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SCIENTIFIC GROUP ON THE INTEGRATION AND MANAGEMENT OF VECTOR CONTROL IN PRIMARY HEALTH CARE

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VECTOR CONTROL: A PRELIMINARY APPRAISAL OF OPTIONS

SUMMARY

Vector control tactics vary widely from country to country depending upon priorities, available resources and administrative structures. Regardless of the type of programme most vector control activities are labour intensive and costly. Operational performance can be improved for most of these tactics and methods for programme evaluation should be refined to assist policy makers select the best technology and administrative structures for their needs.

Vector control has a place in health programmes and certain aspects of it are suitable for primary health care systems and community involvement. However, decentralization of vector control should have as a prerequisite a group of technical experts at a central base and other technically competent people at the referral levels. Central government commitment to delegate authority and responsibility as well as contribute resource assistance is essential.

Not all vector control activities should be delegated to the peripheral levels. There must be a clearly defined division of labour and a plan of action delineating the role of each level. Furthermore, some control capacity may have to remain at the central level for emergencies and post authority work. Some countries may delay implementation of any vector control to primary health care until the decentralization-primary health care structure has improved.

1. INTRODUCTION

Considering the magnitude of vector-borne diseases and the variety of technical approaches for their control, there are bound to be differences of opinion on the role of vector control, the appropriate technical and managerial approaches.

The World Health Organization estimates about 90 million cases of malaria occur each year. Over 100,000 cases of dengue have occurred in Rio de Janeiro so far in 1986 and it is estimated that between 12 and 24 million people in Central and South America are infected with Trypanosoma cruzi. Cases of onchocerciasis, filariasis, yellow fever and other arboviral diseases, plague, typhus and many other vector-borne diseases add to these health statistics. As Gratz (1986) pointed out, the cost of attempting to either control arthropod-borne diseases or to cure the persons ill from these diseases produces a serious burden on the public health systems of most tropical countries. Vector control is expensive regardless of the vector or country involved and will likely become even more expensive but the alternative of not having vector control would produce a greater burden on public health systems.

Primary health care is considered to be the key to the organization of a more effective and more relevant health care system under the present conditions (Bruce-Chwatt 1983). However, primary health care has been criticized and it is considered to be more successful in curative rather then preventive medicine. Regardless of the administrative mechanism, countries require some form of vector control and the demand will increase with urbanization and population growth. Vector control costs are largely re-occurring ones

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and governments are faced with annual budgetary constraints and changing priorities in competition for funds. Nevertheless, decreases of vector control funds have lead to serious public health and political repercussions. However, budget constraints associated with Proposition 13 in California may have actually produced improved vector control. Unfortunately, the expertise of most countries and the operational proficiency of many programmes indicate that as a role the opposite occurs.

Vector control is sufficiently technical to produce situations beyond the expertise of district health officers. Before too much time is devoted to integration and management of vector control in primary health care it is essential to identify the basic defects in vector control technology and find solutions to improve organizational efficiency applicable to either vertical or horizontal administrative structures.

Although certain technical problems will be mentioned, this paper will deal primarily with administrative ones, such as health priorities, finances, logistics and effective management.

2. HEALTH PRIORITIES

Vector control utilizes different methodologies than prevention and cure of disease. Historically staff were trained differently from many others in ministries of health. For this reason promotion of priorities may be more difficult to achieve within the context of primary health care. Selecting health priorities are complicated because determination of cost-benefit and cost-effectiveness of control or prevention measures of a disease is still primitive. Table 1 provides information on the ten leading causes of morbidity and mortality in 32 countries or areas of the South Pacific. Only a few of these countries list a vector-borne disease and it is assumed that these countries listing them maintain active vector control programmes. However, a decision on health is rarely based only on morbidity and mortality. In many cases the effectiveness of vector control and surveillance activities in the countries not listing these diseases undoubtedly influence their not being on the list.

Brown (1986) using increased agriculture production and relief of population pressure in non-malarial areas as indicators, noted that the anticipated effects of malaria control on economy in Sri Lanka and Sardinia did not occur and in neither case did malaria control result in economic growth. Complex interactions of demographic and socio-economic variables related to disease prevention as well as the problems encountered to justify control programmes using primarily economic indicators account for most of the difficulties.

The decision to control a specific vector will rarely be made by a community without outside influence. In most cases those exerting the influence may lack expertise and information to justify the decision. Guidelines should be established to prepare a technical approach for decision making and to implement the most appropriate action.

