11-0	595	1172	-	233
3:1:0	24-8-0	432	1352	-	216
3:1:1	12-4-4	216	676	129	979

Formulations With 12-40-0 Base Suspension

<u>Ratio</u>	<u>Grade</u>	<u>Pounds Per Ton of Product</u>			<u>Water</u>	<u>Clay</u>
		<u>12-40-0</u>	<u>32-0-0</u>	<u>0-0-62</u>		
1:1:1	15-15-15	750	656	484	102	8
1:2:2	10-20-20	1000	250	645	105	-
1:3:1	10-30-10	1500	63	323	114	-
1:3:3	7-21-21	1050	44	677	229	-
2:1:0	24-12-0	600	1275	-	113	12
3:1:0	27-9-0	450	1519	-	14	17
3:1:1	21-7-7	350	1181	226	223	20

Cost of Materials Used

<u>Material</u>	<u>1969 Spring Prices, \$/Ton</u>	
	<u>Albany, Ga. and Springfield, Ill.</u>	<u>Seattle, Wash.</u>
11-37-0 (TVA)	\$68.00 Del.	\$77.00 Del.
32-0-0 (Commercial)	40.00 Del.	66.00 Del.
12-40-0 (TVA)	74.66 Del.	83.41 Del.
0-0-62 (Commercial)	16.12 f.o.b.	16.12 f.o.b.
Clay	33.15 f.o.b.	33.15 f.o.b.

Table 2

Raw-Material Costs Using 11-37-0 for Clear Liquids

and 12-40-0 for Suspensions

<u>Ratio</u> <u>Type of Liquid</u> <u>Grade</u>	<u>1:1:1</u>		<u>1:2:2</u>		<u>1:3:1</u>		<u>1:3:3</u>		<u>2:1:0</u>		<u>3:1:0</u>		<u>3:1:1</u>	
	<u>Clear</u> <u>8-8-8</u>	<u>Suspension</u> <u>15-15-15</u>	<u>Clear</u> <u>5-10-10</u>	<u>Suspension</u> <u>10-20-20</u>	<u>Clear</u> <u>7-21-7</u>	<u>Suspension</u> <u>10-30-10</u>	<u>Clear</u> <u>3-9-9</u>	<u>Suspension</u> <u>7-21-21</u>	<u>Clear</u> <u>22-11-0</u>	<u>Suspension</u> <u>24-12-0</u>	<u>Clear</u> <u>24-8-0</u>	<u>Suspension</u> <u>27-9-0</u>	<u>Clear</u> <u>12-4-4</u>	<u>Suspension</u> <u>21-7-7</u>

Cost, Dollars Per Ton of Fertilizer

<u>Location</u>														
Albany, Georgia	26.01	49.32	26.29	53.04	43.28	62.62	21.74	51.32	43.67	48.14	41.73	47.52	23.00	40.84
Springfield, Ill.	25.87	49.04	26.11	52.67	43.15	62.43	21.57	50.93	43.67	48.15	41.73	47.53	22.93	40.73
Seattle, Wash.	32.77	61.65	30.68	61.25	49.21	70.30	24.45	57.09	61.59	67.47	61.25	69.43	32.89	58.15

Cost, Dollars Per Ton of Plant Nutrients

<u>Location</u>														
Albany, Georgia	108.38	109.60	105.16	106.08	123.66	125.24	103.52	104.73	132.33	133.72	130.41	132.00	115.00	116.69
Springfield, Ill.	107.79	108.98	104.44	105.34	123.29	124.86	102.71	103.94	132.33	133.75	130.41	132.03	114.65	116.37
Seattle, Wash.	136.54	137.00	122.72	122.50	140.60	140.60	116.43	116.51	186.64	187.42	191.41	192.86	164.45	166.14

Table 3

Fixed and Operating Costs for Fluid Fertilizer Cold-Mix Plant

Annual production rate, tons of clear liquid	<u>2,000</u>	<u>4,000</u>	<u>6,000</u>
<u>Item</u>			
Capital investment, \$	23,000 <sup>a</sup>	25,000 <sup>b</sup>	27,000 <sup>c</sup>
Working capital, \$	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>
Annual operating costs, \$			
Power (at \$0.015/kwh.)	60	120	180
Water (at \$0.20/M gal.)	15	30	45
Analysis	50 <sup>d</sup>	100 <sup>e</sup>	150 <sup>f</sup>
Direct labor	6,500 <sup>d</sup>	8,100 <sup>e</sup>	9,600 <sup>f</sup>
Supervision	6,000	6,000	6,000
Maintenance and supplies (6% of capital investment)	1,380	1,500	1,620
Overhead (50% of labor, super- vision, and maintenance)	6,940	7,800	8,610
Interest (6% of total capital)	1,980	2,100	2,220
Depreciation (10% of capital investment per year)	2,300	2,500	2,700
Taxes, insurance, etc. (3% of capital investment per year)	690	750	810
Return on investment (20% of capital investment)	<u>4,600</u>	<u>5,000</u>	<u>5,400</u>
Total annual operating cost	30,515	34,000	37,335
Total cost per ton, \$	15.26	8.50	6.22

