

# **OCCUPATIONAL HEALTH RISK ASSESSMENT (OHRA) AND HEALTH EFFECTS AMONG WORKERS IN BIOGAS PALM OIL PLANTS, SABAH**

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# BACKGROUND OF STUDY

- Malaysia has developed its palm oil industry to become one of the major palm oil exporters and producers in the world

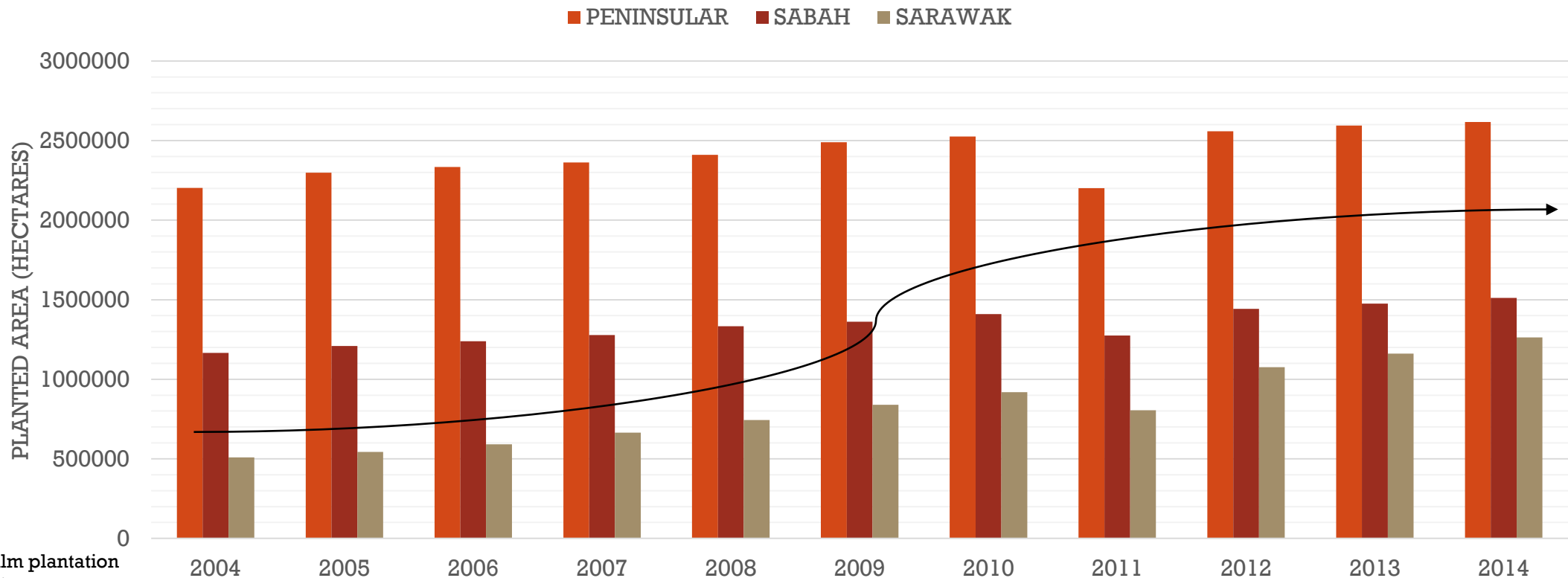
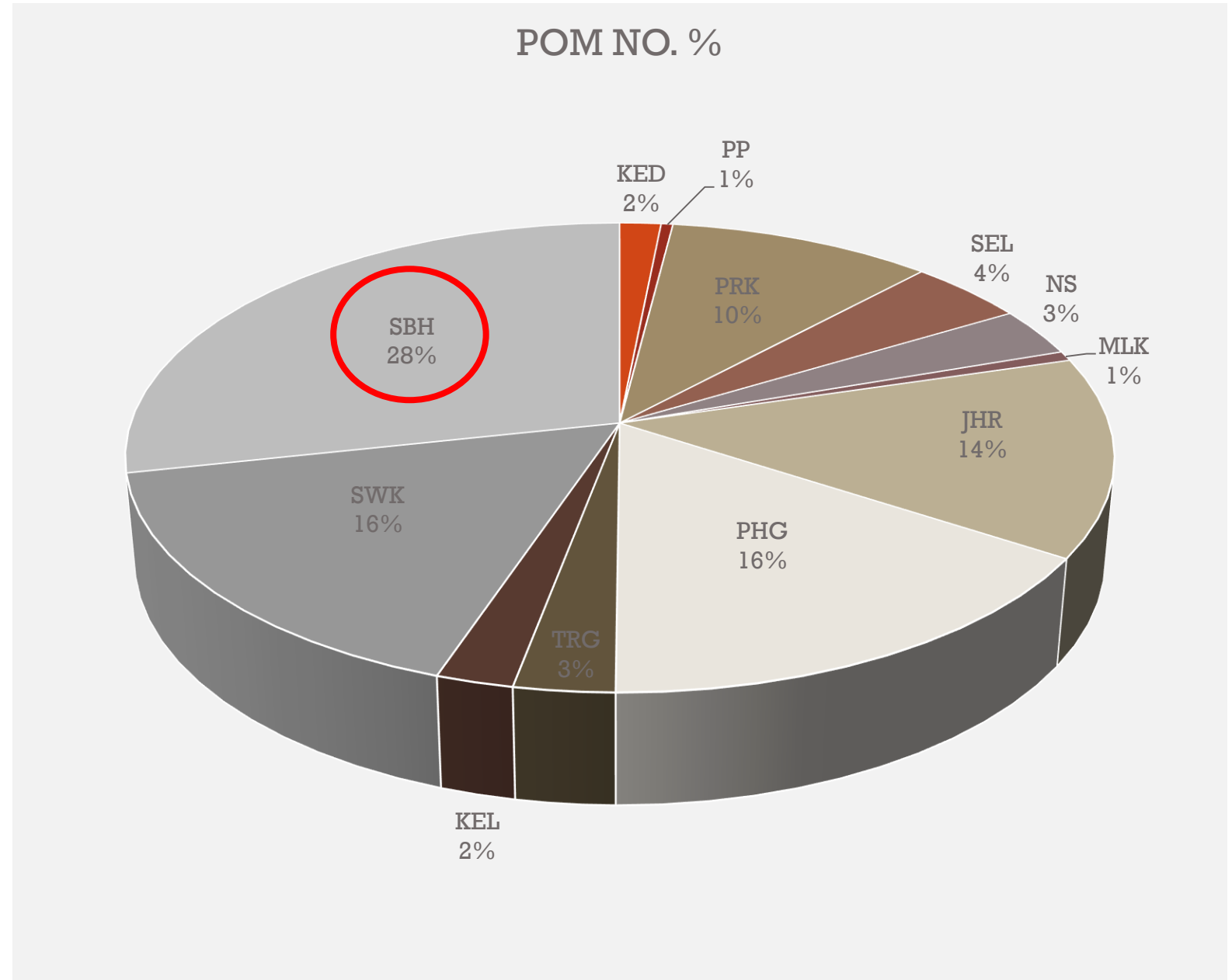