3. THE NEED FOR VECTOR CONTROL

Information obtained from the Chagas' disease control programme in Brazil indicated that it costed about US$13 to treat a house with pesticide in 1983. Of 960 deaths studied in an endemic area of Brazil about 53 (5.5%) could be attributed to Chagas' disease. If this figure was applied to the 65 million people living in all endemic areas of Chagas' disease over 3.5 million could die of Chagas related pathology. Pereira (1984) found 4.3% of the deaths in Brasilia could be attributed to Chagas' disease with one out of 10 deaths in the 25 to 64 year-old age group associated with Chagas' disease, thus it ranks with cancer, heart disease and stroke as a cause of death. On the other hand a serological survey in Venezuela in 1980 showed only 1.9% of the 0-19 year-old age group were seropositive whereas a similar survey done about 20 years earlier showed 26.3% of this age group to be seropositive. The difference was attributed largely to the vector control programme.

The Onchocerciasis Control Programme which is vertically structured has estimated the cost-effectiveness for blindness prevention by onchocerciasis control to be US$20 per year of healthy life and per productive year of healthy life added, and US$150 per discounted year of healthy life and per discounted productive year of healthy life added (Prost & Prescott, 1984). It is estimated that over 3 million children have been protected from losing their sight and this number is increasing.

The estimated economic impact of the 1977-1978 dengue epidemic in Puerto Rico ranged from US$6 million to US$15.5 million. The 1976 population of Puerto Rico was 3,223,800 producing a loss per person of about US$1.86 using the lower level and US$4.80 at the higher one.

4. PROGRAMME COSTS

Most countries can ill afford the present costs of vector control. Despite almost continual dengue transmission Knudsen (1986) estimated the annual cost of Aedes aegypti control in 14 Caribbean countries to be over US$12 million and that the cost over the past five years was around US$50 million. When all 26 countries or areas under his supervision were included, the cost for the past five years was between US$75 to 85 million (Table 2).

The 1984 budget for malaria control in the region of the Americas was over US$125 million (Table 3) and for the same year almost US$21 million was spent in Bangladesh, Indonesia and Sri Lanka (Table 4). Sharma and Mehratra (1986) noted that India is now spending about US$160 million annually for malaria control.

In 1982 the budget for mosquito control for Lee County, Florida alone was US$3.3 million and the combined local and state budgets for Florida exceeded US$26 million (Breeland and Mulrenan, 1983). Greater New Orleans spent US$1,114,203 for mosquito control in 1984. The annual budget for the Onchocerciasis Control Programme is now over US$20 million while the cost for control of Chagas' disease was about US$25 million for Brazil (1983), US$4.2 million for Venezuela (1982) and over US$2 million for Argentina (1983). Fleas, lice, ticks, bedbugs, flies, cockroaches and rodent control programmes exist in many countries and urban areas. If money paid to commercial pest control operators and for personal protection (pesticides, coils, bednets, traps, etc.) is included, for example Smith and Gratz (1984) presented an estimate of US$400 million spent annually for cockroach control in Northeastern USA, the annual cost for vector and pest control must be in the billions of dollars.

Smith (1985) using a hypothetical malarial zone of one million population with two spray rounds of DDT estimated the cost per capita of US$1.47. He estimated the global malaria vector control costs (insecticide and operating costs) to be at the order of US$255 million in 1984. The cost of malaria control in the Americas is about US$0.48 per person in endemic areas or about US$1.51 per treated case (Table 3). Bruce-Chwatt (1983) estimated the expenditure for chemotherapy for malaria in Africa, which is considered to cost less than vector control, to be US$1 per person per year and noted that this still might be too high in some health budgets as only about US$0.05 per person per year for all drug procedures is appropriated.

Smith (1982) and Smith and Gratz (1984) surveyed urban vector control in 26 cities in 1982-83 and noted an annual expenditure of US$19,513,437 (Table 5). Calculated on the population of these urban areas, the per capita expenditure was US$0.35 (Table 6). Applying this amount to the 1980 urban population (1062.9 million) estimate for countries excluding Europe and North America, over US$372 million dollars is spent annually controlling vectors. Projecting urban growth to the year 2000 (2225.1 million) but continuing the US$0.35 cost, the estimated annual expenditure will be over US$778 million.

