• Motion and Time Study •

RESIDUAL HOUSE SPRAYING EQUIPMENT AND CREW-SIZE COMPARISON

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During the 1950 malaria control season, a cooperative study of residual house-spraying equipment and techniques was undertaken by personnel of the Communicable Disease Center, and the South Carolina State Department of Health. The data gathered, indicating crew size and equipment which are most economical of operational time, will be useful for future planning. Although the comparative economy of some individual factors is indicated in this report, the final basis for comparison is the net cost per house-spray application.

OBJECTIVES

The study had two principal objectives:

1. To compare the operating data of one- and two-man crews, both crews using similar types of hand-spray equipment, in order to ascertain reasons for differences in the crews as measured by cost per house sprayed.

2. To compare the operating data for (a) standard 4-gal. hand cans, (b) standard cans with the hand pump replaced by a Schraeder valve and a truck-mounted air reservoir, (c) a constant-pressure hand can with self-contained air reservoir, and (d) power-spraying equipment, in order to ascertain major factors affecting the cost per house sprayed.

METHODS

Timing observations were made in rural areas of two counties where residual spray programs had been conducted during the five previous seasons. Local factors such as types of roads, distance between houses, and types and sizes of houses could be considered typical of rural areas throughout the residual spray program. Plans for field timing observations were made to permit collection of data without changing or interfering with normal operational or crew-activity schedules. Table 1 summarizes basic data of the observed operations.

Householders were customarily contacted in advance to obtain permission to spray their dwellings, and to allow them time to prepare for the spraying. The crew members allotted two 15-minute periods each day for contact purposes, one before lunch and one just before quitting time in the afternoon. This procedure usually was satisfactory. Occasionally, however, when a high refusal rate was encountered, it became necessary to spray houses at the time permission was given to spray. In these instances no charge was made for contact time since it was impractical to separate accurately the time devoted to selling the spray job and that recorded under elements 5 and 6 (table 2). The quantity of data resulting from the observations outlined in table 2 was considered the minimum from which reliable results could be obtained. Four experienced spray men were selected for observation in crew comparisons and one of the four was observed for equipment comparisons. All were classified as "Good" by the State and county supervisors. In determining the extent of spraying at each house the following policy was used:

1. If the house was not well screened, DDT spray was applied to all inside rooms, the privy, weather-protected porch surfaces, eaves, and a band outlining windows and the undersurface of the house next to the outside sills. If householder refused inside spraying, no surfaces were treated.

2. If the house was well screened, procedure was the same as in 1, excluding inside rooms.

Time data for all activities during the day were recorded during field observation by readings to the nearest 5 seconds taken from a continuously running watch. The beginning and ending times for each operation at a house were recorded on time sheets similar to the sample shown in table 2. The amount of emulsion discharged at each house was obtained by weighing the spray can after completion of each house and calculating the weight of material discharged. Speedometer readings to the nearest one-tenth mile also were recorded at each stop.

FIELD OBSERVATIONS

To summarize operational time value data, man-

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Table 1

TABULATION OF OBSERVATIONS AND PURPOSES

PART I

Crew Size and Number	Man No.	Experience	Days Observed	Purpose of Observation
One-Man Crew No. 1	Man No. 1	6 years (Power, Hand Cans)	4	One-Man Crew and Standard Hand Can Efficiency
One-Man Crew No. 2	Man No. 2	6 years (Power, Hand Cans)	4	One-Man Crew and Standard Hand Can Efficiency
Two-Man Crew No. 3	Man No. 1 Man No. 2	6 years each (Power, Hand Cans)	4	Two-Man Crew Efficiency
Two-Man Crew No. 4	Man No. 3 Man No. 4	2 Years each (Hand Cans)	4	Two-Man Crew Efficiency

PART II

One-Man Crew No. 1	Man No. 1	2 years each (Hand Cans)	3	Hand Can Schraeder Valve No Hand-Pump
One-Man Crew No. 1	Man No. 1	2 years each (Hand Cans)	3	Constant Pressure Spray Can
One-Man Crew No. 1	Man No. 1	2 years each (Hand Cans)	3	Power (Hose) Spraying Equipment

minutes of similar elements of table 2 were combined for each size crew. Totals of these values are shown in table 3. Totals for distances traveled between base and field, and amount of emulsion discharged also are shown.