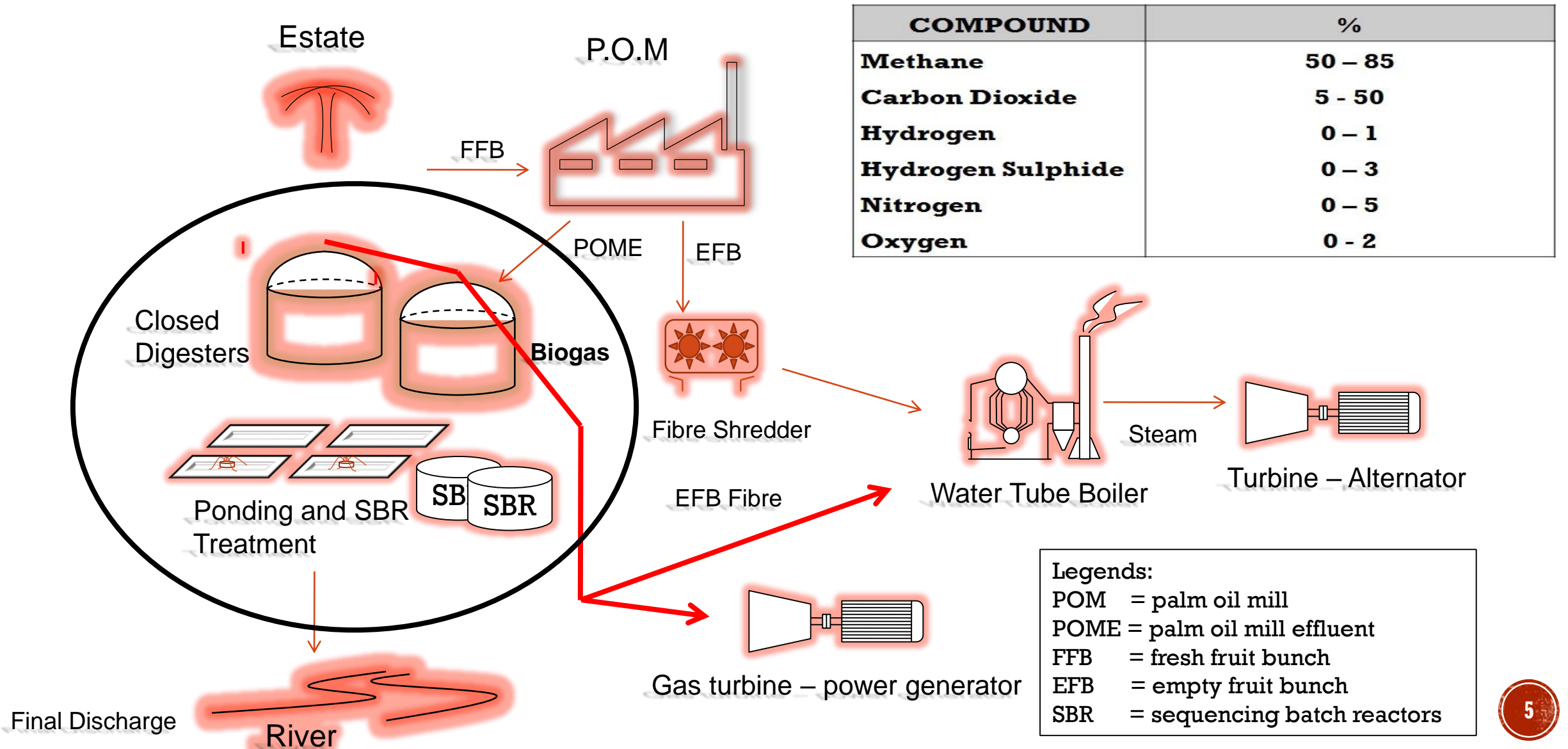
Figure 1: Oil palm plantation areas in Malaysia  
Source: MPOB

