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The Secretary of the Expert Committee on Malaria has the honour to communicate hereunder to the Members of the Expert Committee a

NOTE ON THE COST OF ANTIMALARIA CAMPAIGNS
BY MEANS OF RESIDUAL DDT SPRAYING

The cost of the insecticide weighs heavily upon the total costs.

It appears from the annexed table that the cost of the "finished product" (meaning by this term the insecticidal formulation: solution, emulsion, or suspensions of DDT) employed represents a widely varying proportion of the total cost, reaching up to 91 per cent in areas where labour is very cheap. Obviously, many factors play a part in this proportion: the urban or rural character of the area, the dispersion of houses in rural areas, the type of the houses themselves, the technique of spraying and the standard of organization of the campaign, besides the two more evident factors: the price of the insecticide and the price of labour.

The lowest unit costs so far published are those which have been obtained in India where the cost per capita per year can be reckoned at five to eleven U.S.A. cents in recently published experiments and which is nearly of the same order as the minimum cost (cents 5.7) worked out by RUSSELL, KNIPE and SITHAPATHY in 1943 for pyrethrum space spraying, in spite of the increase in wages which had taken place in 1945-46 as compared with 1943 and notwithstanding the high price of DDT in India. It seems that these low costs might be explained partly on account of the wages which are still comparatively low in India, and partly because the finished product, i.e. the formulations of DDT either as a concentrate for emulsion or as a wettable powder, were Indian made and had been produced at low cost.

The cost of solvents or of emulsifiable or wetting agents in the finished product is a very important item in the budget of a campaign.

Today, the price of DDT has reached a very low level, a factory in the U.S.A. having quoted it at \$0.31 per lb.⁽¹⁾

(1) The Pharmaceutical Journal, 21-2-1948, p.139.

Obviously, this reduction will have greater consequence wherever the price of DDT represents a high proportion of the finished product employed for spraying. However, in countries where DDT is employed dissolved in kerosene and kerosene is expensive, it appears that the price of DDT does not even represent half the cost of the solution. In Italy, for example, during the 1947 campaigns, when DDT was quoted at 1,200 lire per kgm and kerosene at 66 lire per kgm (MISSIROLI, personal communication), DDT (employed in a 5 per cent wt/wt solution), it represented only 42 per cent of the cost of the solution, when calculated in volume. If kerosene were cheaper, DDT would naturally represent a higher proportion of the cost: 65 per cent with kerosene at \$0.175 per gallon (Panama, GALINDO & GALLARDO); 74 per cent with kerosene at \$0.07 (also Panama, TRAPIDO), up to 83 per cent in the U.S.A. (STIERLI et al.)

As it is necessary, for the application of DDT, to employ some substance which, though inert, permits its spraying, it stands to reason that this substance should be the cheapest available, provided that the requisite efficiency of the formulation be ensured. Now, if we pay attention to the cost of emulsions as compared with solutions, we find that for the same quantity of DDT, solutions are much more expensive wherever solvents are not cheap. In the U.S.A., calculating the price of DDT at \$0.64 per lb., that of Xylene at \$0.37 per gallon and Triton-X-100 at \$0.34 per lb. on the one hand, and kerosene at \$0.135 per gallon on the other hand, DDT in the form of emulsion costs about 80 per cent of what it would cost in the form of a kerosene solution. In Italy, the 26 per cent Xylene concentrate costs 370 lire per kgm, containing 260 gms DDT; while the same amount of DDT dissolved in 5,200 gms of kerosene, according to the method employed in Italy, would cost:

260 gms DDT at 1200 lire per kgm	=	Lire 320
5200 " " " 66 " " "	=	" 345
	Total	<u>Lire 665</u>

The same amount of DDT employed under the form of an emulsion would cost 56 per cent of what it would cost under the form of a solution. In Greece, the 26 per cent concentrate costs (April 1947) \$1.70 to 1.80 per gallon, and the 35 per cent concentrate costs \$2.00 to 2.10, while a 5 per cent solution in kerosene costs \$1.00 (DDT technical grade \$0.42 per lb.). This means that the same quantity of DDT sprayed on the walls in the form of a water emulsion prepared with the first or the second of these concentrates costs 35 per cent or 29 per cent respectively of what it would cost were it sprayed under the form of a kerosene solution.

