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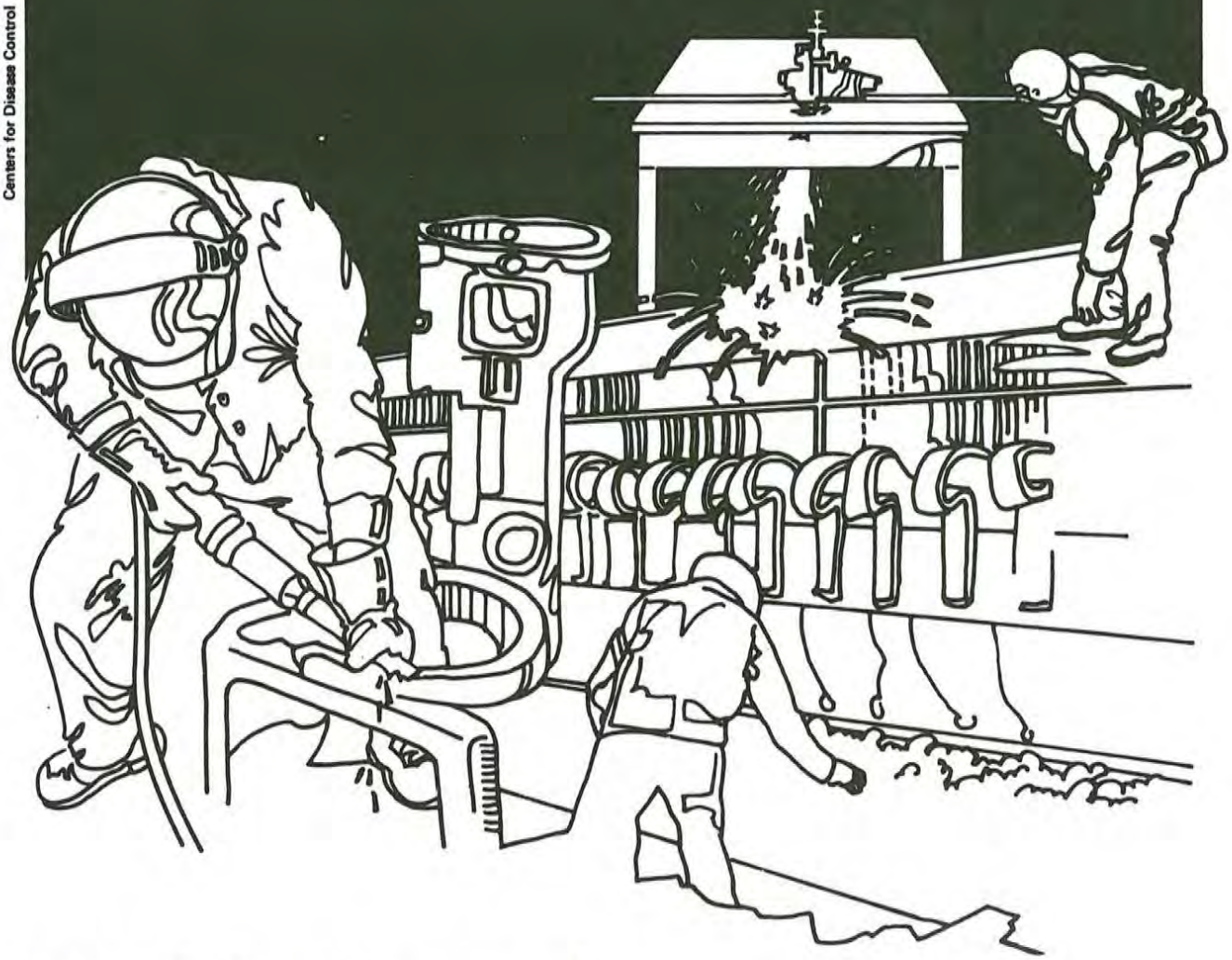