**FIGURE 2: PALM OIL MILL (POM) 2015 STATISTIC IN MALAYSIA (SOURCE: MPOB)**

STATE	POM No.
PRS	0
KED	7
PP	2
PRK	45
SEL	20
KL	0
NS	15
MLK	3
JHR	62
PHG	72
TRG	13
KEL	10
SWK	74
SBH	128
LBN	0



# OVERVIEW OF PALM OIL MILL



# PS1: HEALTH EFFECTS AT BIOGAS PLANT

- 57 million tonnes of POM effluents was generated in 2011 (*Chin et al., 2013*)
- Workers in biogas plant are often exposed to very high levels of bioaerosol microorganisms
  - Development of hypersensitivity pneumonitis,
  - Organic dust toxic syndrome
  - Decline in lung function,
  - Severity of asthma,
  - Respiratory symptoms
  - Airway inflammation (*Douwes, 2003*)



# PS2: INCIDENTS IN BIOGAS PLANT

- 4 Germany workers dead due to release of a extremely high concentrated H<sub>2</sub>S (*Casson Moreno et al., 2015*)
- 1 fatality case due to explosion in biogas plant, Terengganu (*Utusan Online 26<sup>th</sup> Jan, 2010*)
- Fire incident in biogas plant in Sabah (*DOSH incident report 2015*)

