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Institute for Risk Assessment Sciences (IRAS), Utrecht University, Utrecht,

The Netherlands

Pesticide exposure and women's respiratory health in the BriBri indigenous reserve, Talamanca, Costa Rica

Karin Fieten

Supervisors:

Berna van Wendel de Joode, Instituto Regional de Estudios en Sustancias Tóxicas (IRET), Universidad Nacional, Heredia, Costa Rica

Hans Kromhout, Institute for Risk Assessment Sciences (IRAS), Universidad de Utrecht, Utrecht, Países Bajos.

Resumen

Objetivo Se realizó un estudio transversal para evaluar la relación de la salud respiratoria y exposición a plaguicidas en mujeres.

Métodos La población de estudio fue seleccionada en la reserva indígena BriBri en Talamanca, Costa Rica. Las mujeres expuestas a plaguicidas (n=69) trabajaban en plantaciones de plátano convencionales, mientras las mujeres sin exposición a plaguicidas (n=58) trabajaban en plantaciones orgánicas, en la casa o en otro lugar. Solamente las mujeres entre 24 y 58 años fueron invitadas a participar en el estudio. Se entrevistó a las participantes con un cuestionario para estimar la exposición a plaguicidas y la prevalencia de síntomas respiratorios. Se midieron la capacidad vital forzada (CVF) y el volumen respiratorio forzado durante el primer segundo (VEF_1) con un espirometro.

Resultos En las mujeres expuestas, la prevalencia de silbidos o 'pitillos' fue 20%, disnea 36%, tos crónica 10%, asma 10% y de atopia 30%. Las mujeres no fumadoras expuestas a plaguicidas reportaron con mayor frecuencia silbidos que las mujeres no fumadores sin contacto con plaguicidas: OR=8.2 (95% CI 1.4-47.2). Las fumadoras expuestas a paraquat reportaron más frecuentemente síntomas de atopia que las fumadores sin exposición a plaguicidas (OR=14.9; 95% CI 1.2-180.8). No se encontró ninguna asociación entre la exposición a plaguicidas y los valores CVF o VEF_1 medidos con el espirometro.

Conclusion La exposición a plaguicidas se asocia a una prevalencia más alta de silbidos y atopia. No se encontró ninguna asociación entre la exposición a plaguicidas y las valores de VEF_1 o CVF.

Abstract

Objectives A cross-sectional study was conducted to evaluate the relationship between respiratory health and pesticide exposure in women.

Methods The study population was selected in the BriBri indigenous reserve in Costa Rica. Exposed women (n=69) all worked at plantain plantations, unexposed women (n=58) worked at organic banana plantations or another location. Women between 24 and 58 years of age could participate. Study participants were interviewed with use of a questionnaire to estimate exposure and occurrence of respiratory symptoms. Spirometry tests were taken to obtain forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1).

Results The prevalence of wheeze was 20%, of breathlessness was 36%, of chronic cough 10%, of asthma 10% and prevalence of atopy was 30% among the exposed group. Statistically significant higher odds ratios for wheeze (OR=8.2; 95% CI 1.4-47.2) among exposed non-smokers were found. Statistically significant higher odds ratios for paraquat applying smokers were found for atopy (OR=14.9; 95% CI 1.2-181). Higher exposure resulted in higher odds ratios. There was no relationship between exposure and FEV_1 or FVC**.**

Conclusion Exposure to pesticides, in particular the organophosphates terbufos and chlorpyrifos was associated with a higher prevalence of wheeze, which is in concordance with recently published studies in male pesticide applicators. Paraquat application was associated with an increase in atopy. No association between pesticide exposure and FEV_1 or FVC was found.

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1. Background

1.1 Research area

The Talamanca county in the south east of Costa Rica is divided in three districts: Sixaola, Cahuita and Bratsi. It is the poorest canton of Costa Rica, with about half of the population (49.7%) living in poverty [1]. The BriBri indigenous reserve was created in 1977 and is located in the district of Bratsi, which has the highest concentration of poverty within the Talamanca canton [1]. It comprises 43,690 hectares and in the year 2000 the population was registered at 10292 [1].

There are several villages in the reserve, each with varying infrastructure and access to basic services. In 1998, 34.2% of the population of the indigenous territories lived in just three communities: Amubri, Shiroles, and Suretka [2]. These villages are characterized by road access and public transportation, the presence of electricity, potable water, a health clinic and schools. Shiroles is located relatively close to the entrance of the reserve (14 km from BriBri) and has a fairly high incidence of non indigenous people compared to the rest of the reserve.

