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Farming, pesticide exposure and respiratory health: a cross-sectional study in Thailand

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Title

Farming, pesticide exposure and respiratory health: a cross-sectional study in Thailand

Authors

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Key messages

1. What is already known about this subject?

Farm work – including the use of pesticides – has been associated with adverse respiratory health effects. Few studies, however, have used spirometry to examine the risks of chronic airflow obstruction in the context of agricultural work in low- or middle-income countries.

2. What are the new findings?

In a rural community in Thailand, chronic airflow obstruction was uncommon; as with other studies in developing countries, villagers had a low prevalence of smoking. Most farmers applied pesticides regularly but neither this nor other farming practices is likely to be a major cause of chronic respiratory problems in this setting.

3. How might this impact on policy or clinical practice in the foreseeable future?

Agriculture plays a fundamental economic role in developing countries and the use of pesticides is crucial in modern farming practice. While the findings of this work are reassuring, health education and training in self-protection training for farming villagers remain important.

Abstract

Objective To assess the association of lung function and respiratory symptoms with farming, particularly pesticide use in an agricultural province in Thailand.

Methods We undertook a cross-sectional survey of adults aged 40 to 65 in Nan province, Thailand, between May and August 2019. We randomly recruited 345 villagers and enriched the sample with 82 government employees. All participants performed post-bronchodilator spirometry and completed a questionnaire covering information on respiratory symptoms, farming activities, pesticide use and known risk factors for respiratory disease. Associations of respiratory outcomes with farming and pesticide exposures were examined by multivariable regression analysis.

Results The response rate was 94%. Only 11% of the participants were current smokers. The prevalence of chronic airflow obstruction among villagers was 5.5%. Villagers had on average a lower percent predicted post-bronchodilator FEV₁/FVC than government employees (98.3% versus 100.3%; p=0.04). We found no evidence of association of respiratory symptoms or lung function with farming activities, the use of specific herbicides (glyphosate and paraquat), insecticides (organophosphates and pyrethroids) or fungicides. The exception was atrazine, for which duration (p-trend<0.01), intensity (p-trend<0.01) and cumulative hours (p-trend=0.01) of use were all associated with higher FEV₁/FVC in an exposure-response manner. Low duration (-270mL/year), intensity (-270mL/hour/year) and cumulative hours (-280mL/hour) of atrazine use were associated with lower FVC.

Conclusions Chronic airflow obstruction is uncommon among villagers of an agricultural province in Nan, Thailand. Farming and pesticide use are unlikely to be major causes of respiratory problems there.

[Abstract 238 words] [Main Text 2,501 words] [5 tables]

[Supplemental material: 8 tables, 1 questionnaire]

Introduction

Worldwide, more than a billion people – about a third of the global workforce – work on farms. (1) Farmers are frequently exposed to organic and inorganic dusts and fumes, as well as pesticides, which may lead to respiratory tract inflammation and respiratory disease. (2, 3) Whether farming has a role in chronic obstructive pulmonary disease (COPD) remains unclear in developing countries (4). Farming is a common occupation in developing countries and any adverse effects are likely to have a high impact on public health and economic growth. Yet a recent systematic review of 22 studies of COPD in farmers reported just five from developing countries, (three in North Macedonia, one in Nigeria and one in India). (5)

Thailand is one of the largest rice exporters in the world (6) and 31% (11.6 of 37.9 million) of its working population is in the agricultural sector (7), accounting for 11% of gross domestic product. The poorer, lower 40% of the population, are more likely to work in agriculture. (8) Due to the rapid development of intensive agriculture for commercialisation, Thailand has experienced an increasing level of agrochemical use and is among the highest users of complex pesticides per unit area in the world. (9) Yet, there is little published literature regarding the health, and particularly the respiratory health, of farmers in Thailand.

In order to assess the association of lung function and respiratory symptoms with farming, particularly pesticide use, we conducted a survey in Nan – one of the largest agricultural provinces in Thailand – which recently reported the highest number of chronic bronchitis, emphysema and COPD deaths and hospital admission rates in the country. (10)

Methods

Study area and participants

We undertook a survey in the Tha Wang Pha district of Nan province, Thailand, between May and August 2019. This district was selected as, according to a recent census, 47% of its population were farmers. (11) Three hundred and forty-five potential participants, from a pool of adults aged 40 to 65 years old, were sampled using a cluster random method and invited to the study. To increase exposure contrast for the association analysis, we additionally recruited all local government employees (including school teachers, municipality officers, police officers, nurses, public health officers and Buddhist monks) aged 40 to 65, who worked full-time in the same area (n=82). In this way, a total of 427 subjects were invited to participate. This study was approved by the Chulalongkorn University Institutional Review Board (Med Chula IRB no.766/61) and the Imperial College Research Ethics Committee (ICREC ref: 19IC5098); all participants provided written informed consent.

Data collection

We used a structured questionnaire from the Burden of Obstructive Lung Disease (BOLD) study to obtain information on sociodemographic variables and respiratory health and symptoms (12). To assess farming and pesticide activities, practices and exposures, we developed a questionnaire appropriate for developing countries such as Thailand. This

questionnaire covered 1) the farming environment and activities; 2) crops grown and animals raised; 3) pesticide use; and 4) crop burning (see details in the supplemental material). All questionnaires were translated into Thai and applied using Open Data Kit (ODK) electronic forms (<https://opendatakit.org>). In addition, participants had their height, weight, pulse rate, blood pressure, and lung function measured.

Lung function

To measure lung function, we conducted spirometry on all participants using the ndd EasyOne™ spirometer, (ndd Medizintechnik; Zurich, Switzerland). Participants were tested before and 20 minutes after 200µg of salbutamol administered via a spacer. Each spirogram was reviewed and scored using the American Thoracic Society (ATS) and European Respiratory Society (ERS) criteria. (13) Usable spirometry was defined as two or more acceptable trials, with FEV₁ and FVC repeatability within 200mL. At the beginning of each day the spirometer was calibrated using a 3L syringe.

A post-bronchodilator forced expiratory volume in one second (FEV₁) to forced vital capacity (FVC) ratio below the lower limit of normal (LLN) was considered chronic airflow obstruction, and an FVC less than the LLN was considered spirometric restriction. The LLNs were calculated using the Global Lung Initiative (GLI) 2012 equations for South East Asia, which were based on data from the region, including Thailand. (14)

Data analysis

Age, gender, socioeconomic status (household assets, education), body mass index (BMI) using a classification for Asian populations: underweight (<18.5 kg/m²); normal (18.5 to <23.0 kg/m²); overweight (23.0 to <25.0 kg/m²); obese level 1 (25.0 to <30.0 kg/m²) and obese level 2 (≥30.0 kg/m²), smoking status, farming and pesticide exposure data were described. Farming exposure variables including years of living on a farm, farm size, types of crops and reared animals were included in the analyses. Farming activities such as ploughing, harvesting, chemical protection of crops, fertilizer use and crop burning were analysed as potential risk factors. Pesticide exposure variables included mixing pesticides, time of the last exposure to pesticides. Pesticide exposures were also classified by specific types of pesticide. An assessment of the level of pesticide exposure was estimated by 1) duration: years of exposure, 2) intensity: estimated hours of exposure per year and 3) cumulative hours of exposure in a lifetime. Respiratory symptoms, spirometry data, both raw and percent predicted values, were analysed.

We analysed differences between villagers and government employees by Student's t-test and chi-squared test or Fisher's exact test (for n<5), as appropriate. To assess associations, we used multivariable regression models adjusted for age, gender, smoking status, subject group (villagers or government employees), and additionally height for models with FVC or FEV₁ as outcomes. We evaluated potential exposure-response effects by testing for trend using both categorical and continuous exposure variables. Statistical significance was set at p<0.05. We performed all analyses using Stata 16 (Stata Corp., College Station, TX, USA).

Results

Demographic characteristics

Four hundred men and women (94% of those eligible) took part in the study and completed all questionnaires. Almost two thirds had never smoked. Compared with the group of government employees, villagers were 3.4 years older ($p<0.001$), 3.3 centimetres shorter in males ($p<0.001$) and 2.3 centimetres shorter in females ($p=0.03$). Most villagers had only primary school education (68.5%) while most government employees had a university degree. Based on household assets ownership, villagers were worse off than government employees ($p<0.001$). Table 1 summarises some characteristics of the study populations.

Lung function and farming

Among the villagers 86.6% reported farming as their longest-held occupation. (table1) Among villagers, the prevalence of chronic airflow obstruction was 5.5% and the prevalence of restriction was 10.3%. (table 2) We found no evidence of association of lung function with any of the considered farming exposure variables (i.e. harvesting, threshing, ploughing, the application of fertilizers and the burning of crop-residues), except for rearing poultry, which was associated with a small increase in FEV_1/FVC . Lung function was also not associated with the way farmers applied pesticides. For details see tables S1 and S2.

Lung function and pesticides

There were 304 regular pesticide sprayers (76% of all participants). Pesticides were classified into three main types: herbicides, insecticides and fungicides. Specifically, pesticide sprayers used: glyphosate (91%); paraquat (69%); atrazine (13%); organophosphates (34%); pyrethroids (69%); mancozeb (17%) or pyraclostrobin (23%).