# PS3: TOXIC GAS IN BIOGAS PLANT

- Hydrogen sulphide ( $H_2S$ )
  - Toxic with fatalities ( $>500$  ppm)
  - Low odor threshold (0.008 ppm) - high level exposures as they may not be recognized
- In biogas plant,  $H_2S$  content is low but very high toxicity (*Petre Travnicek, 2015*)
- Chronic exposure of low levels  $H_2S$  is significant with higher frequencies of respiratory symptoms (*Legator, Singleton, Morris and Philips, 2001*)



# STUDY OBJECTIVES

1 To identify the health effects among workers in biogas palm oil plants

2 To measure the occupational health risk assessment (OHRA) score among workers in biogas palm oil plants

3 To determine the difference of OHRA score between new biogas plant and old biogas plant

4 To determine the factor that influences the OHRA score of the biogas palm oil plants

5 To determine the factor that influences the health effects of workers in palm oil plants

# RESEARCH QUESTIONS



What is the difference of health effect between workers in biogas plant and workers in unexposed group?



What is the OHRA scores in biogas palm oil plants?



What is the difference of OHRA scores between new biogas plant and old biogas plant?



What is the factors that influences the OHRA score of palm oil plants?



What is the factors that influences the health effects of palm oil plants?

# RESEARCH BACKGROUND & LOCATION

- Cross sectional study
- April – November 2016
- Location → biogas plant in Sabah



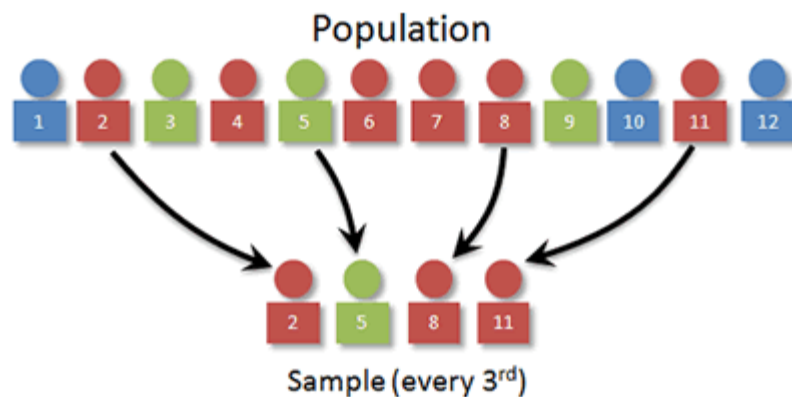
# SAMPLE SELECTION

## Biogas plant population

- 21 biogas palm oil plant in Sabah was selected
- Kota Marudu, Keningau, Sandakan, Lahad Datu & Tawau

## Respondents population

- Sample determinations; Two proportions formula one (Pocok)
- Exposed group in biogas plant; 5-10 respondents per plant (universal sampling)
- Unexposed group in palm oil mill; 5 respondents per palm oil mill (random sampling)



# TOOLS AND STUDY PROCEDURES

- Health effects –
  - Standardized questionnaire – DOSH (occupational health section) – by self administered.
  - spirometer (MIR spirometry II spirometer) – conducted by occupational health section and researcher



- Occupational Health Risk Assessment (OHRA) – DOSH and Petronas Technical standard – assessed by researcher

# DATA ANALYSIS

## Descriptive Statistic

- SPSS version 22.0
- Univariate level analysis
- means, medians, mode and standard deviations - to describe central tendencies

## Inferential Statistic

- SPSS version 22.0
- $t$  -test, Mann-Whitney test, chi-square and correlation - bivariate level analysis
- Multivariate analysis, logistic regression



# RESULT & DISCUSSION

- Response rate;

- i. Biogas plant = 90%

- ii. Respondents = 92% (exposed group), 90% (unexposed group)