Health Hazard Evaluation Report

HETA 81-040-1315
DOLE PINEAPPLE CORPORATION
LANAI, HAWAII

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 81-040-1315
MAY 1983
DOLE PINEAPPLE CORPORATION
LANAI, HAWAII

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I. SUMMARY

On October 20, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from workers at the Dole Pineapple Plantation for an evaluation of the exposure levels and potential health effects of exposure to dibromochloropropane (DBCP) among employees at the Plantation, located on the island of Lanai, Hawaii. DBCP had been used as a soil fumigant for the control of nematodes at the Dole Plantation for approximately 15 years, and was applied each year during planting operations from February through September. In December 1980, the Dole Pineapple Company informed NIOSH that DBCP would not be used during the 1981 planting season. For this reason, NIOSH investigated only the potential residual health effects of prior exposures to DBCP among workers at the Dole Plantation.

NIOSH investigators conducted an initial walk-through survey on October 29-November 4, 1980. A follow-up visit to discuss the revised protocol was made on January 28, 1981, and the medical evaluation was conducted on February 11-13, 1981. Sixty-one potentially exposed workers and 103 non-exposed workers were invited to participate in the study. Thirty potentially exposed and 31 non-exposed workers (49% and 30% participation rates) were interviewed, had physical examinations, and semen samples were obtained for sperm counts and morphology.

Fifty of the sixty-one participants (82%) gave semen samples. The median sperm count for the 27 men exposed to DBCP (86.5×10^6/ml) was almost identical to that for the 23 non-exposed (85.0×10^6/ml). The sperm morphology results (% oval forms) for both groups were also almost identical (median of 63% among exposed compared to 62% among non-exposed). There was no significant difference among the two groups in cumulative percent distribution of sperm counts. There was also no association between the frequency of oligospermia (defined at sperm count less than 20×10^6/ml) and either exposure to DBCP or length of employment in the pineapple industry.

In general, the results show no major adverse response from DBCP exposure which occurred six months prior to this evaluation. However, the representativeness of the participants is uncertain.

KEYWORDS: SIC 0179, Dibromochloropropane, DBCP, reproductive effects, sperm count, pesticides.

II. INTRODUCTION

On October 20, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from workers at the Dole Plantation for an evaluation of the exposure levels and potential health effects of exposure to dibromochloropropane (DBCP) among workers at the Plantation, located on the island of Lanai, Hawaii. Results of the NIOSH evaluation reported in an Interim Report on July 22, 1981.

III. BACKGROUND

Pineapple production involves the use of a large number of potentially toxic substances, including organophosphates, carbamates, and other halogenated hydrocarbons in addition to DBCP. In 1980, DBCP was used on three islands in Hawaii: Lanai, Maui, and Molokai for pineapple cultivation. A different method of application was used on each island. On Lanai, deep fumigastion was done byu injection, followed one to three weeks later by the laying of mulch. On Maui, a much higher (approximately double) rate of DBCP application per acre is utilized, with the injection done at the same time that the mulch is laid. On Molokai, DBCP was applied by drip irrigation.

The basis for EPA granting of Experimental Use Permit for DBCP application to pineapple fields in Hawaii, despite the prohibition of such use on the mainland, has been the hydrology of the islands. Due to their geology, and characteristics of rainfall collection in aquifers, most of the Hawaiian islands have not had drinking water contamination association with DBCP use. The State Department of Health in Hawaii has been responsible for monitoring drinking water on all islands for DBCP contamination. Contamination at very low levels (parts per trillion) have been found on Oahu, where DBCP is no longer used, and on Maui in some surfact streams which are not a source of drinking water.

Lanai

Commercial pineapple fields on Lanai, as on the other islands, require approximately three years from planting to replanting, and produce two crops during this three year period. The first crop is harvested approximately 21 months after planting. The second harvest, known as the "ratoon" crop, grows from the remaining plant and matures approximately 15 months after the first crop is harvested.

DBCP is injected into the soil as a part of the stage known as "preparation". It is applied to deter infestation of a reniform nematode which is particularly harmful to the roots of the pineapple plant. About one to three weeks after fumigation, the pineapple crowns

are planted. The rate of application used on Lanai was approximately three to four gallons of DBCP in a mixture with approximately 27 to 30 gallons of D-D (a mixture of 1,3-dichloropropene and 1,2-dichloropropene) per acre. Injection is performed using deep chisel applicators. This implement is pulled over the fields by a large tractor that has a single operator in an enclosed cab. The injection is done at a depth of 18 inches.