- a. Includes all investments except land; includes minimum storage.  
b. Includes all investments except land; includes storage in addition to storage required for 2,000-ton/year plant.  
c. Includes all investments except land; includes storage in addition to storage required for 4,000-ton/year plant.  
d. One man full time at \$2/hr.; 3 men at \$1.50/hr. for 3 months.  
e. One man full time at \$2/hr.; 5 men at \$1.50/hr. for 3 months.  
f. One man full time at \$2/hr.; 7 men at \$1.50/hr. for 3 months.

Table 4

Total Fixed, Transportation, and Application Costs for One Ton of Plant Nutrients  
Based on 4,000 Tons Per Year, Clear Liquid Production  
(Equivalent to 2,469 Tons Per Year of Suspensions)<sup>a</sup>

Ratio	1:1:1		1:2:2		1:3:1		1:3:3		2:1:0		3:1:0		3:1:1		
	8-8-8	15-15-15	5-10-10	10-20-20	7-21-7	10-30-10	3-9-9	7-21-21	22-11-0	24-12-0	24-8-0	27-9-0	12-4-4	21-7-7	
Tons of grade per ton of plant nutrients	4.17	2.22	4.00	2.00	2.86	2.00	4.76	2.04	3.03	2.78	3.13	2.78	5.00	2.86	
Equivalent annual tons, suspension plant	2,133		2,000		2,800		1,724		3,667		3,556		2,286		
Cost, dollars per ton of plant nutrients															
Fixed costs, <sup>b</sup>	35.44	31.64	34.00	30.20	24.31	23.20	40.46	35.09	25.76	25.58	26.61	26.41	42.50	39.18	
Transportation costs, <sup>c</sup>	8.34	4.44	8.00	4.00	5.72	4.00	9.54	4.08	6.06	5.56	6.26	5.56	10.00	5.72	
Application costs, <sup>d</sup>	27.10	22.87	26.60	22.60	24.60	22.60	28.68	23.03	24.83	24.27	25.04	24.27	28.25	24.60	
Number of refills for purne and applicator tanks <sup>e</sup>		7.35	3.24	7.00	2.91	5.01	2.91	8.99	2.98	5.30	4.03	5.48	4.05	8.75	4.17
Cost of refills	<u>5.83</u>	<u>2.60</u>	<u>5.60</u>	<u>2.33</u>	<u>4.01</u>	<u>2.33</u>	<u>6.66</u>	<u>2.38</u>	<u>4.24</u>	<u>1.28</u>	<u>4.38</u>	<u>3.24</u>	<u>7.00</u>	<u>3.34</u>	
Total fixed, transportation, and application costs	76.71	61.55	74.20	59.13	58.64	52.13	64.74	64.60	60.91	58.65	62.29	59.46	87.75	72.84	

a. Calculated with ratio of clear liquids to suspensions  $\times$  4,000.

b. Calculated with data in Figure 2  $\times$  total tons.

c. Based on annual throughput of 4,000 tons of clear liquids. The length of haul for both clear liquids and suspensions would be the same, because the same quantity of plant nutrients would have to be sold. The average length of haul calculated with data in Table 2 would be 27 miles. With this length of haul and the data in Figure 4, the transportation cost per ton is found to be \$2.00.

d. Based on 100 pounds of plant nutrients per acre and 400 tons of annual throughput through application equipment. Use data in Figure 5.

e. Based on 50 acres per day, 20 minutes per refill, and \$6 per hour for refill. Assume weight of clear liquid is 10 pounds per gallon and suspension 12 pounds per gallon.