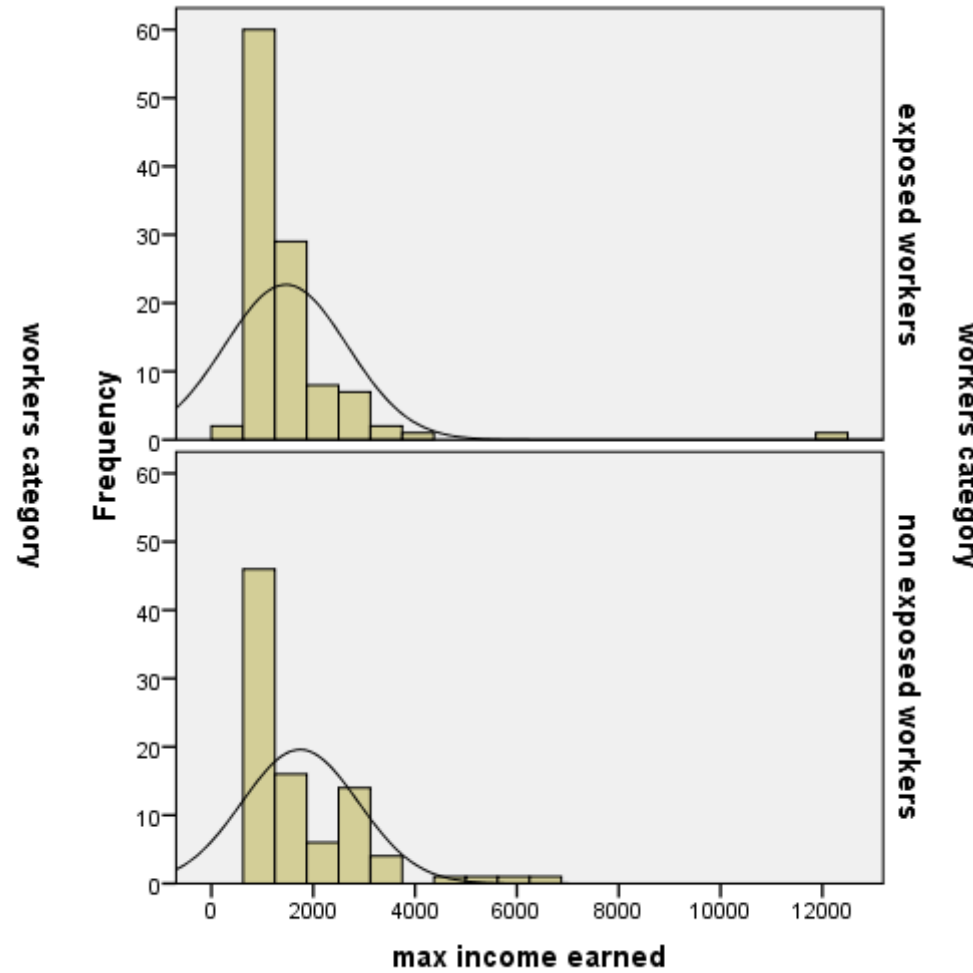
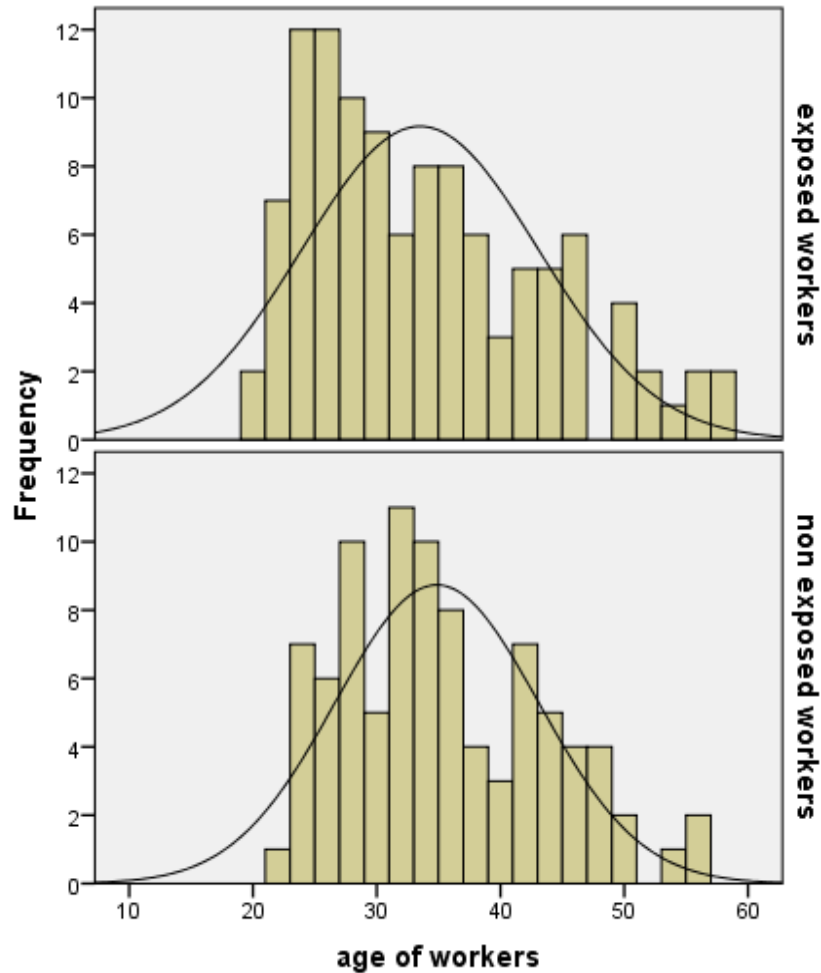