The actual cost per house sprayed was selected as a basis for comparison of crew size efficiencies. The average cost of spray crew labor on the South Carolina program is $0.787 per hour. A transportation cost of $0.0488 per mile, including operation, maintenance, and depreciation was determined from annual automotive cost records for the State.

ANALYSIS OF DATA

In order to evaluate statistically the data in table 3, total values of combinations containing elements 18, 19, 20, 21, and 3 (contact time) were averaged as a group for both one- and two-man crews. Elements 1 through 14 included under the heading, "Time at Houses Sprayed" were averaged separately for the different size crews. Numerical values of the averages for time and distance were determined by equating totals from table 3 as follows:

Time and Distance Averages for One- and Two-Man Crews (Data from Table 3)

A = Average Truck Time between Field and Base (both ways)

$$= \frac{1,217.9 + \frac{1,175.9}{2}}{16 \text{ days}} = 50.37 \text{ truck minutes/day (Elements 18 and 19)*}$$

B = Average Truck Time at Houses Contacted (Elements 1-14 inclusive)

$$= \frac{144.1 + \frac{317.7}{2}}{74 + 130} = 1.49 \text{ truck minutes/house-to-house trip}$$

C = Average Truck Time between Houses Sprayed and Contacted (Element 21)

$$= \frac{334.4 + \frac{1,300.9}{2}}{74 + 75 + 130 + 106 - 16} = 2.669 \text{ truck minutes/house-to-house trip}$$

D_1 = Average Time at House Sprayed by One-man Crew (Elements 1-14 inclusive)

$$= \frac{2,690.8}{75} = 35.88 \text{ man-minutes/house}$$

D_2 = Average Time at House Sprayed by Two-man Crew (Elements 1-14 inclusive)

$$= \frac{4,366.2}{106} = 41.19 \text{ man-minutes/house}$$

E = Average Time Cleaning and Storing Equipment (Element 20)

$$= \frac{65.7 + 151.4}{24 \text{ cleanings}} = 9.05 \text{ minutes/man/day}$$

K = Average Number of Contacts per House Sprayed

$$= \frac{74 + 130}{75 + 106} = 1.127 \text{ contacts/house sprayed}$$

L = Average Distance from Base to Field to Base

$$= \frac{395.52}{16} = 24.74 \text{ miles}$$

X_1 = Average Houses Sprayed per Day, One-man Crew

$$= \frac{75}{8} = 9.37$$

X_2 = Average Houses Sprayed per Day, Two-man Crew

$$= \frac{106}{8} = 13.25$$

*Elements mentioned are shown in table 2.

Table 2

SPRAY OPERATIONS TIME SHEET

DATE 5/30/50 HOUSE NO. 4-C112 CREW NO. 2 STATE S. Carolina COUNTY Calhoun
NO. ROOMS 5 MAN NO. 2
TYPE EQUIPMENT: HAND X POWER ___ (See Over) 5% EMULSION – GAL. OR 35 #WEIGHT