Fields which are not fumigated with DBCP on Lanai are fumigated with ethylene dibromide (EDB). The choice of fumigant depends upon the soil moisture content of particular field. EDB volatilizes from dry soil beds more rapidly than DBCP. In addition, D-D is injected in all fields, and a wide range of other pesticides including organophosphates, carbamates and other halogenated hydrocarbons are used to protect the plants. A dicarboximide is used for fungicidal treatment of pineapple crowns prior to planting.

The pineapple planting season begins in late February and continues until late September of each year. DBCP is used on a non-continuous basis during these months. The chemical is applied to approximately one-third of the total acreage of Lanai plantation. Fields are chosen for DBCP application by assay (counts) of nematodes in the soil of each field and by previous experience with each field. During most of the season, two eight-hour shifts operate. There are many jobs involved in the preparation and planting stage of pineapple.

Job Descriptions

Tractor drivers and job supervisors are the first jobs involved in the field preparation stage. A team consisting of one tractor driver and one job supervisor load DBCP into the chisel-applicator at the loading area. It is syphoned from 30 gallon drums into a supply truck tank (nurse truct). Rubber gloves, full-face respirators, disposal overalls, and shoe coverings are available. Full-face respirators and rubber gloves, at minimum, must be worn. This work group experiences very little turnover in employment. There are two workers on each shift, and during the season there are a total of six people working in these two job categories. After the nurse truck is loaded, it is driven to the field. The tractor driver and job supervisor then pump the mixture of DBCP and DD into the chisel-applicator, and the tractor driver begins the process of fumigation.

Maintenance

During the planting season, the fumigation equipment has major or minor breakdowns on an average of once per day. The breakdowns usually involve cracked metal on the applicator. The maintenance workers who

come to the fields to repair the fumigators are referred to as "field mechanics", as opposed to "automotive mechanics" who work on machinery not associated with DBCP in the repair shop. Two to three field mechanics are assigned to repair the fumigators in the field each season; their major work is welding of the fumigation rig. Electric arc-welding is used to repair the implements in the field. The workers are given the same protective equipment used by the tractor drivers, but frequently do not use the respirator because of the difficulty of using it when wearing a welding hood. Welders are not allowed to weld the drip tank or hoses in the field. The field welders occasionally have to be substituted during the season because they reported developing an "allergy" to DD.

Surveyors

Within one to two days after the deep injection of DBCP and DD, surveyors enter the field to lay out the road and planting patterns. A total of five surveyors work in this job category during the season. Again, there is little turnover. The only personal protective equipment worn is eye protection (goggles) against dust. Each surveyor spends three to five days in the field to complete the task. (The average field size is 200 acres).

Mulch laying

The team which lays the mulch consists of a tractor driver, three attendants, a job supervisor, and two helpers. The tractor driver drives the mulch layer (paper sled), while attendants ride on the back of the sled to adjust the strips of mulch being laid (mulch is a continuous sheet of polyethylene plastic). The job supervisor rides with the attendants on the back of the tractor and supervises the process. Two helpers are on the ground in the field at varying distances from the tractor, straightening the mulch strips and weighting down improperly covered mulch strips.

The mulch layer injects DD at a distance of 8eight inches by shanks while it is laying the mulch. At the edge of the field the DD pumps are turned off and the shanks are lifted in order to make the turn. Check valves are activated after the run is completed so that no DD leaks out. All of the workers on the mulch layer machine are offered dust goggles, paper or dual cartridge respirators, hard hats, gloves, and boots. Most wear goggles, hard hats, gloves and boots. Respirators use is variable. The rate of DD application during mulching is approximately 30 to 40 gallons per acre. There are usually two mulch machine operators per season. Each team has three attendants. Due to the disagreeable nature of the very dusty work,

there is a great deal of turnover within the attendant category. An estimated 20 persons per year work in this job category. There are four job foremen per year, with very little turnover. There are two helpers per team, with high turnover due to the dusty work conditions. An estimated 40 workers per season may work at this job.