Table 5

Costs of Application

Equipment

Nurse tank (1,000-gallon, S. S. with trailer)					\$1,200.00 net
Applicator (400-gallon, S.S.)					800.00 net
Annual capital charge (5-year life)			\$400.00		
Maintenance, 5%			100.00		
Taxes, insurance, etc., 2%			40.00		
Interest on investment, 6%			<u>120.00</u>		
			\$660.00		

Throughput, tons/season	200	300	400	500	600
Equipment cost, \$/ton	3.30	2.20	1.65	1.32	1.10
Spreading rate, pounds/acre					
Labor and overhead to apply, at \$6.00/hour = \$1.00/acre					
Application rate, pounds/acre	100	200	300	400	500
Acres covered by 1 ton	20	10	6.67	5.00	4.00
Cost of labor to apply 1 ton, \$	20	10	6.67	5.00	4.00

Application Costs, \$/Ton of Product

Throughput applicator, tons/year	<u>200</u>	<u>300</u>	<u>400</u>	<u>500</u>	<u>600</u>
Application rate, pounds/acre					
100	23.30	22.20	21.65	21.32	21.10
200	13.30	12.20	11.65	11.32	11.10
300	9.97	8.87	8.32	7.99	7.77
400	8.30	7.20	6.65	6.32	6.10
500	7.30	6.20	5.65	5.32	5.10

Table 6

Total Cost of Mixing, Transporting, and Applying One Ton  
of Plant Nutrients as Clear Liquids and as Suspensions  
in Dollars Per Ton of Plant Nutrients

Ratio Type of Liquid Grade	1:1:1		1:2:2		1:3:1		1:3:3		2:1:0		3:1:0		3:1:1	
	Clear 8-8-8	Suspension 15-15-15	Clear 5-10-10	Suspension 10-20-20	Clear 7-21-7	Suspension 10-30-10	Clear 3-9-9	Suspension 7-21-21	Clear 22-11-0	Suspension 24-12-0	Clear 24-8-0	Suspension 27-9-0	Clear 12-4-4	Suspension 21-7-7
Location														
Albany, Georgia Cost Difference	185.09 13.94	171.15	179.36 14.15	165.21	182.30 4.93	177.37	188.26 18.93	169.33	193.24 .87	192.37	192.70 1.22	191.48	202.75 13.22	189.53
Springfield, Ill. Cost Difference	184.50 13.97	170.53	178.64 14.17	164.47	181.93 4.94	176.99	187.45 18.91	168.54	193.24 .84	192.40	192.70 1.19	191.51	202.40 13.19	189.21
Seattle, Wash. Cost Difference	213.25 14.70	198.55	196.92 15.29	181.63	199.24 6.51	192.73	201.17 20.06	181.11	247.55 1.48	246.07	253.70 1.36	252.34	252.20 13.22	238.98
Average Cost Difference	14.20		14.54		5.46		19.30		1.06		1.26		13.21	