DO NOT WRITE HERE	TIME			(Readings are in minutes and seconds) TIME ELEMENTS AND REMARKS
	18:55		1	ARRIVAL AT HOUSE SPEEDOMETER READING 18.1
0015	20:10	B	2	UNLOADING SPRAY EQUIPMENT FROM TRUCK
	20:25	E		
0050	18:55	B	3	TALKING WITH HOUSEHOLDER INCL. FEE COLLECTION☐ CONTACTED PREV.☐
	19:45	E		Walk in and back; Talking
1135	:	B	4	FILLING & AIRING CANS (Show number of cans filled and aired)
	:	E		2315X 2350W 2440 C 2520X 2535 A 3200 RA 3925 X 4000 W 4130X 2350X 2440W 2520 C 2535X 2635 A 3235 RA 4000 X 4130 W 4145X (over)
1845	:	B	5	WALKING AND SPRAYING HOUSE
	:	E		3445 4325 5000 5940 3900 4920 5505 0310
	:	B	6	WALKING AND SPRAYING PRIVY
	:	E		NONE
1145	:	B	7	WALKING & SPRAYING OUTBUILDINGS INDICATE NUMBER ___
	:	E		2035 2710 3235 0310 2255 3200 3445 0535
	:	B	8	PREPARATION OF ROOMS --MOVING☐ AND COVERING☐ FURNITURE
	:	E		
	:	B	9	RESETTING FURNITURE
	:	E		
0345	:	B	10	(INDICATE TIME USE) Walking
	:	E		2025 2255 2635 3900 4245 5505 5915 0535 WH WT WH WT WH WT WH WT 2035 2315 2710 3925 4325 5535 5940 0615
0025	:	B	11	(INDICATE TIME USE) 1945 Record house number
	:	E		2010
	:	B	12	CLEANING NOZZLE SCREEN
	:	E		
0105	06:15	B	13	LOADING SPRAY EQUIPMENT ONTO TRUCK
	07:20	E		
4825	07 20		14	DEPARTURE (SEE OVER)
	:	B	15	MIXING & LOADING OF CHEMICALS AND EQUIPMENT AT BASE (A.M.)
	:	E		
	:	B	16	SERVICING OF VEHICLE
	:	E		
	:	B	17	CHARGING AIR TANK
	:	E		
	:	B	18	TRAVEL TO FIELD SPEEDOMETER READING (BEGINNING)
	:	E		
	:	B	19	RETURN TO BASE SPEEDOMETER READING (END OF DAY)
	:	E		
	:	B	20	CLEANING & STORING EQUIPMENT
	:	E		
0610	12:45	B	21	(INDICATE TIME USE)
	18:55	E		Travel from previous house

Note: See reverse side for code.

Table 2

SPRAY OPERATIONS TIME SHEET
(Continued)

a) GEOGRAPHICAL PORTION OF COUNTY OPERATED Section C, Adjacent Orangeburg Co. Line

b) TOTAL RURAL HOUSES IN COUNTY

c) AVERAGE NUMBER OF HOUSES PER SQUARE MILE

FS 3530

d) VEHICLE: MAKE Internat'l TYPE ½T-PU MODEL 48 CONDITION VG

e) AIR COMPRESSOR - (Check) MAKE - -

f) RESERVOIR TANK CAPACITY - -

g) EMULSION CONTAINER CAPACITY - - TYPE - -

h) WATER CONTAINER CAPACITY 55 gal. TYPE Commercial

i) CONCENTRATE CONTAINER CAPACITY 2 ea. - 5 gal. GI Cans

j) SPRAY CANS: MAKE Hudson NUMBER 3105 SIZE 4 gal. NOZZLE SIZE 8002
(60 strokes)
INITIAL PRESSURE 50 # MODIFICATIONS Pressure Gauge Added

k) PRESSURE BY Hand Only

l) DUTIES OF CREW MEMBER: Contacting, routing, spraying

m) NUMBER OF YEARS OF RESIDUAL SPRAY EXPERIENCE

n) REMARKS: (NUMBERS REFER TO TIME ELEMENTS ON REVERSE SIDE)

4145		4920		5535	5635		5725	5755	5810
	A		RA		X	W		C	X A
4245		5000		5635	5725		5725	5810	5915

Note in Filling and Airing the following code symbols were used:

X - Remove spray can lid

W - Add water to can

C - Measure and pour in concentrate

X - Replace spray can lid

A - Pump with air

RA - Re-air

Note in recording "Walking," Item 10, WH - Walk to house; WP - Walk to privy; and WT - Walk to truck

o) OBSERVER

Table 3

TABULATION OF OPERATIONAL MAN-MINUTES AND OTHER DATA

Operational Elements	Element No. in Table 2	One-Man Crews	Two-Man Crews
Travel between Field and Base	18, 19	217.9	1,175.9
Cleaning and Storing Equipment	20	65.7	151.4
Contacts to Arrange for Spraying	1-14, inclusive	144.1*	317.7**
Travel between Houses Sprayed and Contacted	21	334.4***	1,300.9†
Time at Houses Sprayed	1-14, inclusive	2,690.8	4,366.2
Total Time		3,563.6	7,312.1
Total Distance Traveled between Houses (Miles)		80.0	115.5
Total Distance Traveled between Base and Field (Miles)		107.02	288.5
Total Pounds Emulsion Discharged		1,768.5	2,656.0

*74 houses contacted in advance.
**130 houses contacted in advance.
***74 contacted - 75 sprayed
†130 contacted - 106 sprayed.

If one should substitute the average values for related symbols in the formula of table 4, columns 1 and 2, only 462 productive man-minutes or 7.7 hours for a one-man crew work day and 854 man-minutes or 14.2 hours for a two-man crew, columns 3 and 4 would be accounted for. Since payment is made on an 8-hour basis, these totals should be 480 and 960 man-minutes respectively. The cost for labor per house sprayed is then $\frac{8 \times 0.787}{7.7}$ = \$0.82/hour or \$6.30/day for one-man crews and $\frac{16 \times 0.787}{14.2}$ = \$0.89/hour or \$12.60/day for two-man crews.

Transportation and Labor Costs (Actual Average):

Cost of One-man Crew.

Base to Field and Return		
24.74 Miles (@) \$0.0488	=	\$ 1.21
Between Houses Contacted and Sprayed		
0.530 x \$0.0488 x 9.37-1	=	0.22
Total Transportation		1.43
Total Labor		6.30
Total Per Day		7.73
Total Per House		0.82

Cost of Two-man Crew.

Base to Field and Return		
24.74 Miles (@) \$0.0488	=	\$ 1.21
Between Houses Contacted and Sprayed		
0.53 x 0.0488 x 13.25-1	=	0.32
Total Transportation		1.53
Total Labor		12.60
Total Per Day		14.13
Total Per House		1.06

According to these data the cost per house treated by a one-man crew is approximately \$0.24 less than the cost of a similar treatment when made by a two-man crew.

To determine the number of houses which could have been treated, had an 8-hour day been devoted to productive work, the formula was made to equal 480 and 960 man-minutes respectively. By substituting known values and solving for X_1 and X_2, the one-man crew should have treated 9.8 houses per day and the two-man crew should have treated 15.5 houses per day. Adjusted values are shown in columns 5 and 6 (table 4). Although the actual and adjusted costs were developed from averaged values, some of these would be expected to vary in other program areas. The following formula is applicable in estimating costs per house (C) in other situations.

$$C = 8W + T(2L + M(X + KX - 1)$$

"W" is the wage rate per hour; and "T", transportation cost per mile. Other symbols are from Time and Distance computations.

Individual time subitems included were statistically analyzed to determine whether there were differences between one- and two-man crews. Subitems showed differences initially but after

Table 4

FORMULAS AND RESULTS OF COMPARISON OF ONE- AND TWO-MAN CREWS

Time Use	FORMULA		ADJUSTED VALUES FROM TABLE OF AVERAGES			
			One-Man Crew		Two-Man Crew	
	One-Man Crew	Two-Man Crew	Man-minutes	% of Day	Man-minutes	% of Day
1. Travel Between Field and Base	A*	2 A	50.37	10.5	100.74	10.5
2. Cleaning and Storing Equipment	E	2 E	9.05	1.9	18.10	1.9
3. Contacting Houses	BKX_1	$2BKX_2$	16.44	3.4	51.96	5.4
4. House to House Travel	$C(X_1+KX_1-1)$	$2C(X_2+KX_2-1)$	52.94	11.0	182.08	19.0
5. Time at Houses Sprayed	$D_1 X_1$	$D_2 X_2$	351.20	73.2	607.12	63.2
Total Man-minutes	480	960	480.00	100.0	960.00	100.0
Houses per Day per Crew			9.788		15.464	
Cost for Transportation @ $0.0488/mile			$1.720		$ 2.030	
Cost for Labor @ $0.787/hour			6.296		12.592	
TOTAL			$8.016		$ 14.622	
Average Cost Per House			$0.820		$ 0.946	