If the concentrate is prepared in Greece instead of being imported, the difference is even greater. One hundred and thirty tons of technical grade DDT can be prepared into a 35 per cent DDT concentrate in Xylol and Triton at a cost of \$51,000, as against a cost of \$455,000 for preparing it into a solution of 5 per cent DDT in kerosene; that is, the inert substances employed for arriving at the emulsion cost 1/9 of the solvent;

besides, as is well known, the emulsion is much more economical in a mass campaign than the solution, as it saves much in transport.

In India (PURI, 1947), one ton of DDT (2240 lbs at \$1.12⁽¹⁾ per lb) prepared into a 2.5 per cent kerosene solution (kerosene at about \$0.32 per gallon) costs \$5,376. The same amount of DDT in Indian made concentrate prepared for aqueous emulsions costs, according to various formulations, from \$2,916 to \$3,607, i.e., about 55 per cent or 67 per cent of what it costs in the form of the kerosene solution. But even cheaper than the emulsion would be the suspension. The same amount of one ton of DDT prepared under the form of a wettable powder (which, in the commercial 50 per cent preparation as available in India, costs as much as the 2.5 per cent in kerosene solution, i.e., \$5,376) prepared in India with acacia and/or gelatine, costs from 8,550 rupees to a minimum of 8,456.4 rupees,⁽²⁾ i.e., \$2,537, which represents about 48 per cent of what it would cost in the form of a kerosene solution.

As a consequence, the greatest saving resulting from any reduction in the price of DDT would be obtained when DDT is employed in the form of suspensions, while the smallest saving would occur when used in the form of solutions; for example, if in the above data relating to India, a reduction of the price of technical grade DDT of, say, 33 per cent of the above stated price (\$1.12) is assumed, the cost of the kerosene solution would drop only to 68 per cent, while the cost of the wettable powder would drop to 34 per cent.

Cost of suppressive prophylaxis as compared with residual DDT campaigns

As said above, the lowest per capita yearly cost with DDT residual spraying has been 4.5 cents in India. Also in India, ADHIKARI (1947), carrying out suppressive mepacrine treatment for 210 days, calculates as follows:

- (a) Cost per person per year (0.10 mepacrine daily
for 210 days).....\$1.45
- (b) " " " " " including extra personnel
required for the campaign.....\$2.05

In the above calculations a tablet of mepacrine has been calculated at \$0.0069. If, instead of mepacrine, paludrine

(1) One rupee being calculated at the rate of \$0.30.

(2) Per lb. about \$1.09. It may be noted that in the U.S.A. at least, the 50 per cent DDT wettable powder is much cheaper, the Indian quoted price of technical grade DDT of Rs.37/8 per 10 lbs, i.e. of \$1.12 per lb., being too high. In August 1947 a 50 per cent wettable powder in the U.S.A. (Deenol 50 F) was quoted at \$0.48. In February 1948, prices went down as far as \$0.27 1/4 per lb.

had been used (0.1 twice weekly for 30 weeks, on the basis of \$0.00475 per 0.1 tablet), the cost per person per year would have been \$0.29

If chloroquine had been used (0.5 weekly aralen diphosphate for 30 weeks, on the basis of \$0.025 per tablet), the cost per person per year would have been \$1.50

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T A B L E

showing unit costs of some programmes of malaria control by DDT residual spraying. (Costs are expressed in U.S. currency, foreign currencies being calculated at the official rate of exchange, unless otherwise stated.)

In Column 5 (Price of DDT), figures in square brackets represent the price as arbitrarily assumed by the authors of the paper from which the relevant data are extracted.

In Column 6 (Price of labour), class "a" comprises Engineering aids, Native assistants, or more generally, supervisors; class "b" refers to foremen or qualified workers; class "c" comprises unqualified labourers.