$$\begin{aligned} \text{Response rate for biogas plant} &= \frac{\text{biogas plants involved}}{\text{Actual biogas plants involved}} \times 100 \\ &= \frac{19}{21} \times 100 \\ &= \mathbf{90\%} \end{aligned}$$

$$\begin{aligned} \text{a. Response rate for exposed group} &= \frac{\text{respondents involved}}{\text{Actual respondents involved}} \times 100 \\ &= \frac{110}{120} \times 100 \\ &= \mathbf{92\%} \end{aligned}$$

$$\begin{aligned} \text{b. Response rate for unexposed group} &= \frac{\text{respondents involved}}{\text{Actual respondents involved}} \times 100 \\ &= \frac{90}{100} \times 100 \\ &= \mathbf{90\%} \end{aligned}$$

# NORMALITY TEST



Kolmogorov-Smirnov Test;

- Age ( $p$ -value  $< 0.05$ )
- Monthly income ( $p$ -value  $< 0.05$ )



# RESPONDENT'S DEMOGRAPHY

Variables	Frequency (%)		X <sup>2</sup> -statistic <sup>a</sup>	p-value
	Exposed (n=110)	Unexposed (n=90)		
<b>Gender</b>				
Male	101 (55.8)	80 (44.2)	0.49	0.482
Female	9 (47.4)	10 (52.6)		

<sup>a</sup> Pearson Chi-square Test was applied

Variables	Median (IQR)		Z-statistic <sup>a</sup>	p-value
	Exposed (110)	Unexposed (90)		
<b>Age (yrs)</b>	32 (15)	33 (13)	-1.48	0.139
<b>Education period (yrs)</b>	11 (3)	11 (4)	-1.78	0.075
<b>Monthly income (RM)</b>	1200 (705)	1216 (1505)	-1.71	0.087

<sup>a</sup> Mann-Whitney Test was applied

# OBJ1: TO IDENTIFY THE HEALTH EFFECTS AMONG WORKERS IN BIOGAS PALM OIL PLANTS

Variable	Frequency (%)		OR (95% CI)	X <sup>2</sup> - statistic <sup>a</sup>	p-value
	Exposed (n=110)	Unexposed (n=90)			
<b>Lung function test result</b>					
Normal	44 (40.0)	51 (56.7)	1.96 (1.12, 3.45)	5.51	0.019 <sup>b</sup>
Abnormal	66 (60.0)	39 (43.3)			