Two shifts of mulch laying teams will work the same field for about two weeks. The mulch laying team enters the field from one day to three weeks after the surveyors have finished.

The surveyors to back into the field, frequently on the same day the mulch has been laid, and walk over the whole field to re-measure it. They spend from one to three days in the field at this point.

Road grading

As soon as the field has been re-surveyed, tractor drivers bring in earth-movers to grade the field. There are three workers in this job category per season, with little turnover. This is cabbed equipment with air-conditioning.

Boom sprayers

Boom sprayers enter the field immediately after the road graders to spray a combination of two pre-emergence herbicides: DCMU (Diuron) and Hyvar (Bromacil). The only worker on the boom sprayer is the driver. There are four drivers per season, and all wear half-face, chemical cartridge respirators.

Crown unloading

From one day to one week after the booms spraying, the crown unloader trucks deposit pineapple crowns at various points in the field. Each team consists of one driver and one controller. The controller judges the number of crowns unloading on the conveyor belt. There are three unloaders of one type and several more of another design, bringing the total of workers in this category to approximately 30 per season.

Planting

One to two days after unloading is completed, workers enter the field to plant the crowns. They may spend a week to several weeks in the same field. About 150 people plant a given field.

Training

All eight job foremen are trained in the State of Hawaii Pesticide Applicators program. None of the other workers receive specific training in health and safety.

Respirator Program

Respirator use was required of DBCP applicators, mulch machine operators during loading of the mulch machine with DD, mulch machine attendants throughout the day, and the boom spray driver. There is no fit testing program.

IV. METHODOLOGY

A. Environmental

No environmental monitoring was done because DBCP application had been suspended for the 1981 season.

B. Medical

The medical evaluation was designed to determine the possible effect of DBCP exposure on the semen quality (sperm count and/or density and sperm morphology) of exposed workers. Comparison of sperm count and morphology between exposed and unexposed workers is the most frequently used method to evaluate the possible association of exposure with effect on the male reproductive system.

With the cooperation of the Dole Pineapple Plantation management and the ILWU Local 142 unit officers, a list of potentially exposed and unexposed job categories were prepared. There were:

EXPOSED:
- fumigation tractor driver
- mechanics (selected)
- surveyors
- mulch layer tractor drivers
- attendants
- helpers
- road grader operators
- boom spray operators
- crown unloaders
- supervisors for the operations listed above

NON-EXPOSED:
- storeroom workers
- harbor workers
- transportation workers
- planters
- irrigation workers

All workers in the exposed categories listed above were invited to participate in the study. Because more than half of the workers are of Filipino origin, and many have a limited knowledge of

English, Ilokano interpreters were used both to discuss participation and in the medical interviews. Sixty-three non-exposed men were asked to participate and were scheduled for examination. During the course of the study another thirty-eight non-exposed were asked to participate because of the low participation rate of the original non-exposed group. All workers were invited to attend a general information meeting explaining the purposes of the study and the method of semen sample collection. Participating individuals were asked to abstain from sexual intercourse for 48 hours before collection a sample.

Participating workers were interviewed and physically examined by NIOSH physicians in the Lanai Hospital outpatient department. The workers were given clear plastic containers for the collection semen samples, and asked to return them to the same location. The semen samples were then analyzed by Dr. Jane Rogers and technical staff of the Kapiolani Children's Medical Center on site in Lanai for sperm count and routine morphology.

V. EVALUATION CRITERIA

Dibromochloropropane (DBCP)

Dibromochloropropane (DBCP), a nematocide, has been recognized as a testicular toxin in animals since 1961[1], and in humans since 1977 [2,3]. DBCP is also a mutagen[4] and an animal carcinogen[5], and has been associated with chromosomal abnormalities in one study of DBCP-exposed male workers[6]. Based on the evidence for carcinogenicity, OSHA promulgated a temporary emergency standard for DBCP in 1977, and in 1978 promulgated a final standard for airborne exposure of 1 ppb (TWA). The EPA restricted DBCP use in the continential United States in 1978, also to protect against potential carcinogenic effects. An Extended Use Permit for DBCP was granted for pineapple cultivation in Hawaii.