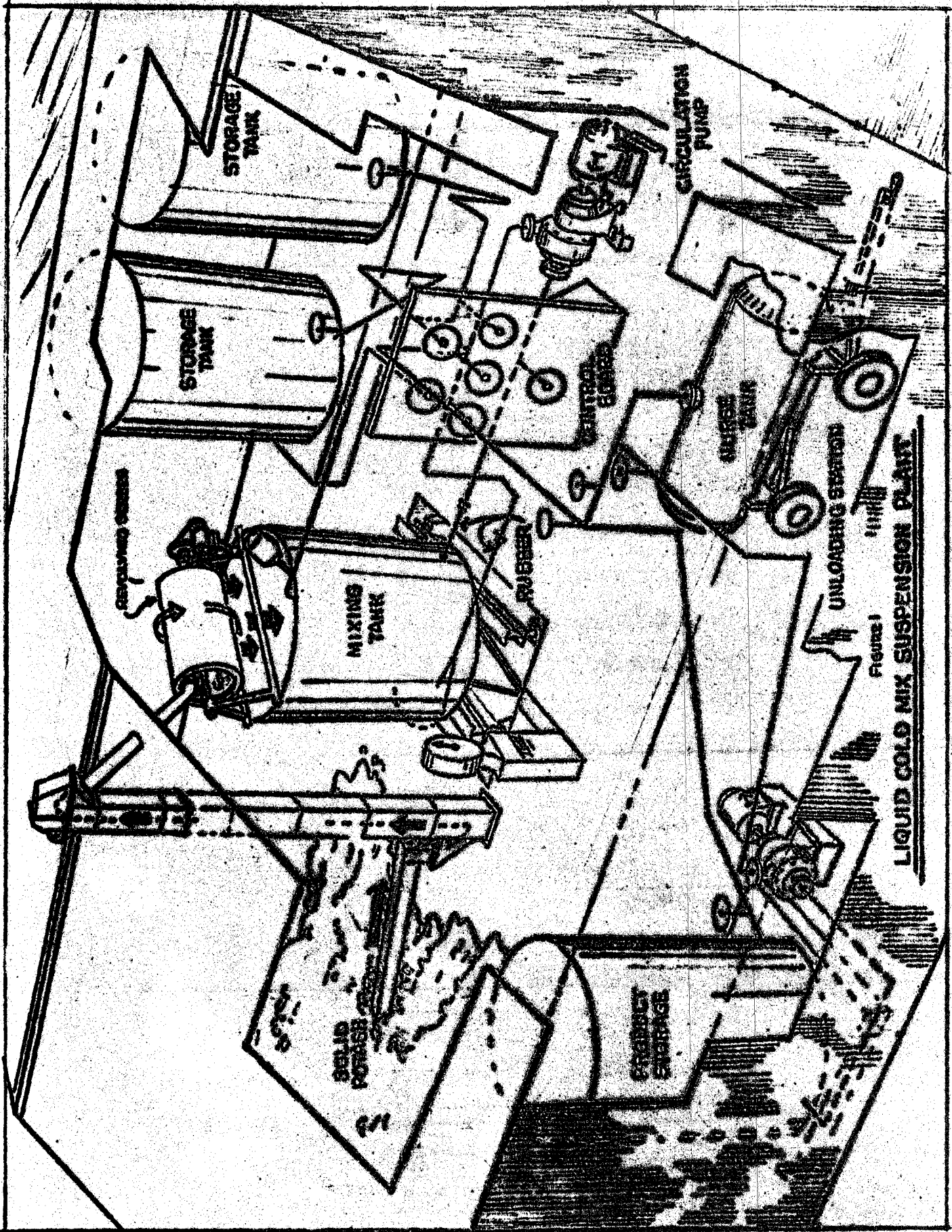
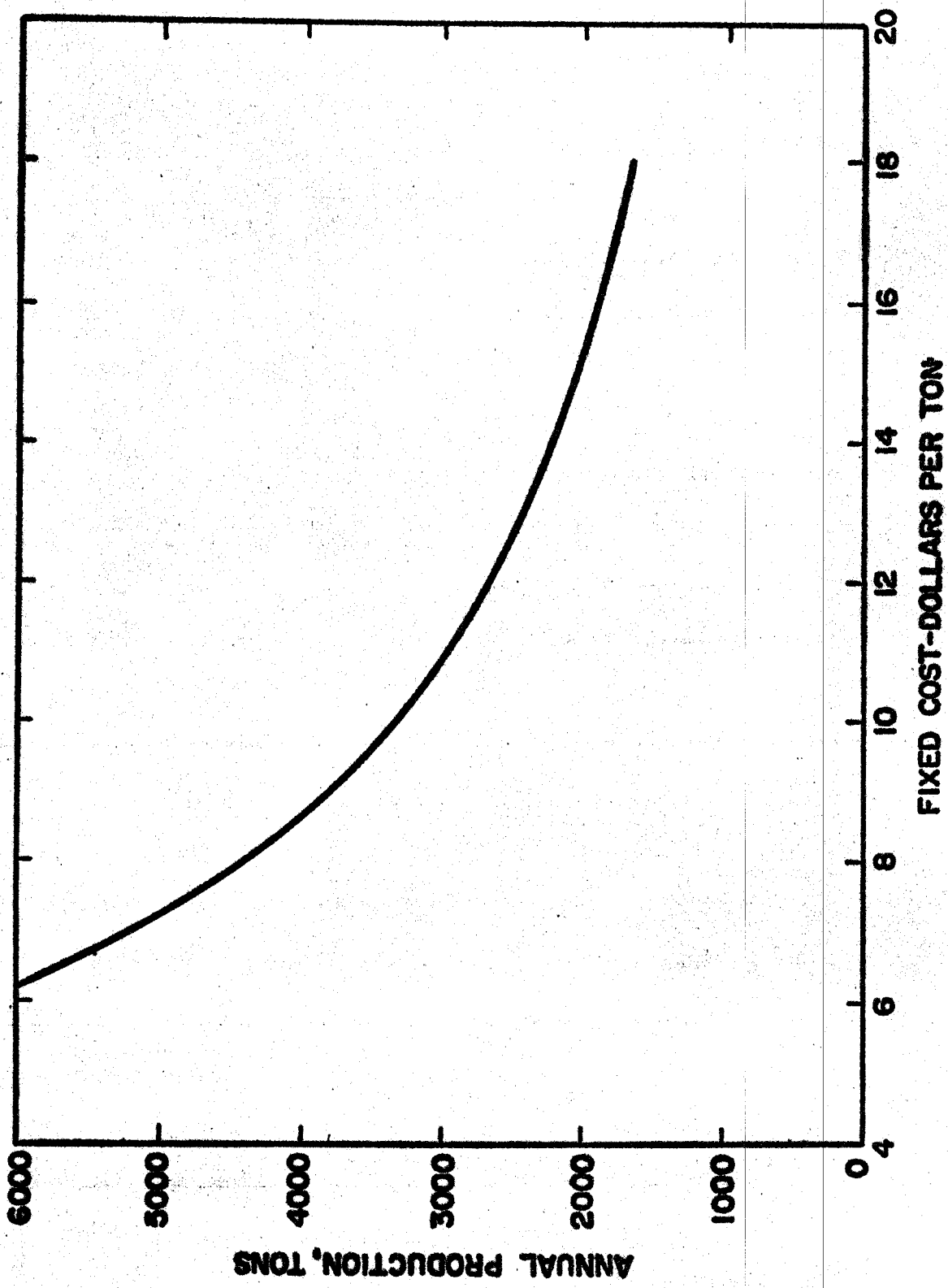