Since the public is already paying the large sum for vector control, the goal should be to use it more efficient. Decentralization of activities through primary health care services utilizing community involvement might eventually increase efficiency or it might produce more activity than a community can absorb. This will be discussed in detail below.

5. ORGANIZATION PROFICIENCY

Few control programmes do an adequate accounting of their expenditures making performance evaluation, cost-effective studies, and cost-benefit studies virtually impossible. In most cases, hidden costs attributed to administration are not included and major expenditure headings are too general for accurate evaluation or are innovations and changes in strategy subjected to cost-effect comparisons. Table 4 on malaria control in Bangladesh, Indonesia and Sri Lanka shows cost in terms of percentage of the total money spent for health ranged from a low of 2.79% in Bangladesh for 1980 to a high of 17.96% in Sri Lanka for 1984. Most of the money was designated for vector control. Surprisingly labour costs as a percentage of the total budget for vector control were low, ranging from 6% in Bangladesh for 1983 to 39% in Indonesia in 1981. On the other hand, 26 urban areas averaged 71.0% of their vector control budget for labour in 1982-83 (Table 6), while labour amounted to 89% of the average costs for Aedes aegypti control in the Caribbean (Table 2). Labour for Chagas' disease control accounts for well over 50% of the operational costs (Tonn, 1984). Labour might be reduced in vector control through community involvement. However, the local worker is more productive when paid for his labour. Furthermore, costs of training, staff replacement, evaluation (i.e. staff development) may initially be higher than for specialized control programmes.

A study in Kern County, California, USA, showed that the cost of a 1% reduction in the mosquito population was related to species and control procedure (Table 7). Similar studies would assist programmes in identifying the most cost-effective methods for a specific control situation. However, few developing countries have the information on costing or the expertise for these comparisons.

Sharma and Mehratra (1986) noted the following problems contributed to malaria resurgence in India; inadequate staff and technical guidance, inadequate supervision, piece meal financing, shortages of DDT and malarial larvicidal oil, insecticide resistance, lack of information on vector and conditions responsible for malaria resurgence, lack of detection of malaria cases, type of housing and human migration. The directors of malaria eradication/control services in the Americas have listed behaviour of vectors, resistance to pesticides, environmental factors, human migration and administrative difficulties as major constraints. Research can assist in reducing the impact of a few of these problems and constraints, but not all. Few factors listed above will be corrected through primary health care and most will be unchanged or will become worse.

6. DECENTRALIZATION-PRIMARY HEALTH CARE-THE COMMUNITY

Three factors are involved in administrative and technical changes in vector control; (1) decentralization of government, (2) role of primary health care services, and (3) community involvement. In theory these factors are suppose to improve vector control but not necessarily reduce its cost. Associated with these factors are redistribution of political power including financial resources, creation of appropriate effective managerial structures, and obtaining public participation. Decentralization, primary health care systems and community involvement are evolving in a variety of forms with different levels of effectiveness and efficiency. The objectives of this change are to shift some political and technical decisions to a lower level to produce greater flexibility for action.

Several constraints are related to these proposed administrative and technical changes. The fundamental constraints will be the technical and administrative competence at the various levels of decentralization and obtaining interest by local populations to become involved in vector control. These constraints may be more serious in rural areas where local governmental structures are primitive and people's priorities are not health oriented. None of these changes can be achieved without a management structure, an educated-motivated public and adequate financing. Consequently without centralized technical and administrative resources, changes may create more problems than they solve.

Vector control activities should be divided at different government levels and it must be recognized that a referral system implies some vertical structuring.

Creation of greater flexibility in vector control through these changes is more theory than fact. Flexibility must be based on the ability to make technical not administrative decisions at lower levels. Unfortunately, technical expertise is not available at any level in many countries or there are too few to function effectively.

Local government, especially where there are large population concentrations, may be capable of selection of vector control priorities and managerial objectives but unless resources are sufficient to provide the required expertise, the objectives will not become operational. The design of an operation requires technical planning and implementation including data collection and analysis necessary for evaluation and action flexibility.

Transfer of vector control activities to primary health care services may have other negative effects. The logistics involved with equipment and pesticides will be more difficult and the amount of equipment required will increase. Since it will not be possible to maintain spare parts at all peripheral levels and pesticide equipment may be used for other purposes, the life span and efficacy of equipment will decrease. Furthermore, there may be a tendency to use simpler less effective equipment. A number of malaria programmes have reported loss of pesticides, mostly re-directed to agriculture; this loss may increase as centralized supervision decreases.