Pesticide exposure-response relationships were examined using medians of the distributions of duration, intensity and cumulative hours of exposure. Table 3 is a summary of the associations between duration (year) of each pesticide use and spirometric parameters. Tables 4 and 5 show the relationships between all spirometric parameters and intensity (hours/year) and lifetime cumulative hours of pesticide exposure. There were no significant associations between the use of specific herbicides (glyphosate and paraquat), insecticides (organophosphates and pyrethroids) or fungicides (mancozeb and pyraclostrobin) and lung function. The exception was atrazine, for which duration (p -trend <0.01), intensity (p -trend <0.01) and cumulative hours (p -trend $=0.01$) of use were all associated with higher FEV_1/FVC in an exposure-response relationship. Low duration, low intensity and low cumulative hours of atrazine use were associated with lower FVC.

To examine the effect of bronchodilator reversibility, we re-ran all analyses using pre-bronchodilator spirometric parameters as outcomes. Villagers had significantly lower percent predicted pre-bronchodilator FEV_1/FVC than government employees. The prevalences of pre-bronchodilator airflow obstruction and spirometric restriction were higher compared to the results from post-bronchodilator spirometry. (table S3) However, after adjustment for confounding factors, multivariable analyses showed that the relationships between farming and pesticide variables and pre-bronchodilator spirometry were similar to post-bronchodilator spirometry results. (tables S4 to S8)

Discussion

In this study, villagers (86.6% of whom defined themselves as farmers) had a low prevalence of chronic respiratory symptoms and chronic airflow obstruction, which was no higher than would be expected in a healthy population. This figure is at the lower end of those reported from previous studies of the association between farming and COPD, where the prevalence of airflow obstruction varied between 3% and 68% (4). A similar study in Thailand reported a similar prevalence of COPD (5.5%) among adult farmers. (15) The prevalence of COPD is generally low (4.5% to 9.4%) in South East Asians, perhaps reflecting the low smoking prevalence in these populations. (16) Moreover, farming in Nan province is mainly crop farming conducted in open fields. A cross-sectional survey in France found that only 2.9% of crop farmers had COPD (17), a figure much lower than those from other studies in European farmers mainly working on livestock farms where the reported COPD prevalence ranged between 10.7% and 30.2%. (18) It is also interesting that our findings suggest a relatively high prevalence of a restrictive spirometric pattern (10.3%) among villagers. Currently, the determinants of restrictive spirometry pattern remain poorly understood; explanations might include genetic factors or some adverse early life exposures impacting on childhood development. (19)

We found no association of organic dust exposure variables, including harvesting and threshing cereals, with significant changes in spirometry. These findings are in agreement with a recent nationwide study in Denmark which indicated no association of cumulative occupational organic dust exposure and an increased risk of COPD. (20) However, we did find an association between rearing poultry and a small increase in FEV₁/FVC with no significant change of FVC, whereas another recent study in the USA concluded that there was no association between raising animals, including poultry, and COPD. (21) The apparently contradictory finding from our study might have occurred by chance or in reflection of a 'healthy worker' effect. (22) For inorganic soil dust exposure, we found no association between ploughing and lung function. One explanation might be due to open air farmland with high humidity, which is typical in the study region and results in relatively low exposure intensities (23) Ambient air pollution in agricultural areas, as a result of crop-residue burning, has given rise to widespread concern over its health consequences. Studies in India found a decline in local subjects' lung function parameters during the period of intense agricultural burning (24, 25); in contrast, we found no such association among villagers in Nan. These differences might be explained by our focus on the long-term exposure effect of burning exposures, while others focused on short-term changes. We found no significant associations between the use of fertilizers and a decline in lung function.

As in a previous meta-analysis, (26) we found no significant association of paraquat exposure with FEV₁/FVC. An explanation is the low volatility of paraquat whereby the risk of damage, mainly via an inhalation route, is low. (27) Nor did we find an association between glyphosate exposure and reduction in lung function. There were significant associations of atrazine exposure (duration, intensity and cumulative lifetime hours) and a higher FEV₁/FVC consistent with a lower FVC; these associations could reflect early lung restriction. There is very limited information on glyphosate and atrazine and respiratory outcomes, particularly lung function. In the USA, a study of male sprayers reported significant relationships between wheezing (no measurement of lung function) and both glyphosate and atrazine exposures. (28) Organophosphate and pyrethroid were common insecticides used by farmers in Nan. We

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3 found no association of spraying organophosphate with significant changes in lung function.
4 This is in contrast to our previous systematic review indicating a significant decline in
5 FEV_1/FVC among those exposed to organophosphates. (26) We found weak exposure-
6 response associations of pyrethroid exposure (intensity and cumulative hours) with an
7 increase in FEV_1/FVC but a decrease in FVC, despite no statistical significance. A study in
8 Canada reported an association between pyrethroid exposure and higher FEV_1/FVC and lower
9 FVC. (29) Nan sprayers mainly used mancozeb and pyraclostrobin as fungicides of choice. A
10 recent meta-analysis included articles reporting an association of unspecified fungicide
11 exposures with obstructive lung disease; (30) our study did not replicate these findings.
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15 Our study has several strengths. First, the response rate was high compared with a range
16 between 42% and 92% in previous similar cross-sectional studies included in recent
17 systematic reviews. (4, 5) This was achieved in part because in the study villages, the local
18 public health volunteer system helped our research team to communicate with eligible
19 participants before and during the fieldwork. Second, the study questionnaire focusing on
20 farming and pesticide use considered the local context, including local crops and best-selling
21 pesticides, so that the farming exposure data truly reflected local participants' exposures.
22 Moreover, this study has filled a gap in that most previous studies did not examine
23 associations with specific farming activities and types of pesticides. Third, the study had very
24 few missing data due to the use of an electronic data collection system. Fourth, we undertook
25 high quality post-bronchodilator spirometry; the majority of previous studies identified
26 abnormalities of respiratory outcomes only from either self-reported questionnaires or pre-
27 bronchodilator spirometry. (4, 5)
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31 A limitation of this cross-sectional study is its inability to assess the direction of any potentially
32 causal relationship. Furthermore, the self-reported information might be open to recall bias.
33 Exposure misclassification might have occurred and, if at random, would bias the study
34 findings towards the null. Also, we were unable to measure quantitatively individual exposures
35 to pesticides, but we estimated cumulative metrics that allowed us to test for exposure-
36 response trends. The lack of evidence of association between farming practices or pesticide
37 exposures and spirometric parameters might be due to a healthy worker effect, as previously
38 found in a recent large population-based study where only by analysing lifetime job-histories
39 agriculture-related jobs emerged at increased COPD risk (31) whereby farmers affected by
40 farming practices and/or pesticides would have quit farming and only healthier farmers would
41 stay in the job, work longer and accept riskier farming tasks. In this study, having conducted
42 around a hundred tests increased the probability of finding false positives, perhaps an
43 explanation for the positive relationship between rearing poultry and FEV_1/FVC we report.
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49 Although we found no evidence of increased risk of abnormal respiratory outcomes with
50 farming, particularly pesticide exposures, it does not necessarily mean that such exposures
51 have no serious effects on other aspects of health. There is growing evidence, for example,
52 examining the associations of pesticide exposures and health effects such as cancer,
53 reproductive and nervous system abnormalities. (32)
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56 In conclusion, chronic airflow obstruction was uncommon among villagers in Nan, Thailand.
57 A high proportion of Nan farmers were pesticide applicators but farming and pesticide use
58 seem unlikely to be a major cause of respiratory problems in this setting.
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Contributors

JR, AFSA, SDM, PC and PB were engaged in the initial design of the study. JR was responsible for data collection and spirometry testing. PB conducted the quality control of the spirometry data. JR analysed all data and drafted the initial manuscript, and all authors contributed to its development and approved the final version.

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Competing Interests

None declared.

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Tables [5 tables]**Table 1** Demographic characteristics and respiratory symptoms of the study participants

Study variables	Villagers (n=322)		Government employees (n=78)		p-value†
	Mean	SD	Mean	SD	
Age (year)	53.8	0.4	50.4	0.7	<0.001
Height (cm), male	163.4	0.4	166.7	0.9	<0.001
Height (cm), female	154.7	0.4	157.0	0.9	0.03
Working hours (hour/week)	43.4	0.9	39.9	1.2	0.09
Study variables	<i>n</i>	Percent	<i>n</i>	Percent	p-value††
Sex					1.00
Male	156	48.5%	41	52.6%	
Female	166	51.5%	37	47.4%	
Education					<0.001
None	13	4.1%	0	0.0%	
Primary school	220	68.5%	4	5.1%	
Secondary/high/vocational school	78	24.3%	18	23.1%	
University	10	3.1%	56	71.8%	
Household asset score					<0.001
≥12	175	54.4%	69	88.5%	
Smoking status					0.15
Never	200	62.1%	49	62.3%	
Ex	90	28.0%	16	26.5%	
Current	32	9.9%	13	11.2%	
Body Mass Index (Asian)					0.15
Underweight (<18.5 kg/m ²)	39	12.1%	3	3.8%	
Normal (18.5 to <23.0 kg/m ²)	128	39.8%	30	38.5%	
Overweight (23.0 to <25.0 kg/m ²)	69	21.4%	17	21.8%	
Obese level 1 (25.0 to <30.0 kg/m ²)	73	22.7%	23	29.5%	
Obese level 2 (≥30.0 kg/m ²)	13	4.0%	5	6.4%	
Longest held job in lifetime					<0.001
Farming	278	86.6%	2	2.6%	
Respiratory symptoms	<i>n</i>	Percent	<i>n</i>	Percent	p-value††
Chronic cough	37	11.5%	6	7.7%	0.41
Chronic phlegm	25	7.8%	3	3.9%	0.32
Shortness of breath	9	2.8%	0	0.0%	0.22
Wheezing	20	6.2%	4	5.3%	1.00
Self-reported chronic bronchitis	3	0.9%	1	1.3%	0.58

†Analysing differences between subject groups by Student's t-test; ††Analysing differences between subject groups by chi-squared test or Fisher's exact test (for n<5).