Although epidemiologic studies done in manufacturing and formulating facilities have gound azo- and oligospermia among workers exposed to low levels of DBCP[2,3], there have been few studies of applicators and other field workers that are exposed to DBCP on a regular basis. Glass et al found a statistically significant decrease in sperm counts among California pesticide applicators that had a minimum of two months' exposure to DBCP during the preceding year[8]. Sandifer et al, in a study of pesticide applicators from six states, also found a significant decrease in sperm counts associated with DBCP exposure.[9] Partial recovery has been shown in some studies.

More recently, agricultural workers involved in pineapple production on the island of Molokai in Hawaii were studied by the Pacific BioMedical Research Studies Center.[10] In a comparison of 13 workers (4 drip irrigators, 4 agricultural research workers, and a miscellaneous group of other agricultural research workers, and a miscellaneous group of other agricultural workers) with 18 local controls and with the fertile Honolulu population, a significant decrease in mean sperm count was detected. In addition, an increase in the rate of spontaneous abortion among wives of DBCP field applicators has also been reported[11]. This is presumed to be due to the effect on the sperm rather than due to direct effect on the woman or embryo. None of these studies of agriculatural field workers, however, have attempted to correlate sperm count with measured occupational exposure to DBCP.

VI. RESULTS

Sixty-one workers participated in the medical interview and physical examination. Of these, thirty were from potentially exposed job categories and thirty-one from unexposed categories. Three individuals had not been invited to participate, but presented themselves at the time of the study and asked to be included. Table I summarizes the participation in the examination.

Table II presents descriptive statistics for demographic information. The median age of the cohort is 49 years. 82% are married, and 85% have fathered at least one child. Only one man had had a vasectomy. The medical interview and physical examination did not reveal any pattern of positive responses or findings exceeding what would be expected based on clinical experience.

Of the 61 men interviewed and examined, only fifty (82%) contributed semen samples for analysis. Twenty-seven were potentially exposed to DBCP, and 23 non-exposed. Those who contributed semen samples tended to be younger than those who did not, and had not been in the pineapple industry as long as those men who declined to provide samples (median age of those who provided ssamples was 48 years, versus 53 years for non-contributors; median years in the industry were 13 versus 27).

The results of the semen analyses are presented in Table III. The median sperm count for all 50 men is 85.7 x 10^6/ml). The median sperm count for the 27 men exposed to DBCP 86.5 x 10^6/ml) is almost identical to the median sperm count for those 23 non-exposed (85.0 x 10^6/ml). The morphology results as percentage of oval forms for both groups were also almost identical for both median and mean in the two respective groups (63% and 60% compared to both median and mean in the two respective groups (63% and 60| compared to 62% and 61.5%). Table IV shows the sperm count cumulative percent distribution for the two groups. There is no significant difference between the two distributions (p. >0.05) when compared by the Kolmogrov-Smirnov test.

The possible association of the frequency of oligospermia (low sperm count, defined as less than 20 million per ml) with exposure to DBCP or length of time in the pineapple industry was also evaluated. Table V presents the results of these tests. There does not appear to be any association between exposure to DBCP or length of time in the industry and oligospermia.

As summarized in the background, DBCP can produce both permanent and reversible adverse effects on the testes. Since this evaluation was done some six months after DBCP was last used, only the more severe and/or permanent effects would be likely to be detected. There was adequate time for recovery to occur; thus, the transient or slight injury would not be detected.

The data indicate that no difference in semen quality parameters of sperm counts and oval form morphology was found between the 27 employees with DBCP potentially exposed jobs and the 23 in non-exposed jobs. A major problem in evaluating these results was the low participation rate, which was due in some part to severe weather problems; on two of the examination days, there was no work due to previous night rains. Half (49%) of the exposed individuals identified by the company and union came for the initial physician interview and examination and 44% provided a semen sample. Obtaining a control or non-exposed group was much more difficult, as indicated in the results and Table I. Of the group 103 identified as non-exposed, 30% participated in the initial physician interview and examination and 22% provided semen samples. The low rate of participation does not appear to be due to lack of effort by the union nor the company; the union worked hard to encourage men to be examined, and the company provided four hours off with pay as incentive to participate.