Since vector control is labour intensive and assuming that initially community commitment for it will be weak, another constraint may be the inability of the community to provide effective control or to sustain it (i.e. significant reduction of disease transmission). If this occurs, will interest and support continue.

CONCLUSIONS

Although vector control is important in the control of many vector-borne diseases, its implementation has to fit the priorities of the people and no single option can be recommended. The cost of vector and pest control globally is high and most control programmes being neither efficient nor effective can be improved. At present primary health care probably will not reduce the cost nor initially make control more effective, but it does have the potential for being more cost-effective. However, the willingness of governments and individuals to allocate money for control is an important first step and the improvement of the quality of life probably justifies vector control in most cases. Pilot studies and other small scale field trials will establish ways of integration of priority vector control activities into primary health care systems.

Improvement of vector and pest control in the developing countries will require time to produce local expertise, to select the option most suitable to the overall situation, to determine the most cost-effective approaches toward control of specific insects within the option, and to improve operational performance. Without a well designed plan of action or full commitment of government and people, shifting of control activities into primary health care systems until those systems can cope with curative medicine and more medically oriented problems may further delay this process. That is not to say that vector control should not be a part of primary health care. Two factors must be developed, one is improving education of the people of the community and providing better technical expertise at all levels. The other is redistribution of authority, responsibility and funds to lower levels but maintain a strong centralized technical capability. Community utilization of personal protection, localized environmental management and biological control agents will increase especially for control of selected vectors, but control of others may be beyond the present capacity of the community. As a result, some vector control activities such as those associated with disease epidemics, sea and airport surveillance and control may remain within a more centralized administrative structure. However operational performance of any vector control activity must be constantly evaluated and remain sufficiently flexible to insure change when necessary.

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TABLE 1
IMPORTANCE OF VECTOR-BORNE DISEASES AS REPORTED IN 1985
REVISION OF WPRO DATA BANK ON SOCIOECONOMIC AND HEALTH INDICATORS(1)

		10 Leading Causes of Communicable Diseases Morbidity - Rates/100,000			10 Leading Causes of Communicable Diseases Mortality - Rates/100,000		
	Country/Area	Malaria	Arbovirus	Filariasis	Malaria	Arbovirus	Filariasis
1	American Samoa	0	0	3	0	0	0
2	Australia	3	0	0	0	0	0
3	Brunei Darussalam	0	0	0	0	0	0
4	China	87.2	3.6	0	0	0.3	0
5	Cook Islands	0	0	0	0	0	0
6	Democratic Kampuchea	0	0	0	0	0	0
7	Fiji	0	0	0	0	0	0
8	French Polynesia	0	0	0	0	0	0
9	Guam	0	0	0	0	0	0
10	Hong Kong	2	0	0	0	0	0
11	Japan	0	0	0	0	0	0
12	Kiribati	0	0	0	0	0	0
13	Lao People's Democratic Republic	688	0	0	7	0	0
14	Macao	0	0	0	0	0	0
15	Malaysia	118.5	0	0	0	0	0
16	Nauru	0	7.370	0	0	0	0
17	New Caledonia	0	0	0	0	0	0
18	New Zealand	0	0	0	0	0	0
19	Niue	0	0	0	0	0	0
20	Papua New Guinea	0	0	0	12.0	0	0
21	Philippines	206.8	0	0	0	0	0
22	Republic of Korea	0	0	0	0	0	0
23	Samoa	0	0	0	0	0	0
24	Singapore	0	0	0	0	0	0
25	Solomon Islands	32635.5	0	0	2.0	0	0
26	Tokelau	0	0	0	0	0	0
27	Tonga	0	1389	0	0	0	0
28	Trust Territory of the Pacific Islands	0	0	0	0	0	0
29	Tuvalu	0	0	0	0	0	0
30	Vanuatu	*	0	0	*	0	0
31	Viet Nam	171	128	0	2	1	0
32	Wallis and Futuna	0	191	0	0	0	0

* = Listed but no figures given.
0 = not listed.
(1) = In some cases vector-borne diseases may have been reported under general heading of Communicable or Parasitic Diseases by country.