N=200,

<sup>a</sup> Pearson Chi-square Test was applied,

<sup>b</sup> significance at p<0.05

- Exposure of H<sub>2</sub>S and endotoxin associated with respiratory health
  - Eduard, Omenaas, Sigvald Bakke, Douwes and Heederik (2004) studied for farmers
  - Portengen, Preller, Tielen, Doekes and Heederik (2005) studied for pig farmers
  - Carlsen, Zoëga, Valdimarsdóttir, Gíslason and Hrafnkelsson (2012) studied for Iceland population

# OBJ1: TO IDENTIFY THE HEALTH EFFECTS AMONG WORKERS IN BIOGAS PALM OIL PLANTS

Variable		Frequency (%)		X <sup>2</sup> -statistic <sup>a</sup>	p-value
		Exposed (n=110)	Unexposed (n=90)		
Eye irritation	yes	18 (16.4)	18 (20.0)	0.44	0.505
	no	92 (83.6)	72 (80.0)		
Nose congested	yes	19 (17.3)	14 (15.6)	0.11	0.745
	no	91 (82.7)	76 (84.4)		
Chronic cough	yes	2 (1.8)	3 (3.3)	0.47	0.495
	no	108 (98.2)	87 (96.7)		
Shortness breath	yes	12 (10.9)	2 (2.2)	5.74	0.017 <sup>b</sup>
	no	98 (89.1)	88 (97.8)		
Wheezing	yes	5 (4.5)	7 (7.8)	0.92	0.338
	no	105 (95.5)	83 (92.2)		
Chest discomfort	yes	17 (15.5)	9 (10.0)	1.30	0.254
	no	93 (84.5)	81 (90.0)		
Abdominal pain	yes	24 (21.8)	9 (10.0)	5.01	0.025 <sup>b</sup>
	no	86 (78.2)	81 (90.0)		
Vomiting / queasiness	yes	23 (20.9)	16 (17.8)	0.31	0.578
	no	87 (79.1)	74 (82.2)		

<sup>a</sup> Pearson Chi-square Test was applied

<sup>b</sup> significance at p<0.05

# DISCUSSION OBJ1

- The shortness of breath –
  - Result match those observed by Legator *et al.* (2001) at communities who exposed to low levels of industrial sources of H<sub>2</sub>S.
- Abdominal pain –
  - Employees in the sewage treatment plants were more common to have gastrointestinal tract symptoms than control groups (*Thorn and Kerekes , 2001*).
- Other health effects –
  - Similar studied by Legator *et al.* (2001) at communities who exposed to low levels of industrial sources of H<sub>2</sub>S.

# OBJ2: TO MEASURE THE OHRA SCORES AMONG WORKERS IN BIOGAS PALM OIL PLANTS

Item	Health Hazard Related to Respiratory System	
	Toxic Gas	Bioaerosol Dust
	<b>Hazard classification or health effect</b>	Acute: toxicity category 2 (inhalation) and chronic: may cause to respiratory disease
<b>Work unit</b>	Biogas operator & supervisor, maintenance technician, lab attendant	Cooling pond operator, biogas operator & supervisor

Item	Health Hazard Related to Respiratory System	
	Toxic Gas	Bioaerosol Dust
	<b>Mean of hazard rating</b>	3.37
<b>Mean of exposure rating</b>	3.53	2.00
<b>Risk rating</b>	11.89	5.68
<b>Risk category</b>	Medium	Medium

Likelihood (L)	Severity (S)				
	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

High ■  
 Medium ■  
 Low ■

# OBJ3: TO DETERMINE THE DIFFERENCE OF OHRA SCORE BETWEEN NEW BIOGAS PLANT AND OLD BIOGAS PLANT

Variable	Median (IQR)		Z-statistic <sup>a</sup>	p-value
	New Plant	Old Plant		
<b>OHRA</b>				
toxic risk score	9.00 (0)	12.00 (4)	-3.68	<0.001 <sup>b</sup>
bioaerosol risk score	4.00 (2)	6.00 (1)	-2.27	0.023 <sup>b</sup>