Table 2 Percent predicted values of post-bronchodilator spirometric parameters and prevalence of abnormal spirometric patterns among study participants

Spirometric parameter	Villagers (n=290)		Government employees (n=68)		p-value†
	Mean	SD	Mean	SD	
FEV ₁ /FVC (%predicted)	98.34	7.51	100.32	3.99	0.04
FVC (%predicted)	92.88	13.28	90.93	11.83	0.26
FEV ₁ (%predicted)	91.41	14.04	90.93	11.91	0.80
Spirometric patterns	<i>n</i>	Percent	<i>n</i>	Percent	p-value††
Chronic airflow obstruction	16	5.5%	0	0.0%	0.05
Spirometric restriction	30	10.3%	9	13.0%	0.51

Chronic airflow obstruction: FEV₁/FVC<LLN; spirometric restriction: FVC<LLN. LLN, lower limit of normal based on GLI2012 reference equations.

†Analysing differences between subject groups by Student's t-test.; ††Analysing differences between subject groups by chi-squared test or Fisher's exact test (for n<5).

Table 3 Post-bronchodilator spirometric parameters by duration (years) of pesticide exposure

Years of exposure (years) (n=358)	n	FEV ₁ /FVC (%)				FVC (L)				FEV ₁ (L)			
		β	95% CI			β	95% CI			β	95% CI		
<i>Herbicide</i>													
Glyphosate unexposed	108	ref				ref				ref			
<11 years	123	0.23	-1.42	to	1.89	0.03	-0.11	to	0.17	0.04	-0.07	to	0.14
≥11 years	127	0.13	-1.54	to	1.80	0.00	-0.11	to	0.11	0.01	-0.09	to	0.11
Paraquat unexposed	172	ref				ref				ref			
<11 years	89	-0.13	-1.69	to	1.42	0.02	-0.09	to	0.13	0.02	-0.08	to	0.11
≥11 years	97	-0.37	-1.89	to	1.16	-0.01	-0.12	to	0.10	-0.01	-0.10	to	0.09
Atrazine unexposed	319	ref††				ref				ref			
<10 years	21	2.90*	0.35	to	5.45	-0.27**	-0.45	to	-0.09	-0.13	-0.29	to	0.03
≥10 years	18	3.16*	0.43	to	5.89	-0.01	-0.21	to	0.18	0.07	-0.10	to	0.24
<i>Insecticide</i>													
Organophosphate unexposed	265	ref				ref				ref			
<10 years	39	-0.07	-2.03	to	1.89	0.03	-0.11	to	0.17	0.06	-0.06	to	0.17
≥10 years	54	-0.17	-1.87	to	1.53	-0.05	-0.17	to	0.07	-0.03	-0.14	to	0.07
Pyrethroid unexposed	165	ref				ref				ref			
<10 years	91	0.59	-1.02	to	2.21	-0.01	-0.13	to	0.10	-0.01	-0.11	to	0.08
≥10 years	102	0.51	-1.04	to	2.06	-0.06	-0.17	to	0.05	-0.04	-0.14	to	0.05
<i>Fungicide</i>													
Mancozeb unexposed	313	ref				ref				ref			
<6 years	23	-0.76	-3.22	to	1.71	-0.77	-3.22	to	1.69	0.04	-0.10	to	0.19
≥6 years	22	-0.67	-3.17	to	1.83	-0.75	-3.23	to	1.74	0.07	-0.08	to	0.23
Pyraclostrobin unexposed	299	ref				ref				ref			
<4 years	31	-0.36	-2.51	to	1.77	-0.23	-2.37	to	1.90	0.05	-0.08	to	0.18
≥4 years	28	0.30	-1.93	to	2.54	0.36	-1.87	to	2.58	0.07	-0.07	to	0.20

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. reference; *p<0.05, **p<0.01, †p-trend<0.05, ††p-trend<0.01

Table 4 Post-bronchodilator spirometric parameters by intensity (hours/year) of pesticide exposure

Intensity (hours/year) (n=358)	n	FEV ₁ /FVC (%)			FVC (L)			FEV ₁ (L)					
		β	95% CI		β	95% CI		β	95% CI				
<i>Herbicide</i>													
Glyphosate unexposed	108	ref											
<20 hours/year	120	0.44	-1.20	to	2.08	0.02	-0.10	to	0.14	0.04	-0.06	to	0.14
≥20 hours/year	130	-0.13	-1.82	to	1.56	-0.01	-0.13	to	0.11	0.01	-0.10	to	0.11
<i>Paraquat</i>													
unexposed	172	ref											
<17 hours/year	93	0.24	-1.28	to	1.76	0.00	-0.11	to	0.11	0.00	-0.10	to	0.09
≥17 hours/year	93	-0.81	-2.38	to	0.76	0.01	-0.10	to	0.12	0.01	-0.08	to	0.11
<i>Atrazine</i>													
unexposed	319	ref††											
<16 hours/year	17	2.90*	0.11	to	5.69	-0.27**	-0.46	to	-0.08	-0.14	-0.32	to	0.03
≥16 hours/year	22	3.12*	0.60	to	5.63	-0.05	-0.23	to	0.13	0.05	-0.11	to	0.21
<i>Insecticide</i>													
<i>Organophosphate</i>													
unexposed	265	ref											
<18 hours/year	43	-0.45	-2.33	to	1.43	-0.01	-0.14	to	0.12	0.01	-0.10	to	0.13
≥18 hours/year	50	0.14	-1.62	to	1.90	-0.02	-0.14	to	0.11	0.00	-0.11	to	0.10
<i>Pyrethroid</i>													
unexposed	165	ref											
<16 hours/year	89	-0.05	-1.64	to	1.55	-0.02	-0.14	to	0.09	-0.04	-0.13	to	0.06
≥16 hours/year	104	1.09	-0.46	to	2.65	-0.06	-0.17	to	0.06	-0.02	-0.12	to	0.07
<i>Fungicide</i>													
<i>Mancozeb</i>													
unexposed	313	ref											
<18 hours/year	20	0.25	-2.36	to	2.86	0.22	-2.38	to	2.82	0.06	-0.09	to	0.21
≥18 hours/year	25	-1.49	-3.86	to	0.87	-1.54	-3.90	to	0.81	0.06	-0.09	to	0.20
<i>Pyraclostrobin</i>													
unexposed	299	ref											
<8 hours/year	26	-0.08	-2.41	to	2.26	0.01	-2.31	to	2.34	0.02	-0.12	to	0.17
≥8 hours/year	33	-0.03	-2.10	to	2.04	0.07	-1.99	to	2.14	0.08	-0.04	to	0.21

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. reference; *p<0.05, **p<0.01, †p-trend<0.05, ††p-trend<0.01

Table 5 Post-bronchodilator spirometric parameters by lifetime cumulative hours of pesticide exposure classified by pesticide types

Cumulative exposure (total hours in lifetime) (n=358)	n	FEV ₁ /FVC (%)			FVC (L)			FEV ₁ (L)				
		β	95% CI		β	95% CI		β	95% CI			
<i>Herbicide</i>												
Glyphosate unexposed	108	ref			ref			ref				
<240 hours	117	-0.06	-1.71	to 1.59	0.06	-0.06	to 0.17	0.05	-0.05	to 0.15		
≥240 hours	133	0.44	-1.23	to 2.12	-0.05	-0.17	to 0.07	-0.01	-0.11	to 0.09		
<i>Paraquat</i>												
unexposed	172	ref			ref			ref				
<240 hours	83	0.30	-1.27	to 1.86	0.01	-0.10	to 0.12	0.01	-0.08	to 0.11		
≥240 hours	103	-0.75	-2.27	to 0.77	0.00	-0.11	to 0.10	0.00	-0.10	to 0.09		
<i>Atrazine</i>												
unexposed	319	ref†			ref			ref				
<240 hours	19	2.91*	0.26	to 5.56	-0.28**	-0.46	to -0.09	-0.15	-0.32	to 0.01		
≥240 hours	20	3.13*	0.49	to 5.78	-0.02	-0.21	to 0.17	0.08	-0.09	to 0.24		
<i>Insecticide</i>												
<i>Organophosphate</i>												
unexposed	265	ref			ref			ref				
<144 hours	44	0.70	-1.15	to 2.56	0.01	-0.12	to 0.14	0.06	-0.06	to 0.17		
≥144 hours	49	-0.87	-2.64	to 0.90	-0.04	-0.16	to 0.09	-0.04	-0.15	to 0.07		
<i>Pyrethroid</i>												
unexposed	165	ref			ref			ref				
<128 hours	98	-0.04	-1.60	to 1.53	-0.02	-0.13	to 0.09	-0.03	-0.12	to 0.07		
≥128 hours	95	1.17	-0.42	to 2.76	-0.07	-0.18	to 0.05	-0.03	-0.13	to 0.07		
<i>Fungicide</i>												
<i>Mancozeb</i>												
unexposed	313	ref			ref			ref				
<120 hours	18	-0.06	-2.83	to 2.70	-0.03	-2.78	to 2.72	0.06	-0.10	to 0.23		
≥120 hours	27	-1.14	-3.41	to 1.14	-1.23	-3.50	to 1.03	0.06	-0.08	to 0.19		
<i>Pyraclostrobin</i>												
unexposed	299	ref			ref			ref				
<24 hours	27	-0.09	-2.37	to 2.20	0.01	-2.27	to 2.28	0.04	-0.10	to 0.18		
≥24 hours	32	-0.02	-2.12	to 2.08	0.08	-2.01	to 2.17	0.07	-0.06	to 0.20		