TABLE 2
ESTIMATED AEDES AEGYPTI PROGRAM (ANNUAL) COST IN
US DOLLARS DURING REPORT PERIOD OF EITHER
1983 or 1985(1)

COUNTRY	YEAR	SALARIES	% OF	EQUIP./SUPPLIES/OTHERS	INSECTICIDE	TOTAL
Anguilla	1985*	23,000	92	500	1,500	25,000
Antigua	1983*	80,000	96	300	3,000	83,300
Barbados	1983*	537,512	92	16,953	30,415	584,880
Bahamas	1983*	174,600	74	27,000	33,500	235,100
Tortola	1985	45,000	86	5,300	2,200	52,500
Dominica	1985**	2,190	24	3,260	3,840	9,290
Grenada	1985	114,000	78	21,100	11,100	146,200
Jamaica	1983*	464,000	80	105,560	12,760	582,320
Montserrat	(Estimation)					50,000
St kitts	1983	3,000	60	500	1,500	5,000
St. Lucia	1983*	75,000	89	6,600	2,500	84,100
St. Vincent	1983	22,800	100			22,800
Gr. Turks	1985	3,000	77		920	3,920
Sub Totals:		1,544,102		187,073	103,235	1,884,410
Trinidad	1985	9,381,833	90	(Comb.)	1,029,417	10,411,200
GRAND TOTALS:		10,925,935	89	187,073	1,132,652	12,295,660

* = Estimates based on previous years data provided by country.
** = Country essentially had no active program during this year.
(1) = Data provided by A.B. Knudsen of AMRO.

TABLE 3
DATA ON MALARIA COSTS FOR THE AMERICAS (1983)

Total population (excluding United States of America)	659,535,000
Population of malarious area	257,276,000
Registered cases of malaria	525,593
Morbidity/1000 inhabitants (total)	138.61
Morbidity/1000 inhabitants (malarious area)	355.33
Budget of malaria operation (US$)	125,306,704.00
Cost of operation/person in malarious area (US$)	0.48
Cost of operation/malaria case (US$)	1.51
Personnel in malaria programmes	26,517

TABLE 4
COST OF VECTOR CONTROL IN NATIONAL MALARIA PROGRAMMES*
(Approximate in US million dollars)

Country and year	Malaria Budget		Spending in Vector Control Activities				
	Total	% of total spending for health services	Insect-icides(1)	Equip. (3)	Labour (%) (1)	Transp. (2)	Total
BANGLADESH							
1980	2.4	2.79	0.31	0.61	0.21(18)	0.03	1.16
1981	2.6	3.29	1.08	0.15	0.32(19)	0.08	1.63
1982	3.1	3.98	0.85	0.55	0.25(15)	0.04	1.69
1983	2.6	3.34	0.80	2.50	0.23(6)	0.05	3.58
1984	2.4	2.81	1.48	0.001	0.19(10)	0.26	1.93
1985	2.3	3.32	1.27	0.20	0.13(7)	0.18	1.78
INDONESIA							
1980	10.43	8.3	5.25	1.26	1.29(15)	0.95	8.75
1981	8.82	5.6	1.81	0.44	1.75(39)	0.54	4.54
1982	10.99	5.7	2.62	1.22	2.04(32)	0.45	6.33
1983	8.76	6.8	4.14	0.19	1.43(23)	0.49	6.25
1984	8.64	4.4	4.34	0.45	1.28(20)	0.48	6.55
1985	7.95	7.9	4.04	0.15	1.29(22)	0.41	5.89
SRI LANKA							
1980	4.9	9.7	2.40	0.21	1.47(32)	0.52	4.61
1981	5.5	10.58	2.60	0.04	1.54(33)	0.49	4.67
1982	6.0	9.9	3.19	0.03	1.80(32)	0.54	5.56
1983	6.2	8.28	3.31	0.07	2.05(34)	0.56	5.99
1984	9.7	17.96	5.04	0.15	2.14(27)	0.54	7.85
1985	10.9	16.61	6.57	0.07	2.49(25)	0.69	9.83

(1) = Total actually spent regardless of origin of sources.
(2) = Total for new purchases and maintenance cost including spare parts.
* = Information provided by SEARO.