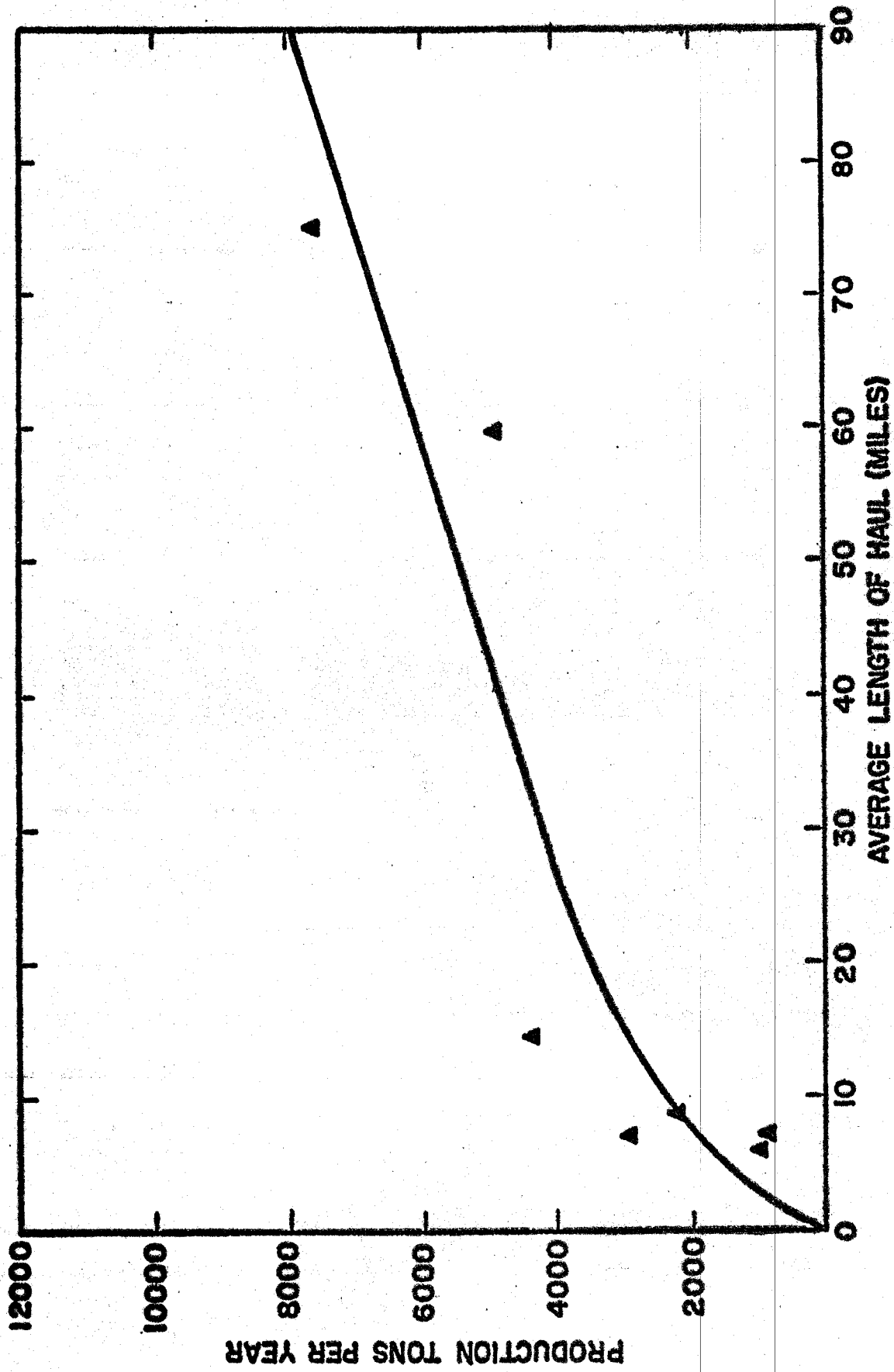