N=19, <sup>a</sup> Mann-Whitney Test was applied, <sup>b</sup> significance at p<0.05

# OBJ4: TO DETERMINE THE FACTOR THAT INFLUENCES THE OHRA SCORE OF THE BIOGAS PALM OIL PLANTS

Dependent Variable (respiratory health risk assessment score)		Regression Coefficients (b)	t-statistic	p-value
<b>By toxic gas</b>				
	(constant)	7.948	5.18	< 0.001 <sup>a</sup>
	Duration of biogas plant operation	0.873	6.40	< 0.001 <sup>a</sup>
	Workers number	-0.047	-0.32	0.751
	H <sub>2</sub> S gas reading	0.311	2.64	0.020 <sup>b</sup>
<b>By bioaerosol dust</b>				
	(constant)	3.774	3.17	0.007 <sup>a</sup>
	Duration of biogas plant operation	0.663	3.01	0.010 <sup>b</sup>
	Workers number	-0.062	-0.29	0.778
	Bioaerosol dust reading	-0.145	-0.82	0.426

N=19

<sup>a</sup> significant at p < 0.01    <sup>b</sup> significant at p < 0.05

Regression method: enter

F value = 14.82 (toxic) / 4.32 (bioaerosol)

R<sup>2</sup> = 0.851 (toxic) / 0.624 (bioaerosol)

# DISCUSSION ON OBJ4

- Duration of biogas plant operation by toxic gas -
  - Pukkala & Pönkä (2001) studied at residential housing on a former dump area containing industrial and household waste in Finland → the relative risk slightly increased with the number of years lived in the area
- Duration of biogas plant operation by bioaerosol dust -
  - Herr et al. (2003) examined the health effects on community residents of bioaerosol, emitted by a composting plant associated to periods of residency over 5 years



# OBJ5: TO DETERMINE THE FACTOR THAT INFLUENCES THE HEALTH EFFECTS OF WORKERS IN PALM OIL PLANTS

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Step 1 <sup>a</sup>								
age of workers	-.026	.020	1.817	1	.178	.974	.937	1.012
working period in mill	.035	.026	1.863	1	.172	1.036	.985	1.089
education period	-.044	.042	1.124	1	.289	.957	.882	1.038
active in sport or exercise(1)	-.970	.308	9.941	1	.002	.379	.207	.693
smoking(1)	.051	.310	.027	1	.869	1.052	.573	1.931
drinking alcohol(1)	-.025	.570	.002	1	.965	.976	.319	2.981
eating seafood(1)	-.027	.306	.008	1	.930	.973	.535	1.772
BMI measurement as standard formula	-.052	.035	2.240	1	.134	.949	.886	1.016
Constant	2.903	1.181	6.046	1	.014	18.234		

a. Variable(s) entered on step 1: age of workers, working period in mill, education period, active in sport or exercise, smoking, drinking alcohol, eating seafood, BMI measurement as standard formula.

# IMPLICATIONS OF STUDY

- Biogas plant environment has significant effects to the workers' health especially related to shortness of breath and abdominal pain, exposed to medium occupational health risk and old biogas plant.
- Active in sport or exercise has protective role from getting respiratory health effect in palm oil plant.

# RECOMMENDATIONS

1. Medical surveillance for workers who exposed to H<sub>2</sub>S should be conducted periodically in biogas plant.
2. The outcome of occupational health risk assessment and the status of biogas plant, should be monitor closely and control effectively by the employer.
3. The safety and health committee should encourage employees to do continuous physical activity and healthy lifestyle.
4. Future research on biochemical blood test and environmental air sampling appropriately to be conducted.

# CONCLUSIONS

1. Biogas plant environment has significant effects to the workers' health especially related to shortness of breath and abdominal pain.
2. There was medium risk level in biogas palm oil plants in Sabah.
3. There was significant difference in the occupational health risk assessment score between the new and old biogas palm oil plants in Sabah.
4. The longer duration of biogas plant operation, the higher occupational health risk assessment score.
5. Active in sport or exercise has protective role from getting respiratory health effect in palm oil plant.

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# PHOTOS





**Q & A**

**Thank you**