1	2	3	4	5	6	7	8	9	10	11		
Country	Area	Year of operations	Reference	Price DDT Techn. Grade lb. \$	Price of labor per day, in \$	Cost of material as a % of total costs	Formulation of DDT used	Dose of DDT in mgms. x sq. ft. x sq. m.	No. of sprayings per year	Per house	Per capita	Per year Per house Per capita
U.S.A.	Arkansas	1944	KNOWLES & SMITH 1945	0.64	7.04	39%	5% emulsion	64		0.99 ^a	0.25 ^a	
U.S.A.	Georgia	1944	STIERLI et al. 1945	0.64	4.80	61% using power sprayer	" "	200		1.20 ^b		
Puerto Rico	"	"	"			44% hand sprayers	5% "	200		1.39 ^b		
Puerto Rico	"	1945	STEPHENS & PRANT 1947	0.64				147-309	3	1.09	0.20-0.26	0.60-0.80
U.S.A.	(T.V.A)	1944-45	HINMAN et al. 1947	[0.50]	3.33	63.5	5% in kerosene	undet-ermined	3	3.92 ^c		
Panama			TRAPIDO 1946				"			1.31		3.93
Panama	Village of Nata	1946	GALINDO & GALLARDO 1947	0.75	4.33	2.00	"	undet-ermined	2	3.84	0.83	1.66
Panama	Various villages	"	"	"	"	32-4-67	"		2	2.86	0.23-1.27	0.87
Brit. Guiana		1947	GIGLIOLI 1947				" (mainly)	150	1.5		0.58	0.60
Peru	Mala Valley	1947	CORRADETTI 1947	0.45 f			5% in kerosene		1			0.49 ^g
Peru	Various areas	1947	VILLALOBOS (p.c.) 1947			72.5%	" "		1	n		2.35
S. Africa	(Zulu-land)	1945	CLUVER 1946		1.00	91%	5% in paraffin		4	0.35		1.40
Mauritius		1946	TOKING & GEBERT 1947			60%	4.6% in kerosene	146 aver.	1.5		0.60	0.90
India	Jeyapore Hills	1944	SENIOR WHITE 1945	[1.00]	0.40	49%	5% in kerosene	57			0.032	
India	Bombay Prov.	1945-6	VISHWANATHAN et al. 1946	[1.20]		76%	" " or in oil	610	2.3			0.15
India	Various regions	1945	PURI 1947	1.12	1.20	48%	2.5% suspension	50	2		0.037	0.066 ^d
India	Baluchistan	1946	AFRIDI & BHATTIA 1947			60%	2.5% emulsion	25-38	2			0.045 ^e
India	Bombay Pr.		VISHWANATHAN et al. 1948				5% emulsion	56				0.113 ^o
Greece		1947	WHO.IC/Mal.8	0.42		52%	5% emulsion		2.3			0.26
Italy	Various areas	1946	U.N.R.R.A			65% (from 48 to 70%)	5% in kerosene		1			j
Italy	Prov. of Latina	1947	MISSIROLI p.c	k		80%	" "	1169-1740	1			1
Italy	Prov. of Frosinone	1947	RAFFAELLE p.c	k			" "	1800	1			m

- a. Including depreciation of trucks and of sprayers - if these items were excluded, the material and labour costs and houses were \$0.74
- b. Exclusive of overhead expenses
- c. House with its corresponding outbuildings. The cost of spraying per house alone would amount to about \$3.00
- d. Total costs include also overhead expenses and pro rata of equipment (in Indian currency - 3.49 annas)
- e. This cost (in Indian currency 2.4 annas) does not include supervision by a medical officer, which would raise this figure to \$0.074
- f. To this price must be added 20%, that the Ministry of Health must pay to the "Proveduzia General" of the State.
- g. Based on the number of inhabitants protected on 31 December 1947 (77,979) and the total costs of the campaign (\$38,340)
- h. 5 per cent solution of DDT in paraffin, per gallon (Imp.) 6s. 6d. = \$1.30
- i. 4.6 per cent solution of DDT in kerosene, per gallon (Imp.) = \$0.843
- j. Figured at lire 180 per inhabitant
- k. Figured at lire 1,200 per kg.
- l. Cost per square metre of surface treated = lire 5.45
- m. Cost per square metre of surface treated - lire 1.73
- n. Cost per square metre of surface treated = \$0.0075
- o. In Indian currency - 6 annas.