*For explanation of symbols, see "Time and Distance Averages for One- and Two-Man Crews."

the adjustment for number of houses, pounds of emulsion discharged, or number of men in the crew required for each item, significant differences remained only in subitem, "Waiting for Other Man," which occurred in the case of two-man crews. The total continued to show a significant difference that could be explained only by a slight accumulative deviation in the same direction in each of the subitems. Formulas of the equations and distance averages are shown in table 4.

Equipment Compared:

Power spraying equipment consisted of an engine-mounted air compressor with governor set at 90 lb. of pressure per square inch coupled to an 8-gal. air reservoir tank which was in turn connected through a constant pressure regulating valve to a 50-gal. emulsion tank. Pressure on the emulsion tank was maintained at 50 lb./sq. in. A xylene-resistant hose, 125 ft. long, was used in reaching the houses. In unusually large houses pressure occasionally dropped to 45 p.s.i.

The Constant Pressure Hand Can. This hand can is constructed from two concentric tanks connected by a constant pressure valve (40 p.s.i.) with a Schraeder valve tapped into the outer air compartment. When this can was used, the truck air reservoir contained 125 p.s.i. initially and the air chamber of the can was filled with compressed air to 70 p.s.i. Emulsion from the pressure emulsion tank was simultaneously added to fill the inner chamber.

Standard Hand Cans. These were 4-gal. Hudson cans, weight 8½ lb., models 210G and 310G without modification other than the addition of a pressure gage. These cans were charged with 13 pt. of water and 2 pt. of 25 percent DDT concentrate and were pumped 60 strokes to produce an initial pressure of approximately 50 p.s.i. Water was provided from a 55-gal. commercial drum by gravity flow through a ¾-in. hose. Concentrate was measured and poured into the can.

Hand Can With Schraeder Valve, No Pump. This can, weight 7 lb., was the Hudson model 310G with hand pump replaced by Schraeder valve. Emulsion was supplied from the pressure valve set at 50 p.s.i. One and three-tenths gallons of emulsion constituted a charge, and it was seldom necessary to recharge the can with air.

The same type data were collected in the equipment studies as in the crew-size study but only those items which would be affected by variations in equipment were analyzed. Table 5 shows the