TABLE 5
DATA ON COST IN US DOLLARS FOR URBAN VECTOR CONTROL - 1981*

Cities	Budget in US Dollars of Urban Control 1981				
	Total	Personnel	Transport	Pesticides	Other Control
Dar-es-Salaam	269,502	201,248	417	67,837	0
Mombasa	228,152	201,694	5,757	6,650	665
Ouagadougou	39,206	31,760	1,517	3,308	0
Sao Paulo	337,405	286,522	-	50,883	-
Sao Caetano do Sol	45,197	22,599	5,650	11,299	5,650
Bogota	31,111	23,809	952	6,349	0
Port of Spain	551,185	454,366	20,968	42,330	-
Alexandria	348,048	275,252	3,542	69,254	-
Mogadishu	-	-	-	-	-
Khartoum	290,000	215,000	30,000	40,000	5,000
Tel Aviv - Yafo	203,200	21,640	33,600	46,400	-
Adana	337,660	250,250	23,409	64,000	-
Bombay	2,418,390	1,471,378	150,000	655,550	-
Delhi	3,695,000	2,141,304	-	1,183,152	-
Madras	1,112,390	978,260	58,040	76,087	-
Bangkok	245,574	146,724	14,723	83,843	283
Colombo	136,267	79,333	13,889	31,111	0
Rangoon	51,897	38,133	2,221	11,407	-
Agana	91,356	83,318	3,677	843	0
New Orleans	790,758	560,247	29,500	68,400	0
Accra	111,048	74,357	10,006	26,684	0
Freetown	183,192	140,441	-	42,750	-
Alexandria	348,048	273,252	3,542	69,254	-
Jakarta	71,214	11,938	1,605	34,146	-
Kuala Lumpur	1,932,323	1,750,084	46,296	92,593	43,350
Manila	98,562	87,979	-	10,583	-
Singapore	5,389,777	4,856,190	64,864	351,682	-

*From Smith and Gratz 1984.

TABLE 6
DATA ON BUDGET IN US DOLLARS FOR URBAN VECTOR CONTROL - 1981*

Cities	Population	Cost/Person	Number of Staff	% of Budget for Staff
Dar-es-Salaam	1,133,371	0.23	341	74.7
Mombosa	425,000	0.53	181	88.4
Quagadougou	242,000	0.16	21	81.0
Sao Paulo	8,729,823	0.03	103	84.9
Sao Caetano	180,000	0.25	10	50.0
Bogota	6,000,000	0.005	8	76.5
Port of Spain	54,919	10.04	102	82.4
Alexandria	2,500,000	0.14	264	79.1
Khartoum	668,000	0.43	1,773	74.1
Tel-Aviv - Yafo	336,000	0.60	25	10.6
Adana	584,363	0.58	130	74.1
Bombay	8,220,000	0.29	1,681	60.8
Delhi	5,227,077	0.71	4,329	57.9
Madras	4,000,000	0.28	2,296	87.9
Bangkok	5,331,412	0.05	136	59.7
Colombo	585,776	0.23	238	58.2
Rangoon	2,201,183	0.02	1,356	73.4
New Orleans	50,000	0.93	30	70.8
Accra	1,032,716	0.11	297	67.0
Brazzaville	360,000	1.63	-	-
Freetown	276,247	0.66	41	76.7
Alexandria	2,500,000	0.14	264	79.1
Jakarta	6,500,000	0.01	22	16.8
			7	91.2
Kuala Lumpur	1,070,000	1.80	602	90.6
Manila	1,600,000	0.06	39	89.3
Singapore	2,400,000	2.25	1.123	90.1
Average per capita expenditure		0.353	Average	71.0

*From Smith and Gratz 1984.

TABLE 7
COST OF A ONE PER CENT REDUCTION IN MOSQUITO POPULATION BY CONTROL METHOD, KERN COUNTRY MOSQUITO ABATEMENT DISTRICT (1975-76 COSTS)*

Species	Control Method	Cost
Culex tarsalis	Spot locations treated	$ 12.74
	Fills, levees, etc.	$ 70.22
	Sumps (1 year effect)	$234.28
	Ponds (10-year effect)	$ 45.63
	Ditches (1 year effect)	$ 22.49
	Ditches (10-year effect)	$ 4.38
Aedes nigromaculus	Spot locations treated	$ 69.97
	Fills, levees, etc.	$ 47.83
	Ditches (1 year effect)	$ 59.35
	Ditches (10-year effect)	$ 11.55

*Adapted from Sarhan, M.E. et al. 1980. Economic evaluation of mosquito control programs. California Agriculture, November-December 1980:22-24.

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