Figure 1

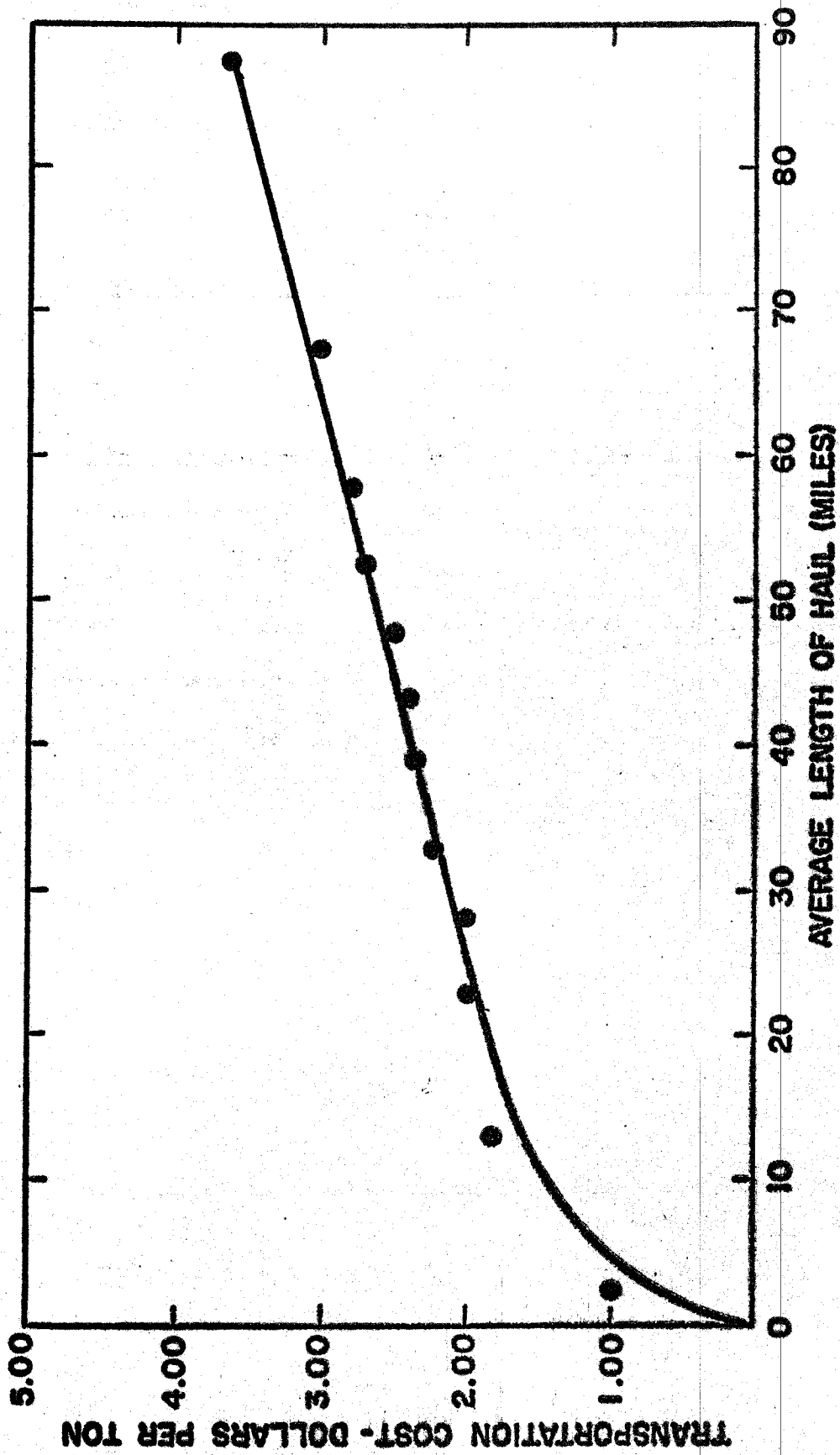
**LIQUID COLD MIX SUSPENSION PLANT**