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. reference; *p<0.05, **p<0.01, †p-trend<0.05, ††p-trend<0.01

Supplemental material**Table S1** Post-bronchodilator spirometric parameters and farming variables

Farming variables (n=358)	n	FEV ₁ /FVC (%)			FVC (L)			FEV ₁ (L)					
		β	95% CI		β	95% CI		β	95% CI				
Years of living on a farm													
Never	32	ref			ref			ref					
<33 years	162	-0.48	-2.88	to	1.93	0.05	-0.12	to	0.22	0.03	-0.12	to	0.18
≥33 years	164	-0.21	-2.75	to	2.33	0.04	-0.14	to	0.22	0.02	-0.13	to	0.18
Farmland size													
<18.5 rai (7.3 acre)	199	ref			ref					ref			
≥18.5 rai (7.3 acre)	159	0.57	-0.79	to	1.93	0.02	-0.07	to	0.12	0.04	-0.05	to	0.12
Growing rice													
No	148	ref			ref					ref			
Yes	210	0.64	-0.62	to	1.91	0.02	-0.07	to	0.11	0.04	-0.03	to	0.12
Growing maize/corn													
No	175	ref			ref					ref			
Yes	183	0.00	-1.30	to	1.30	-0.05	-0.15	to	0.04	-0.05	-0.13	to	0.03
Growing longan													
No	90	ref			ref					ref			
Yes	268	1.07	-0.46	to	2.59	0.03	-0.08	to	0.14	0.06	-0.03	to	0.15
Keeping poultry													
No	216	ref			ref					ref			
Yes	142	1.38*	0.17	to	2.59	-0.02	-0.11	to	0.06	0.01	-0.06	to	0.09
Harvesting cereal													
No	167	ref			ref					ref			
Yes	191	1.15	-0.43	to	2.73	0.00	-0.12	to	0.11	0.03	-0.06	to	0.13
Threshing cereal													
No	284	ref			ref					ref			
Yes	74	1.77	-0.16	to	3.69	-0.02	-0.15	to	0.12	0.03	-0.08	to	0.15
Ploughing													
No	189	ref			ref					ref			
Yes	169	0.36	-0.96	to	1.67	-0.05	-0.14	to	0.05	-0.02	-0.10	to	0.06
Applying natural fertilizer													
No	130	ref			ref					ref			
Yes	228	0.40	-0.89	to	1.68	0.06	-0.03	to	0.15	0.07	-0.01	to	0.14
Applying chemical fertilizer													
No	94	ref			ref					ref			
Yes	264	0.11	-1.41	to	1.63	0.03	-0.07	to	0.14	0.05	-0.04	to	0.14
Burning crop-residue													
smoke exposure													
No	282	ref			ref					ref			
Yes	76	0.73	-0.78	to	2.23	0.02	-0.09	to	0.13	0.03	-0.06	to	0.12
Converting an arable land by burning													
No	228	ref			ref					ref			
Yes	130	1.20	-0.05	to	2.44	0.00	-0.09	to	0.09	0.03	-0.04	to	0.11

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. means a reference representing an unexposed group of each variable.; *p<0.05

Table S2 Post-bronchodilator spirometric parameters and pesticide practice

Pesticide practice (n=358)	n	FEV ₁ /FVC (%)			FVC (L)			FEV ₁ (L)				
		β	95% CI		β	95% CI		β	95% CI			
Spraying pesticide												
Never	84	ref			ref				ref			
Ever	274	-0.25	-2.02	to 1.52	-0.02	-0.15	to 0.10	-0.02	-0.13	to 0.77		
Mixing pesticide												
Never use pesticide	84	ref			ref			ref				
Not involved with	85	-0.68	-2.68	to 1.33	0.00	-0.14	to 0.14	0.00	-0.12	to 0.13		
Involved with	189	0.00	-1.85	to 1.85	-0.04	-0.17	to 0.09	-0.03	-0.14	to 0.09		
Part of body usually contact pesticide												
Never use pesticide	84	ref			ref			ref				
No contact	83	-0.98	-2.96	to 1.00	-0.06	-0.21	to 0.08	-0.06	-0.19	to 0.06		
At least one part	191	0.25	-1.62	to 2.12	0.00	-0.13	to 0.14	0.02	-0.10	to 0.13		
Last pesticide exposure												
Unexposed	84	ref			ref			ref				
More than 12 months	39	-0.90	-3.30	to 1.50	-0.02	-0.19	to 0.16	-0.04	-0.18	to 0.11		
Within 12 months	109	-1.15	-3.09	to 0.79	-0.02	-0.16	to 0.11	-0.04	-0.16	to 0.08		
Recent (within 1 week)	126	0.79	-1.12	to 2.71	-0.03	-0.16	to 0.11	0.01	-0.11	to 0.13		

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. means a reference representing an unexposed group of each variable.; *p<0.05

Table S3 Percent predicted values of pre-bronchodilator spirometric parameters and prevalence of abnormal spirometric patterns among study participants

Spirometric parameter	Villagers (n=290)		Government employees (n=68)		p-value [†]
	Mean	SD	Mean	SD	
FEV ₁ /FVC (%predicted)	95.73	0.46	98.03	0.51	0.02
FVC (%predicted)	94.34	0.91	90.98	1.47	0.10
FEV ₁ (%predicted)	90.13	0.81	89.20	1.44	0.63
Spirometric patterns	<i>n</i>	Percent	<i>n</i>	Percent	p-value ^{††}
Chronic airflow obstruction	29	10.7%	0	0.0%	0.004
Spirometric restriction	25	9.2%	8	13.3%	0.33

Chronic airflow obstruction: FEV₁/FVC<LLN; spirometric restriction: FVC<LLN. LLN, lower limit of normal based on GLI2012 reference equations.

[†]Analysing differences between subject groups by Student's t-test.; ^{††}Analysing differences between subject groups by chi-squared test or Fisher's exact test (for n<5).

Table S4 Pre-bronchodilator spirometric parameters and farming variables

Farming variables (n=332)	n	FEV ₁ /FVC (%)			FVC (L)			FEV ₁ (L)					
		β	95% CI		β	95% CI		β	95% CI				
Years of living on a farm													
Never	27	ref			ref			ref					
<33 years	150	0.12	-2.59	to	2.84	0.02	-0.19	to	0.23	0.01	-0.14	to	0.17
≥33 years	155	0.83	-1.99	to	3.65	-0.02	-0.24	to	0.20	0.02	-0.13	to	0.18
Farmland size													
<18.5 rai (7.3 acre)	215	ref			ref					ref			
≥18.5 rai (7.3 acre)	143	0.21	-1.27	to	1.69	-0.01	-0.12	to	0.11	0.01	-0.08	to	0.09
Growing rice													
No	130	ref			ref					ref			
Yes	202	0.29	-1.07	to	1.65	0.04	-0.07	to	0.14	0.06	-0.02	to	0.13
Growing maize/corn													
No	160	ref			ref					ref			
Yes	172	-0.93	-2.29	to	0.44	-0.04	-0.14	to	0.07	-0.06	-0.14	to	0.01
Growing longan													
No	84	ref			ref					ref			
Yes	248	1.15	-0.49	to	2.78	-0.02	-0.15	to	0.10	0.02	-0.07	to	0.11
Keeping poultry													
No	200	ref			ref					ref			
Yes	132	0.46	-0.83	to	1.75	0.01	-0.09	to	0.11	0.00	-0.07	to	0.07
Harvesting cereal													
No	155	ref			ref					ref			
Yes	177	0.33	-1.37	to	2.03	0.04	-0.09	to	0.17	0.03	-0.06	to	0.13
Threshing cereal													
No	263	ref			ref					ref			
Yes	69	1.32	-0.72	to	3.36	0.01	-0.15	to	0.17	0.05	-0.07	to	0.16
Ploughing													
No	172	ref			ref					ref			
Yes	160	-0.01	-1.42	to	1.41	-0.04	-0.15	to	0.07	-0.02	-0.10	to	0.06
Applying natural fertilizer													
No	122	ref			ref					ref			
Yes	210	0.53	-0.83	to	1.90	0.03	-0.08	to	0.14	0.03	-0.05	to	0.11
Applying chemical fertilizer													
No	87	ref			ref					ref			
Yes	245	0.19	-1.45	to	1.82	0.07	-0.05	to	0.20	0.05	-0.04	to	0.14
Burning crop-residue													
smoke exposure													
No	258	ref			ref					ref			
Yes	74	-0.41	-1.99	to	1.17	0.07	-0.05	to	0.20	0.02	-0.07	to	0.11
Converting an arable land by burning													
No	215	ref			ref					ref			
Yes	117	1.04	-0.29	to	2.37	0.00	-0.11	to	0.10	0.03	-0.05	to	0.10