Table 5

ADJUSTED AND ACTUAL EQUIPMENT PERFORMANCE DATA ON FOUR TYPES OF RESIDUAL HOUSE-SPRAYING EQUIPMENT

AVERAGE MAN-MINUTES PER HOUSE – ONE- AND TWO-MAN CREWS					AVERAGE MAN-MINUTES PER HOUSE – ONE-MAN CREW					
Equipment Variable Items	Standard Hand Cans* One-Man Crews Base Data		Standard Hand Cans Two-Man Crews		Hand Can, No Hand Pump With Schraeder Valve		Constant Pressure		Power (Hose) Equipment	
	Actual	Adjusted	Actual	Adjusted	Actual	Adjusted	Actual	Adjusted	Actual	Adjusted
Unloading Spray Equipment	0.39	0.39¼	0.56	0.56	0.29	0.29¼	0.32	0.32¼	0.25	0.25½
Filling and Airing Cans	8.41	6.94	7.76	7.30	2.61	4.19	3.55	2.59	0.20	0.20
Spraying Inside House, Privy, and Outside Surfaces	21.28	21.28	19.90	18.72	13.93	23.15	14.85	18.90	14.61	16.05
Walking Between Truck, House, and Privy	2.80	2.80	3.10	2.92	2.05	3.41	2.27	2.89	1.14	1.25
Loading Spray Equipment	0.90	0.90	1.04	1.04	0.38	0.38	0.42	0.42	0.75	0.75
Washing Hands	–	–	–	–	–	–	–	–	0.07	0.08
Moving Spray Truck	–	–	–	–	–	–	–	–	0.06	0.06
SUBTOTAL	33.78	32.31	32.36	30.54	19.26	31.42	21.41	25.12	17.08	18.64
Other Items at House										
Talking with Householder, Preparing House Recording Data, Cleaning Nozzle Screen, and Other Details	3.57	3.57	8.83	8.72	3.57	3.57	3.57	3.57	3.57	3.57
TOTAL	37.35	35.88	41.19	39.26	22.83	34.99	24.98	28.69	20.65	22.21
Pounds 5 percent DDT Emulsion per House	23.58	23.58	25.06	23.58	14.19	23.58	18.5	23.58	21.47	23.58
Actual and Adjusted Houses per Day	9.375	9.788	13.250	15.464	14.667	9.994	12.000	11.741	13.333	14.313
Cost per Application Labor	$0.671	$0.644	$0.950	$0.814	$0.429	$0.630	$0.525	$0.536	$0.472	$0.440
Mileage	0.111	0.176	0.194	0.132	0.079	0.173	0.095	0.156	0.148	0.137
Total	$0.782	$0.820	$1.44	$0.946	$0.508	$0.803	$0.620	$0.692	$0.620	$0.577

*Emulsion for standard hand can was carried in 5-gal. cans; that for hand can with Schraeder valve, in a large drum with delivery hose. This accounts for differences in unloading and loading times since in the former case these operations included also handling a 5-gal. can of emulsion.

selected data for the several types of equipment, before and after adjustment to the house size, used in obtaining the standard hand can data. Insertion of these data in the original formula gives the cost per house results shown in table 5. The actual results are shown for comparison.

ADJUSTMENTS

In the final analysis of data recorded for both crew-size and equipment performance, all operations were brought as nearly to the same basis as possible. This was accomplished by adjusting the data so that the crews and equipment compared would be considered as having sprayed the same average size houses over the same terrain and with the same acceptance rate. For this reason the formula shown in table 4 was developed. The average "Time At House Sprayed" data were

adjusted in terms of actual average pounds of emulsion used by a one-man crew per house, using standard hand cans. This common denominator was 23.58 lb. of emulsion per house. In making adjustments, those factors affected by variations in house size were computed on a "man-minutes per pound" basis and multiplied by the average for one-man crews. Other factors remained on an actual average per house basis. The effects of these adjustments are shown in table 5 where actual performance data averages are compared with adjusted values of separate and combined time elements. According to cost of houses sprayed based on unadjusted values (table 5) the most efficient operational organizations are listed in order below:

1. One-Man Crew With----Hand Can Schraeder Valve
2. One-Man Crew With----Power Sprayer
3. One-Man Crew With----Constant Pressure Hand Can
4. One-Man Crew With----Standard Hand Can
5. Two-Man Crew With----Standard Hand Can

When elements are adjusted for time and pounds of emulsion applied, the order of efficiencies occur as follows:

1. One-Man Crew With----Power Sprayer
2. One-Man Crew With----Constant Pressure Hand Can
3. One-Man Crew With----Hand Can Schraeder Valve
4. One-Man Crew With----Standard Hand Can
5. Two-Man Crew With----Standard Hand Can

In the comparisons of spray equipment efficiencies (above), initial cost was not considered. In order to compare the different types of equipment on an equal basis, each unit was evaluated on a performance basis (number of houses treated per day by one-man crew) to amortize the initial cost. Factors considered in determining spray equipment cost per house sprayed are summarized in table 6.