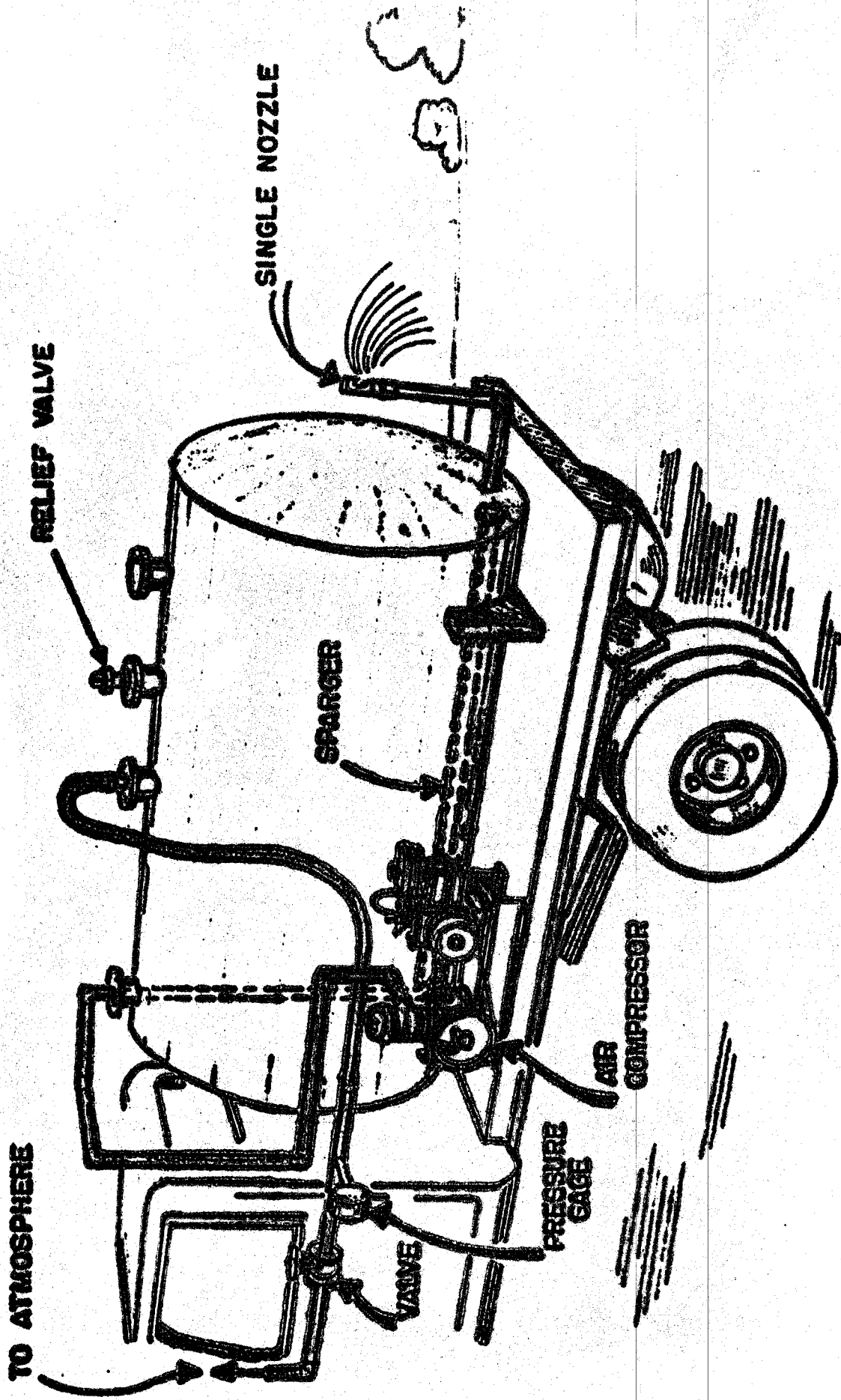
**FIGURE 2**  
**FIXED COST vs ANNUAL PRODUCTION RATE**