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. means a reference representing an unexposed group of each variable.; *p<0.05

Table S5 Pre-bronchodilator spirometric parameters and pesticide practice

Pesticide practice (n=332)	n	FEV ₁ /FVC (%)			FVC (L)			FEV ₁ (L)				
		β	95% CI		β	95% CI		β	95% CI			
Spraying pesticide												
Never	75	ref			ref				ref			
Ever	257	-0.14	-2.05	to 1.78	0.00	-0.14	to 0.15	-0.02	-0.15	to 0.10		
Mixing pesticide												
Never use pesticide	75	ref			ref			ref				
Not involved with	75	-0.47	-2.66	to 1.72	0.06	-0.11	to 0.23	0.00	-0.14	to 0.14		
Involved with	182	0.03	-1.96	to 2.02	-0.02	-0.18	to 0.13	-0.04	-0.17	to 0.09		
Part of body usually contact pesticide												
Never use pesticide	75	ref			ref			ref				
No contact	72	-0.51	-2.70	to 1.67	-0.08	-0.25	to 0.09	-0.06	-0.21	to 0.08		
At least one part	185	0.08	-1.93	to 2.09	0.05	-0.10	to 0.21	0.00	-0.13	to 0.14		
Last pesticide exposure												
Unexposed	75	ref			ref			ref				
More than 12 months	41	-0.71	-3.20	to 1.78	0.00	-0.19	to 0.20	-0.02	-0.19	to 0.16		
Within 12 months	99	-0.30	-2.44	to 1.84	-0.02	-0.19	to 0.14	-0.02	-0.16	to 0.11		
Recent (within 1 week)	117	0.24	-1.84	to 2.32	0.03	-0.13	to 0.19	-0.03	-0.16	to 0.11		

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. means a reference representing an unexposed group of each variable.; *p<0.05

Table S6 Pre-bronchodilator spirometric parameters by duration (years) of pesticide exposure

Years of exposure (years) (n=332)	n	FEV ₁ /FVC (%)				FVC (L)				FEV ₁ (L)			
		β	95% CI			β	95% CI			β	95% CI		
<i>Herbicide</i>													
Glyphosate unexposed	97	ref				ref				ref			
<11 years	114	-0.33	-2.13	to	1.46	0.08	-0.05	to	0.22	0.04	-0.06	to	0.14
≥11 years	121	0.12	-1.67	to	1.91	0.04	-0.10	to	0.18	0.03	-0.07	to	0.13
Paraquat unexposed	152	ref				ref				ref			
<11 years	85	-0.49	-2.14	to	1.17	0.07	-0.06	to	0.20	0.02	-0.07	to	0.12
≥11 years	95	-0.21	-1.82	to	1.39	0.01	-0.12	to	0.13	0.01	-0.08	to	0.10
Atrazine unexposed	295	ref††				ref				ref			
<10 years	20	3.78**	1.13	to	6.43	-0.27*	-0.48	to	-0.06	-0.09	-0.24	to	0.07
≥10 years	17	3.05*	0.19	to	5.91	-0.01	-0.24	to	0.21	0.10	-0.07	to	0.26
<i>Insecticide</i>													
Organophosphate unexposed	244	ref				ref				ref			
<10 years	37	-1.21	-3.26	to	0.83	0.12	-0.04	to	0.28	0.05	-0.06	to	0.17
≥10 years	51	0.06	-1.73	to	1.84	-0.02	-0.16	to	0.12	-0.01	-0.11	to	0.09
Pyrethroid unexposed	150	ref				ref				ref			
<10 years	83	0.93	-0.79	to	2.66	-0.05	-0.18	to	0.08	-0.01	-0.10	to	0.09
≥10 years	99	0.39	-1.25	to	2.02	-0.09	-0.22	to	0.04	-0.03	-0.12	to	0.06
<i>Fungicide</i>													
Mancozeb unexposed	285	ref				ref				ref			
<6 years	24	-0.54	-3.01	to	1.94	0.09	-0.10	to	0.28	0.08	-0.06	to	0.22
≥6 years	23	0.47	-2.04	to	2.98	0.10	-0.09	to	0.29	0.09	-0.06	to	0.23
Pyraclostrobin unexposed	281	ref				ref				ref			
<4 years	25	-1.90	-4.29	to	0.49	0.10	-0.09	to	0.29	0.04	-0.10	to	0.17
≥4 years	26	1.47	-0.88	to	3.82	0.07	-0.11	to	0.25	0.08	-0.05	to	0.21

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. reference; *p<0.05, **p<0.01, †p-trend<0.05, ††p-trend<0.01

Table S7 Pre-bronchodilator spirometric parameters by intensity (hours/year) of pesticide exposure

Intensity (hours/year) (n=332)	n	FEV ₁ /FVC (%)			FVC (L)			FEV ₁ (L)				
		β	95% CI		β	95% CI		β	95% CI			
<i>Herbicide</i>												
Glyphosate unexposed	97	ref			ref			ref				
<20 hours/year	111	0.55	-1.21	to 2.31	0.09	-0.05	to 0.22	0.06	-0.03	to 0.16		
≥20 hours/year	124	-0.88	-2.69	to 0.94	0.03	-0.11	to 0.17	-0.01	-0.11	to 0.10		
Paraquat unexposed	192	ref			ref			ref				
<17 hours/year	87	0.11	-1.51	to 1.73	0.05	-0.07	to 0.18	0.02	-0.07	to 0.11		
≥17 hours/year	93	-0.82	-2.46	to 0.82	0.02	-0.10	to 0.15	0.01	-0.08	to 0.11		
Atrazine unexposed	295	ref††			ref			ref				
<16 hours/year	16	3.54*	0.62	to 6.46	-0.20**	-0.43	to 0.03	-0.08	-0.25	to 0.09		
≥16 hours/year	21	3.37*	0.75	to 5.99	-0.11	-0.31	to 0.10	0.06	-0.09	to 0.21		
<i>Insecticide</i>												
Organophosphate unexposed	244	ref			ref			ref				
<18 hours/year	41	-1.23	-3.19	to 0.74	0.09	-0.06	to 0.24	0.04	-0.07	to 0.15		
≥18 hours/year	47	0.17	-1.67	to 2.02	-0.01	-0.15	to 0.13	0.00	-0.11	to 0.10		
Pyrethroid unexposed	150	ref			ref			ref				
<16 hours/year	83	0.26	-1.43	to 1.96	-0.07	-0.20	to 0.06	-0.03	-0.13	to 0.06		
≥16 hours/year	99	0.97	-0.68	to 2.62	-0.07	-0.20	to 0.05	-0.01	-0.10	to 0.08		
<i>Fungicide</i>												
Mancozeb unexposed	285	ref			ref			ref				
<18 hours/year	21	0.55	-2.06	to 3.17	0.10	-0.10	to 0.30	0.12	-0.02	to 0.27		
≥18 hours/year	26	-0.52	-2.90	to 1.86	0.09	-0.09	to 0.27	0.05	-0.09	to 0.19		
Pyraclostrobin unexposed	281	ref			ref			ref				
<8 hours/year	21	0.00	-2.64	to 2.64	0.01	-0.19	to 0.22	0.03	-0.11	to 0.17		
≥8 hours/year	30	-0.31	-2.52	to 1.90	0.13	-0.04	to 0.30	0.08	-0.04	to 0.21		

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. reference; *p<0.05, **p<0.01, †p-trend<0.05, ††p-trend<0.01

Table S8 Pre-bronchodilator spirometric parameters by lifetime cumulative hours of pesticide exposure classified by pesticide types