The estimate of houses sprayed per year is based on an average of a 3-month or a 65-working-day spray season, multiplied by the adjusted daily accomplishment shown in table 5. The particular constant pressure hand can tested, developed by Technical Development Services, CDC, indicates a high degree of efficiency; however, it is not available commercially.

To determine the time required to amortize the difference in cost of spray equipment, a comparison was made of the standard hand can and the power sprayer performance. The difference between the number of houses treated per day with the hand can and the power unit is 4.5 houses. Cost per house with hand can is $0.82. Then 4.5 x 0.82 = $3.70 per day approximately. The difference in cost of the two units is $225 - 8.50 = $216.50. Amortization time $\frac{216.50}{3.70}$ = 58.5 days, which is less than one normal spray season.

When crew activity element groups were analyzed statistically, a significant difference was noted in the time spent by the different size crews in contacting huoseholders and in travel between houses. In order to determine the economic value of this difference, these data first were analyzed on the basis of actual cost per house sprayed by both one- and two-man crews during the study.

Table 6

SPRAY EQUIPMENT COSTS PER HOUSE SPRAYED

Unit	Original Cost	Service Years	No. Houses Sprayed per Year Adjusted Value	Cost per House Sprayed
Standard Hand Can	$ 8.50	1	635	$0.013
Hand Can Schraeder Valve (Including cost of Air Reservoir)	$ 20.00	2	710	$0.014
Constant Pressure Hand Can (Including cost of Air Reservoir)	$ 60.00	5	920	$0.013
Constant Pressure Power Sprayer With Compressor	$225.00	10	1,020	$0.022
Without Compressor	$ 95.00	10	1,020	$0.009

The cost of labor, transportation, and materials was included in the cost per house-spray application. On this basis the cost per house sprayed by the one-man crew was approximately $0.24 less than the same operation by a two-man crew. Because of the difference in house size and distance between houses, a cost analysis was made on adjusted values. The amount of operational materials required for an average-size house was used as a basis for data adjustments. When based on adjusted average accomplishments, results indicate that under normal conditions in the rural areas of South Carolina, the total cost per house sprayed by a one-man crew was approximately $0.12 per house less than the cost per house for spraying by a two-man spray crew (table 5).

In comparing relative performance efficiency of different type spray equipment, the same man used four types of equipment for a period of 3 days each. Data collected have been analyzed according to actual and adjusted results. When these are considered, on the basis of houses sprayed per day and together with initial cost, the contact pressure power spray equipment appeared the most efficient and economical of the four types tested.

SUMMARY AND CONCLUSIONS

Operational data pertaining to DDT residual spray crew activities and spray equipment performance are outlined and analyzed. Two one-man spray crews and two two-man spray crews were observed for a period of four full spray days each while operating in typical rural areas of South Carolina. The performance of four different types of spray equipment, used by the same person, was observed for a period of 3 days each. Spray crews were observed while treating 181 dwellings. Activities which normally include 21 elements were timed continuously from the beginning of operations in the morning until equipment was cleaned and stored at night. Related or similar elements were grouped and were averaged for analysis.

The data presented show that where automotive and spray equipment are available in sufficient quantities to complete a season's spray cycle during the early part of the normal insect production season:

1. A one-man residual spray crew is significantly more economical than larger size crews.
2. The difference in cost is the result of time saved contacting householders and in travel between houses.
3. Under conditions prevailing during equipment comparison study, the contact pressure power spray, when provided with adequate length hose, was considerably more efficient than any of the other types tested. However, there are situations in some States where, due to the inaccessibility of houses, power spray equipment would not be suitable.

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MILK COMPOSITION

Information on the "Composition of Milk of Various Mammals" has been compiled for the Zoo Veterinarians by Leonard J. Goss. This is for the use of veterinarians who from time to time find occasion to hand-rear orphaned animals.

Interested persons may obtain this information from: Dr. Patricia O'Connor, Secretary Zoo Veterinarians, Staten Island Zoological Society, Inc., Broadway, West New Brighton, Staten Island 10, N. Y.