In general, the results show no major adverse response from DBCP exposure which occurred six months prior to this evaluation. It is unknown whether or not these results are representative, because of the low rate of participation or because the actual number of eligible workers was not ascertainable.

VII. RECOMMENDATIONS

Because DBCP is no longer used at the Dole Pineapple Plantation, no recommendations are offered at this time.

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Dole Company
2. Requestor
3. NIOSH, Region IX
4. OSHA, Region IX

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days..

TABLE I

Number of Individual Participants in the Initial Phase of the Examination by Exposure Category

Dole Pineapple Corporation
Lanai, Hawaii
HETA 81-040

	Total	Participants	%
Potentially Exposed to DBCP			
Originally scheduled: hourly employees	47	24	51
salaried employees	13	5	38
Non-scheduled employees	1	1	100
Total	61	30	49
Non-exposed			
Originally scheduled: hourly employees	62	20	32
salaried employees	1	1	100
Second group requested to participate	38	8	21
Non-scheduled employeed	2	2	100
Total	103	31	30

TABLE II

Descriptive Information
LANAI

Dole Pineapple Corporation
Lanai, Hawaii
HETA 81-040

	Number	Percent
Number in cohort	61	100
Married	50	82
Born in U.S.	26	43
English is first language	28	46
Smoke cigarettes	31	51
Ever heavy drinkers	25	41
Fathered children	52	85
Lifetime U.S. residents	22	37
Vasectomy	1	2
Trouble producing pregnancy	8	20*
Ever miscarriage	10	20*
Ever stillbirth	1	2*
Exposed to DBCP	30	49
Supplied semen sample	50	82

* Excludes men who were never married.

TABLE III

Semen Sample Results

Dole Pineapple Corporation
Lanai, Hawaii
HETA 81-040

	Volume (ml)	Count (10^6/ml)	Morphology (% Oval Forms)
Total Group:			
Median	2.3	85.7	62.5
N=50			
Exposed:			
Median	2.3	86.5	63.0
N=27			
Non-exposed:			
Median	2.0	85.0	62.0
N=23			

TABLE IV

Cumulative Percent Distribution for Sperm Counts for the 27 DBCP Exposed Men and the 23 Non-exposed Men at

Dole Pineapple Corporation
Lanai, Hawaii
HETA 81-040

Sperm Count x 10^6/ml	EXPOSED N	EXPOSED Cumulative Percent	NON-EXPOSED N	NON-EXPOSED Cumulative Percent
0	0	0	0	0
>0<10	2	7.4	2	8.7
10-19	2	14.8	0	8.7
20-29	1	18.5	3	21.7
30-39	2	25.9	1	26.0
40-49	0	25.9	2	34.7
50-59	3	37.0	2	43.4
60-69	1	40.7	1	47.7
70-79	1	44.4	0	52.0
80-89	2	51.8	1	52.0
90-99	2	59.2	2	60.7
100-109	2	66.6	3	73.7
110-119	2	74.0	1	78.0
1220-129	3	85.1	0	78.0
130-139	0	85.1	1	82.3
140-149	1	88.8	0	82.3
>150	3	100.0	4	100.0
Total	27		23	
Median Sperm Count	86.5		85.0	
Median Age (Years)	51		44	

TABLE V

Observed (and Expected) Frequencies of Oligospermics and Normospermics by Exposure Classification and Duration of Employment - Age Selected Control Group

Dole Pineapple Corporation
Lanai, Hawaii
HETA 81-040

	Oligospermics*	Normospermics
Exposed	4 (3.9)	15 (15.1)
Non-exposed	2 (2.1)	8 (7.9)

Odds Ratio = 1.1
= .01
= 1

	Oligospermics*	Normospermics
>10 years work in pineapple	4. (4.7)	18 (17.3)
<10 years work in pineapple	2 (1.3)	4 (4.7)

Odds Ratio = 0.4
= 6.1
.25< p <.5

*Sperm count < 20 x 10^6/ml

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