Cumulative exposure (total hours in lifetime) (n=332)	n	FEV ₁ /FVC (%)			FVC (L)			FEV ₁ (L)				
		β	95% CI		β	95% CI		β	95% CI			
<i>Herbicide</i>												
Glyphosate unexposed	97	ref			ref			ref				
<240 hours	107	1.04	-1.68	to 1.89	0.12	-0.02	to 0.25	0.07	-0.03	to 0.17		
≥240 hours	128	-0.32	-2.12	to 1.48	0.00	-0.13	to 0.14	-0.01	-0.11	to 0.09		
<i>Paraquat</i>												
unexposed	192	ref			ref			ref				
<240 hours	75	0.16	-1.53	to 1.85	0.06	-0.07	to 0.19	0.02	-0.07	to 0.12		
≥240 hours	105	-0.74	-2.32	to 0.84	0.02	-0.10	to 0.14	0.01	-0.08	to 0.10		
<i>Atrazine</i>												
unexposed	295	ref			ref			ref				
<240 hours	18	3.72**	0.95	to 6.49	-0.23**	-0.45	to -0.02	-0.10	-0.25	to 0.06		
≥240 hours	19	3.17*	0.41	to 5.94	-0.07	-0.28	to 0.15	0.09	-0.07	to 0.25		
<i>Insecticide</i>												
<i>Organophosphate</i>												
unexposed	244	ref			ref			ref				
<144 hours	42	-0.60	-2.55	to 1.34	0.09	-0.06	to 0.24	0.05	-0.06	to 0.16		
≥144 hours	46	-0.36	-2.23	to 1.51	-0.01	-0.16	to 0.13	-0.01	-0.12	to 0.09		
<i>Pyrethroid</i>												
unexposed	150	ref			ref			ref				
<128 hours	90	0.23	-1.44	to 1.90	-0.07	-0.20	to 0.06	-0.03	-0.12	to 0.06		
≥128 hours	92	1.04	-0.64	to 2.71	-0.07	-0.20	to 0.06	-0.01	-0.11	to 0.08		
<i>Fungicide</i>												
<i>Mancozeb</i>												
unexposed	285	ref			ref			ref				
<120 hours	18	0.16	-2.68	to 2.99	0.11	-0.11	to 0.33	0.12	-0.03	to 0.28		
≥120 hours	29	-0.16	-2.42	to 2.10	0.09	-0.09	to 0.26	0.06	-0.07	to 0.19		
<i>Pyraclostrobin</i>												
unexposed	281	ref			ref			ref				
<24 hours	20	-1.60	-4.28	to 1.08	0.08	-0.13	to 0.28	0.03	-0.12	to 0.17		
≥24 hours	31	0.71	-1.46	to 2.88	0.09	-0.08	to 0.26	0.09	-0.04	to 0.21		

FEV₁/FVC ratio coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, sex, smoking status and study subject (villagers vs government employees).

FVC and FEV₁ coefficients (β) and 95% CIs were calculated by using a multivariable regression model adjusted for age, height, sex, smoking status and study subject (villagers vs government employees).

ref. reference; *p<0.05, **p<0.01, †p-trend<0.05, ††p-trend<0.01

Agricultural questionnaire

1. Have you ever lived on a farm? Yes No

[If "yes" ask question 1A., otherwise skip to question 2.]

1A. Are you still living on a farm? Yes No

[If "yes" ask question 1A.i., otherwise skip to question 1B.]

1A.i. What size is the farm (in local unit)? Rai Ngan
 Tarang Wa (Wa²)

1B. How many years have you lived on a farm? years

2. Have you ever ploughed the soil or prepared it for planting? Yes No

[If "yes" ask all question 2A. to 2E., otherwise skip to question 3.]

2A. How many years have you ploughed the soil or prepared it for planting? years

2B. In the years that you ploughed the soil or prepared it for planting, how many months of each year did you do it? months

2C. In the months that you ploughed the soil or prepared it for planting, how many days of each month did you do it? days

2D. On the days that you ploughed the soil or prepared it for planting, how many hours of each day did you do it? hours

2E. Are you still ploughing the soil or preparing it for planting? Yes No

Plants grown

3. Do you grow plants? Yes No

[If "yes" ask question all 3A. to 3O., otherwise skip to question 4.]

3A. Cereal Yes No

[If "yes" ask all question 3A.i to 3A.iii, otherwise skip to question 3B.]

3A.i. Which cereal crop(s) do you grow? [SELECT ALL THAT APPLY]

In-season rice

Off-season rice

Maize

Sweet corn

Wheat

Other cereal

3A.i.i. If select "other cereal", please specify: _____

3A.ii. Are you involved with harvesting the cereal crops? Yes No

3A.iii. Are you involved with threshing the cereal crops? Yes No

3B. Vegetables and melons Yes No

[If "yes" ask all question 3B.i, otherwise skip to question 3C.]

3B.i. Which vegetables and melons do you grow?[SELECT ALL THAT APPLY]

Cauliflower

Cabbage

Chinese kale

Pak Choi

Coriander

Chinese convolvulus

Water convolvulus

Chinese cabbage

Mustard Green

Lettuce

Broccoli

Courgette

Cucumber

Japanese Cucumber, Suhyo

Watermelon

Wax gourd

Pumpkin

Tomato

Thai eggplant

Aubergine

Eggplant

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Bitter melon
 Garlic
 Onion
 Shallot
 Indian Oyster
 Other vegetable and melon
 3B.i.i. If select "other vegetable and melon", please specify: _____

3C. Fruit and nuts Yes _____
No _____

[If "yes" ask all question 3C.i, otherwise skip to question 3D.]
 3C.i. Which fruit and nuts do you grow? [SELECT ALL THAT APPLY]

Pineapple
 Santol
 Banana
 Rambutan
 Durian
 Guava
 Monkey apple
 Tamarind
 Lime
 Mango
 Papaya
 Langsat
 Longan
 Lychee
 Strawberry
 Mulberry
 Tangerine
 Pomelo
 Passion fruit
 Avocado
 Tung oil, tree China wood-oil tree
 Cashew tree
 Other fruit and nut
 3C.i.i. If select "other fruit and nut", please specify: _____

3D. Oilseed crops Yes _____
No _____

[If "yes" ask all question 3D.i, otherwise skip to question 3E.]
 3D.i. Which oilseed(s) do you grow? [SELECT ALL THAT APPLY]

Sesame
 Peanut
 Soybean
 Oil Palm
 Other oilseed
 3D.i.i. If select "other oilseed", please specify: _____

3E. Root/tuber crops with high starch or inulin content Yes _____
No _____

[If "yes" ask all question 3E.i, otherwise skip to question 3F.]
 3E.i. Which root/tuber crops with high starch or inulin content do you grow?
 [SELECT ALL THAT APPLY]

Sweet potato
 Potato
 Cassava
 Other root
 3E.i.i. If select "other root", please specify: _____

3F. Beverage and spice crops Yes _____
No _____

[If "yes" ask all question 3F.i, otherwise skip to question 3G.]
 3F.i. Which beverage and spice crops do you grow?
 [SELECT ALL THAT APPLY]

Coffee bean
 Tea
 Ginger
 Bird eye chili
 Chilli pepper
 Sweet pepper
 Bell pepper
 Makhwaen/Sichuan pepper
 Other beverage/spice crop
 3F.i.i. If select "other beverage", please specify: _____

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3 3G. Leguminous crops Yes —
4 No —
5 [If "yes" ask all question 3G.i, otherwise skip to question 3H.]
6 3G.i. Which leguminous crops do you grow? [SELECT ALL THAT APPLY]
7 — Mung bean
8 — Black gram, urad bean
9 — Cow pea
10 — Common bean
11 — Asparagus bean
12 — Pea
13 — Other legume
14 3G.i.i. If select "other legume", please specify: _____
15 3H. Sugar cane Yes —
16 No —
17 3I. Grasses and other fodder crops Yes —
18 No —
19 3J. Fibre crops Yes —
20 No —
21 [If "yes" ask all question 3J.i, otherwise skip to question 3K.]
22 3J.i. Which fibre crops do you grow? [SELECT ALL THAT APPLY]
23 — Cotton
24 — Other fibre
25 3J.i.i. If select "other fibre", please specify: _____
26 3K. Medicinal, aromatic, pesticidal, or similar crops Yes —
27 No —
28 [If "yes" ask question 3K.i, otherwise skip to question 3L. and 3M.]
29 3K.i. Which medicinal, aromatic, pesticidal, or similar crops do you grow?,
30 please specify: _____
31 3L. Rubber Yes —
32 No —
33 3M. Flower crops Yes —
34 No —
35 [If "yes" ask all question 3M.i, otherwise skip to question 3N.]
36 3M.i. Which flower crops do you grow?, please specify: _____
37 3N. Tobacco Yes —
38 No —
39 3O. Other crops Yes —
40 No —
41 [If "yes" ask all question 3O.i, otherwise skip to question 4.]
42 3O.i. Which other crops do you grow? [SELECT ALL THAT APPLY]
43 — Teak
44 — Calameae
45 — Bamboo
46 — Agarwood/Eagle wood
47 — Other crop
48 3O.i.i. If select "other crop", please specify: _____

Weedkillers

43 **Weedkillers**
44 4. Have you ever used weedkillers to protect your plants? Yes —
45 No —
46 [If "yes" ask question 4A., otherwise skip to question 5.]
47 4A. When did you start spraying weedkillers? _____ (year in B.E.)
48 4B. Over the past year, have you sprayed weedkillers? Yes —
49 No —
50 [If "no" ask question 4C., otherwise skip to question 4B.1. then 4D.]
51 4B.1. Time since last weedkillers exposure
52 i. ___ hours
53 ii. ___ days
54 iii. ___ months
55 4C. When did you stop spraying weedkillers? _____ (year in B.E.)
56 [Continue question 4D.]