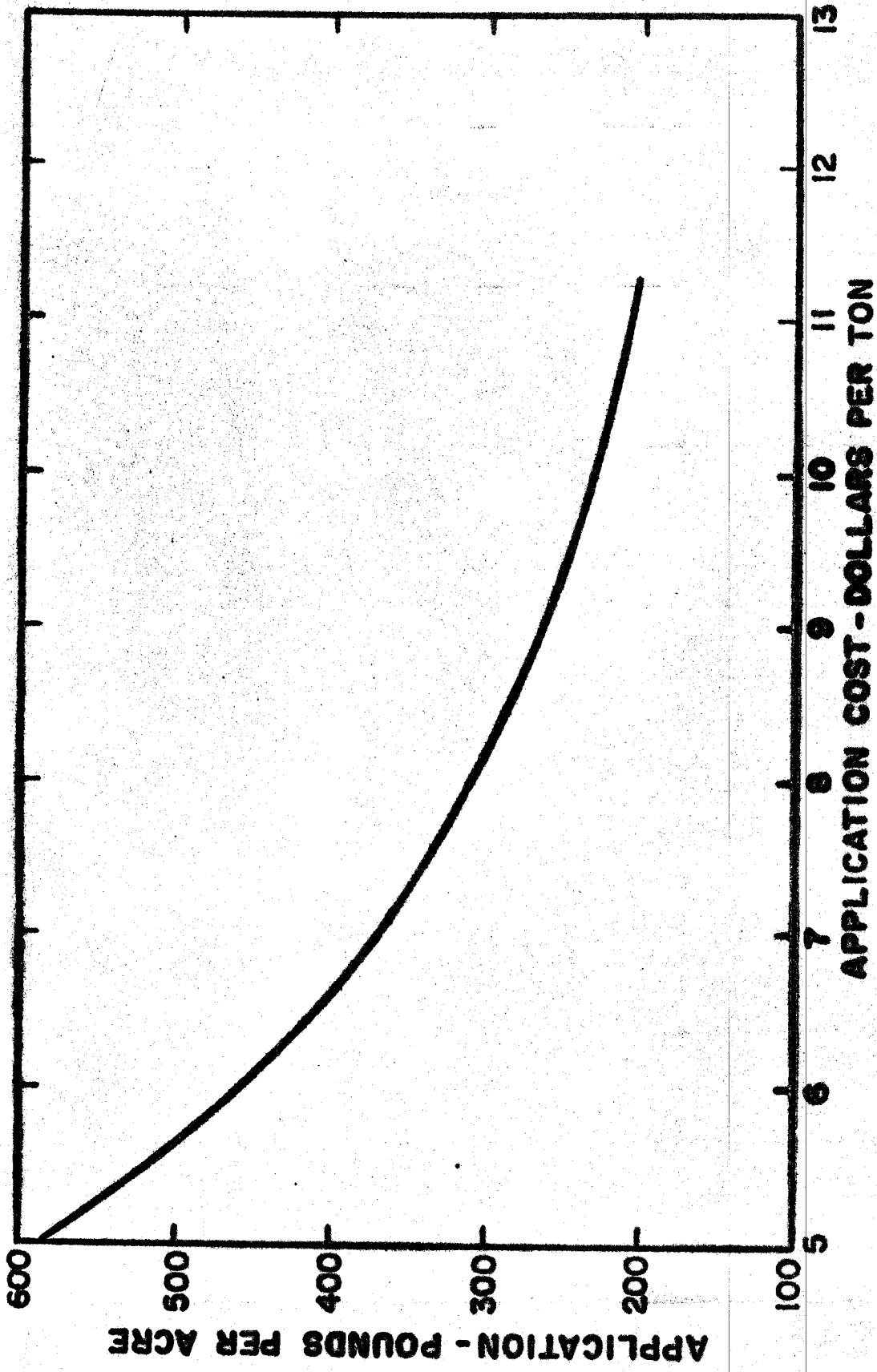
**FIGURE 3**  
**ANNUAL PRODUCTION RATE VS AVERAGE LENGTH OF HAUL**



**FIGURE 4**  
**AVERAGE LENGTH OF HAUL vs TRANSPORTATION COST - DOLLARS PER TON**



**FIG. 5**  
**BROADCAST APPLICATION TRUCK**  
**FOR FLUID FERTILIZERS THAT UTILIZES AIR COMPRESSOR**



**FIGURE 6**  
**APPLICATION COST VS APPLICATION RATE**  
**(ANNUAL THROUGHPUT - 400 TONS PER YEAR)**