4D. weedkillers

57 Now I am going to ask you about *weedkillers* that you have ever used. I would like you to tell me each *weedkiller* that you apply (or
58 applied), and how long do (or did) you spray? If possible, please show the *weedkiller* package(s)/label(s). In case the name(s) of
59 *weedkiller(s)* used is/are not in the lists below, please specify on question 4D.i. in the 'other' cell, and allow the interviewer to take a photo
(by a device provided).

i. Which weedkillers have you ever used? [SELECT ALL THAT APPLY]	ii. How many years have you sprayed your crops with weedkillers?	iii. In the years that you sprayed weedkillers, how many months of each year did you spray?	iv. In the months that you sprayed weedkillers, how many days of each month did you spray?	v. On the days that you sprayed weedkillers, how many hours of each day did you spray?	vi. Over the past year, have you used this?	If applicable, take a photo of weedkiller package(s)/label(s). [Only 'other' selected]
_ 1. glyphosate <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 2. paraquat <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 3. 2,4-D-dimethylammonium <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 4. atrazine <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 5. acetochlor <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 6. alachlor <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 7. pendimethalin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 8. metsulfuron-methyl <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 9. isoxaflutole <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 10. cyprosulfamide + isoxaflutole <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 11. 2,4-D sodium salt <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 12. quizalofop-P-tefuryl <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 13. fomesafen <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 14. glufosinate-ammonium <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ other: please specify..... <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	<i>Please record a photo no.</i>

4E. When you spray, which parts of your body usually come into contact with weedkillers? [SELECT ALL THAT APPLY]

- Face _____
 Hands _____
 Arms _____
 Trunk _____
 Legs _____
 None of the above _____

4F. Do you mix these weedkillers yourself? Yes _____
 No _____

[If "yes" ask question 4G., otherwise skip to question 4H.]

4G. Did you mix them inside home, outside home or both?

- Outside home _____
 Inside home _____
 Both outside and inside home _____

4H. Do you store the mixed chemicals in your home? Yes _____
 No _____

4I. When mixing, loading or applying these weedkillers what protective clothing do you wear? [SELECT ALL THAT APPLY]

- Boots _____
 Gloves _____
 Respirator _____
 Goggles/Safety glasses _____
 Mask _____
 Balaklavas or clothes wrapped around the face _____
 Hat _____
 Full face shield _____
 Apron _____
 None of the above _____

4J. After spraying the weedkillers do you...? [SELECT ALL THAT APPLY]

- | | |
|-------------------------------|---|
| Wash your hands, in home | — |
| Wash your hands, outside home | — |
| Have a shower, in home | — |
| Have a shower, outside home | — |
| Change your clothes | — |
| None of the above | — |

Insecticides

5. Have you ever used insecticides to protect your plants? Yes —
No —
- [If "yes" ask question 5A., otherwise skip to question 6.]
- 5A. When did you start spraying insecticides? _____ (year in B.E.)
- 5B. Over the past year, have you sprayed insecticides? Yes —
No —
- [If "no" ask question 5C., otherwise skip to question 5B.1. then 5D.]
- 5B.1. Time since last insecticides exposure i. ___ hours
ii. ___ days
iii. ___ months
- 5C. When did you stop spraying insecticides? _____ (year in B.E.)
[Continue question 5D.]

5D. insecticides

Now I am going to ask you about *insecticides* that you have ever used. I would like you to tell me each *insecticide* that you apply (or applied), and how long do (or did) you spray? If possible, please show the *insecticide* package(s)/label(s). In case the name(s) of *insecticide(s)* used is/are not in the lists below, please specify on question 5D.i. in the 'other' cell, and allow the interviewer to take a photo (by a device provided).

i. Which insecticides have you ever used? [SELECT ALL THAT APPLY]	ii. How many years have you sprayed your crops with insecticides?	iii. In the years that you sprayed insecticides, how many months of each year did you spray?	iv. In the months that you sprayed insecticides, how many days of each month did you spray?	v. On the days that you sprayed insecticides, how many hours of each day did you spray?	vi. Over the past year, have you used this?	If applicable, take a photo of insecticide package(s)/label(s). [Only 'other' selected]
_ 1. chlorpyrifos <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 2. cartap hydrochloride <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 3. cypermethrin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 4. acetamiprid <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 5. fipronil <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 6. chlorpyrifos + cypermethrin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 7. pyridaben <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 8. imidacloprid <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 9. emamectin benzoate <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 10. chlorfenapyr <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 11. buprofezin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 12. sulphur <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 13. carbaryl <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 14. abamectin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 15. propargite <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 16. Petroleum oil <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 17. dinotefuran <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 18. <i>B Thuringiensis</i> <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 19. thiamethoxam <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 20. indoxacarb <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 21. lambda-cyhalothrin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ other: please specify..... <i>If selected, answer ii. to vi..</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	<i>Please record a photo no.</i>

5E. When you spray, which parts of your body usually come into contact with insecticides? [SELECT ALL THAT APPLY]

- Face _____
 Hands _____
 Arms _____
 Trunk _____
 Legs _____
 None of the above _____

5F. Do you mix these insecticides yourself?

- Yes _____
 No _____

[If "yes" ask question 5G., otherwise skip to question 5H.]

5G. Did you mix them inside, outside home or both?

- Outside home _____
 Inside home _____
 Both outside and inside home _____

5H. Do you store the mixed chemicals in your home? Yes No

5I. When mixing, loading or applying these insecticides what protective clothing do you wear? [SELECT ALL THAT APPLY]

Boots

Gloves

Respirator

Goggles/Safety glasses

Mask

Balaklavas or clothes wrapped around the face

Hat

Full face shield

Apron

None of the above

5J. After spraying the insecticides do you...? [SELECT ALL THAT APPLY]

Wash your hands, in home

Wash your hands, outside home

Have a shower, in home

Have a shower, outside home

Change your clothes

None of the above

Fungicides

6. Have you ever used fungicides? Yes No

[If "yes" ask question 6A., otherwise skip to question 7.]

6A. When did you start spraying fungicides? _____ (year in B.E.)

6B. Over the past year, have you sprayed fungicides? Yes No

[If "no" ask question 6C., otherwise skip to question 6B.1. then 6D.]

6B.1. Time since last fungicides exposure

i. _____ hours

ii. _____ days

iii. _____ months

6C. When did you stop spraying fungicides? _____ (year in B.E.)

[Continue question 6D.]

6D. fungicides

Now I am going to ask you about *fungicides* that you have ever used. I would like you to tell me each *fungicide* that you apply (or applied), and how long do (or did) you spray? If possible, please show the *fungicide* package(s)/label(s). In case the name(s) of *fungicide(s)* used is/are not in the lists below, please specify on question 6D.i. in the 'other' cell, and allow the interviewer to take a photo (by a device provided).

i. Which fungicides have you ever used? [SELECT ALL THAT APPLY]	ii. How many years have you sprayed your crops with fungicides?	iii. In the years that you sprayed fungicides, how many months of each year did you spray?	iv. In the months that you sprayed fungicides, how many days of each month did you spray?	v. On the days that you sprayed fungicides, how many hours of each day did you spray?	vi. Over the past year, have you used this?	If applicable, take a photo of insecticide package(s)/label(s). [Only 'other' selected]
_ 1. mancozeb <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 2. hexaconazole <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 3. carbendazim <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 4. thiram <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 5. copper II hydroxide <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 6. quintozone + Etridiazole <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 7. triforine <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 8. pyraclostrobin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 9. dimethomorph <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 10. etridiazole <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 11. cuprous oxide <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 12. prochloraz <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 13. tetraconazole <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ other: please specify..... <i>If selected, answer ii. to vi..</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	<i>Please record a photo no.</i>

6E. When you spray, which parts of your body usually come into contact with fungicides? [SELECT ALL THAT APPLY]

- Face _____
 Hands _____
 Arms _____
 Trunk _____
 Legs _____
 None of the above _____

6F. Do you mix these fungicides yourself? Yes _____
 No _____

[If "yes" ask question 6G., otherwise skip to question 6H.]

6G. Did you mix them inside, outside home or both?

- Outside home _____
 Inside home _____
 Both outside and inside home _____

6H. Do you store the mixed chemicals in your home? Yes _____
 No _____

6I. When mixing, loading or applying these fungicides what protective clothing do you wear? [SELECT ALL THAT APPLY]

- Boots _____
 Gloves _____
 Respirator _____
 Goggles/Safety glasses _____
 Mask _____
 Balaklavas or clothes wrapped around the face _____
 Hat _____
 Full face shield _____
 Apron _____
 None of the above _____

6J. After spraying the fungicides do you...? [SELECT ALL THAT APPLY]

- | | |
|-------------------------------|---|
| Wash your hands, in home | — |
| Wash your hands, outside home | — |
| Have a shower, in home | — |
| Have a shower, outside home | — |
| Change your clothes | — |
| None of the above | — |

Storage of food crops

7. Have you ever used chemicals to protect food crops during storage? Yes —
No —

[If "yes" ask question 7A., otherwise skip to question 8.]

7A. Which chemicals do you apply to protect food crops during storage?

[SELECT ALL THAT APPLY]

- | | |
|-------------|---|
| Rodenticide | — |
| Fumigant | — |

Animals

8. Do you keep animals? Yes —
No —

[If "yes" ask question 8A. and 9., otherwise skip to question 10.]

8A. Which of these animals do you keep? [SELECT ALL THAT APPLY]

- | | |
|--|---|
| Insects (bees/silkworms/other worms or insects) | — |
| Large ruminants (Cattle/buffaloes/yaks) | — |
| Small ruminants (Sheep/goats) | — |
| Pigs or swine | — |
| Equines | — |
| Poultry: hens, ducks, geese etc. | — |
| Dogs and cats | — |
| Rabbits and hares | — |
| Other animal(s) | — |
| 8A.i. If select "other animal(s)", please specify: _____ | |

Insecticides protecting animals

9. Have you ever used insecticides to protect your animals? Yes —
No —

[If "yes" ask question 9A., otherwise skip to question 10.]

9A. When did you start dipping insecticides protecting animals? _____ (year in B.E.)

9B. Over the past year, have you dipped insecticides protecting animals?

Yes —
No —

[If "no" ask question 9C., otherwise skip to question 9B.1. then 9D.]

9B.1. Time since last insecticides protecting animal exposures

i. ___ hours
ii. ___ days
iii. ___ months

9C. When did you stop spraying insecticides protecting animals? _____ (year in B.E.)

[Continue question 9D.]

9D. insecticides protecting animals

Now I am going to ask you about *insecticides* that you have ever used to protect your animals. I would like you to tell me each *insecticide* that you apply (or applied), and how long do (or did) you dip? If possible, please show the *insecticide* package(s)/label(s). In case the name(s) of *insecticide(s)* used is/are not in the lists below, please specify on question 9D.i. in the 'other' cell, and allow the interviewer to take a photo (by a device provided).

i. Which insecticides have you ever used? [SELECT ALL THAT APPLY]	ii. How many years have you dipped insecticides to protect animals?	iii. In the years that you dipped insecticides, how many months of each year did you dip?	iv. In the months that you dipped insecticides, how many days of each month did you dip?	v. On the days that you dipped insecticides, how many hours of each day did you dip?	vi. Over the past year, have you applied this?	If applicable, take a photo of insecticide protecting animals package(s)/label(s). [Only 'other' selected]
_ 1. chlorpyrifos <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 2. cartap hydrochloride <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 3. cypermethrin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 4. acetamiprid <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 5. fipronil <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 6. chlorpyrifos + cypermethrin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 7. pyridaben <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 8. imidacloprid <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 9. emamectin benzoate <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 10. chlorfenapyr <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 11. buprofezin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 12. sulphur <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 13. carbaryl <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 14. abamectin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 15. propargite <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 16. Petroleum oil <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 17. dinotefuran <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 18. <i>B Thuringiensis</i> <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 19. thiamethoxam <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 20. indoxacarb <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ 21. lambda-cyhalothrin <i>If selected, answer ii. to vi.</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	
_ other: please specify..... <i>If selected, answer ii. to vi..</i>	__ years	__ months	__ days	__ hours	_ Yes _ No	<i>Please record a photo no.</i>

9E. When you dip, which parts of your body usually come into contact with insecticides? [SELECT ALL THAT APPLY]

- Face _____
 Hands _____
 Arms _____
 Trunk _____
 Legs _____
 None of the above _____

9F. Do you mix these insecticides yourself?

- Yes _____
 No _____

[If "yes" ask question 9G., otherwise skip to question 9H.]

9G. Did you mix them inside, outside home or both?

- Outside home _____
 Inside home _____
 Both outside and inside home _____

9H. Do you store the mixed chemicals in your home?

- Yes _____

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|---|-----------|-----|---|
| | | No | — |
| 9I. When mixing, loading or applying these insecticides what protective clothing do you wear? [SELECT ALL THAT APPLY] | | | |
| Boots | — | | |
| Gloves | — | | |
| Respirator | — | | |
| Goggles/Safety glasses | | — | |
| Mask | — | | |
| Balaklavas or clothes wrapped around the face | — | | |
| Hat | — | | |
| Full face shield | — | | |
| Apron | — | | |
| None of the above | — | | |
| 9J. After dipping the insecticides do you...? [SELECT ALL THAT APPLY] | | | |
| Wash your hands, in home | — | | |
| Wash your hands, outside home | — | | |
| Have a shower, in home | — | | |
| Have a shower, outside home | — | | |
| Change your clothes | — | | |
| None of the above | — | | |
| 10. Have you ever worked in a barn/silo storing grain or fodder? | | Yes | — |
| | | No | — |
| <i>[If "yes" ask question 10A. to 10E., otherwise skip to question 11.]</i> | | | |
| 10A. How many years have you worked in a barn/silo storing grain or fodder? __ years | | | |
| 10B. In the years that you worked in a barn/silo storing grain or fodder, how many months of each year did you do it? | __ months | | |
| 10C. In the months that you worked in a barn/silo storing grain or fodder, how many days of each month did you do it? | __ days | | |
| 10D. On the days that you worked in a barn/silo storing grain or fodder, how many hours of each day did you do it? | __ hours | | |
| 10E. Are you still working in a barn/silo storing grain or fodder? | | Yes | — |
| | | No | — |
| 11. Have you ever driven farm machines? | | Yes | — |
| | | No | — |

[If "yes" ask question 11A., otherwise skip to question 12.]

11A. farm machines

Now I am going to ask you about *farm machines and fuels* that you have ever used. I would like you to tell me each *farm machine* that you drive (or drove), how long do (or did) you use, and its fuel? The following are explanations for each *farm machine*. In case of 'other' selected, please specify a name of machine used.

- **Farm trucks:** Pick-ups, cargo vans, cars and other passenger vehicles used in farm business
- **Tractors**
- **Tillage equipment:** Moldboard plow; Disk plow; Subsoiler; Lister; Disk harrow; Spring tooth harrow; Spike; Land roller; Float
- **Planting equipment:** Spacing drill; Planters; Transplanters; Sugar cane planter
- **Crop protection equipment:** Water pumps; Sprats; Cultivator; Fertiliser distributors; Mowers
- **Harvesting equipment:** Combine harvester; Sugar harvester; Straw or fodder balers; Root or tuber harvesting; Threshing; Hullers and Mills
- **Other:** e.g. Livestock machine, Milking machines, Feeding stuffs, Poultry keeping, Crop processing equipment, Grading, Dryers, Conveyors

i. Which of these machines have you driven on the farm? [SELECT ALL THAT APPLY]	ii. How many years have you driven these farm machines	iii. In the years that you drove these farm machines, how many months of each year did you drive it?	iv. In the months that that you drove these farm machines, how many days of each month did you drive it?	v. On the days that that you drove these farm machines, how many hours of each day did you drive it?	vi. Which of these sources of fuel is used for driving your driving farm machinery? [SELECT ALL THAT APPLY]	vii. Over the past year, have you driven these farm machines?
_ Farm trucks <i>If selected, answer ii. to vii.</i>	__ years	__ months	__ days	__ hours	_ Diesel _ Petrol (gasoline) _ Biodiesel _ Gasohol _ Other fuel <i>specify:.....</i>	_ Yes _ No
_ Tractors <i>If selected, answer ii. to vii.</i>	__ years	__ months	__ days	__ hours	_ Diesel _ Petrol (gasoline) _ Biodiesel _ Gasohol _ Other fuel <i>specify:.....</i>	_ Yes _ No
_ Tillage equipment <i>If selected, answer ii. to vii.</i>	__ years	__ months	__ days	__ hours	_ Diesel _ Petrol (gasoline) _ Biodiesel _ Gasohol _ Other fuel <i>specify:.....</i>	_ Yes _ No
_ Planting equipment <i>If selected, answer ii. to vii.</i>	__ years	__ months	__ days	__ hours	_ Diesel _ Petrol (gasoline) _ Biodiesel _ Gasohol _ Other fuel <i>specify:.....</i>	_ Yes _ No
_ Crop protection equipment <i>If selected, answer ii. to vii.</i>	__ years	__ months	__ days	__ hours	_ Diesel _ Petrol (gasoline) _ Biodiesel _ Gasohol _ Other fuel <i>specify:.....</i>	_ Yes _ No
_ Harvesting equipment <i>If selected, answer ii. to vii.</i>	__ years	__ months	__ days	__ hours	_ Diesel _ Petrol (gasoline) _ Biodiesel _ Gasohol _ Other fuel <i>specify:.....</i>	_ Yes _ No
_ Other: please specify..... <i>If selected, answer ii. to vii.</i>	__ years	__ months	__ days	__ hours	_ Diesel _ Petrol (gasoline) _ Biodiesel _ Gasohol _ Other fuel <i>specify:.....</i>	_ Yes _ No

12. Do you apply natural fertilizer?

Yes _____

No _____

13. Do you apply chemical fertilizer?

Yes _____

No _____

14. Do you burn forest/previous crops for converting to farm lands?

Yes _____

No _____

[If "yes" ask question 14A., otherwise finish this interview]

14A. Over the past year, have you burnt forest/previous crops for converting to farm lands?

Yes _____

No _____

[If "yes" ask question 14A.1., otherwise skip to question 14B.]

14A.1. Time since last burning forest/previous crops for converting to farm lands?

i. _____ hours

ii. _____ days

iii. _____ months

14B. How long have you burnt forest/previous crops for converting to farm lands?

____ years

14C. How many times a year did you burn forest/previous crops for converting to farm lands?

____ times

Completed by: _____