Source: www.casacanada.net

1.2 Agricultural practice in the reserve

Plantain has always been cultivated in small parcels within the indigenous reserve, but for home consumption. In the late 1970s plantain production increased when intermediaries from the central valley started purchasing it for commercialization within the national market. In the early 1980s transnational companies started to buy plantain for export to the USA. Since then the plantain market has continued to expand. In 2001 approximately 1600 hectares of export plantain and 3000 hectares of plantain for the national market was in production in Talamanca [1]. About 52% of the national production of plantain takes place in Talamanca.

Nowadays, many households in the lower regions of the reserve depend on plantain cultivation for a living. In the highlands banana and cacao are the preferred crops for cultivation. Besides plantain, banana and cacao which are grown in the reserve for national and international markets, maize, rice and beans are also grown but mainly for private consumption.

Banana is mainly cultivated in the indigenous reserve in small parcels for home consumption. During the last decade of the previous century, production and commercialization of organic products has grown exponentially as a result of increased demand in Europe and the US, price premiums and the development of several certification and accreditation systems [3]. In the mid 1990s organic banana production in the reserve started to increase, with the arrival of organizations interested in purchasing organic banana in the area. In 2001, approximately 2000 hectares of certified organic banana was in production in Costa Rica, of which 90% was produced in Talamanca [1].

1.3 Plantain production

Plantain production is favored over banana production in most households in the reserve. It is easier to sell plantain than banana, which is an important factor for many households. For example, plantain can be sold each week, whereas organic banana can only be sold every 15 to 22 days. An additional advantage lies in the fact that households are paid immediately by plantain intermediaries, whereas due to organizational rules, households that sell organic bananas receive delayed payment.

However, in Shiroles several households that presently cultivate plantain would rather cultivate organic banana. As neighbors were cultivating plantain nearby with agrochemicals, their parcel did not meet the requirement of a specified distance of a 'non-chemical zone'. This means that these households were unable to attain the certification needed in order to commercialize their banana in organic markets. Other households claimed that they favored organic banana production but, because they had small landholdings already dedicated to plantain, they could not afford to undertake the transition period required by certifying agencies to shift from conventional to organic production.

A major disadvantage of the plantain producing households in the indigenous reserve, is that they have little options to sell their product. Intermediaries drive big trucks into the reserve and most people sell their product to them. However, they have to sell their product at the price demanded by the intermediaries, there are no other options. This leads to a lot of unrest in the reserve, because in the next step of the commercialization chain huge profits are made by the intermediaries. Producers often charge the group of intermediaries of collusion, that they arrange the price among themselves ahead of time, regardless of what the going price is. This year, the price of plantain has been declining since January. Consequently the family income lowers drastically as well, some households earned €140 a month last year and now €56 a month*. Some producers have organized themselves and sell directly to companies such as Dole, which lead to a higher and more stable income. But most people do not have the option to do this, because they do not have sufficient funds to bypass the intermediaries or are unable to comply with the demanded product standards.

* Rate 100 colones: 0,14eurocent (wisselkoers.nl, visited 17/08/07)

2. Introduction

2.1 Pesticides

Pesticides are an extensively documented occupational and environmental hazard in Central America [4]. In Costa Rica, the use of synthetic pesticides in agriculture is widespread. Inorganic pesticides were first introduced in the 1950s. Organochloride insecticides dominated the market during the 1960s and 1970s. Since then the use of pesticides has steadily increased in Costa Rica. In the 1980s and 1990s when the use of organochloride insecticides was restricted, these were replaced by others such as organophosphates. Between 1994 and 2002 there was a 32% increase of pesticide use in Costa Rica and numbers keep rising [5]. Nowadays Costa Rica is one of the Central American countries with the largest use of pesticides, in terms of active ingredient per inhabitant, per farmer and per cultivated area [6].

The downsides of pesticide use have been revealed in the last three decades. Extensive use of pesticides affects the environment as well as human health. Rivers and soil are polluted, ecosystems affected and after years of intensive pesticide use, the soil is exhausted. It is difficult to decrease the amount of pesticides used, since over time more and stronger pesticides are needed to reach the same effect [7].

2.2 Pesticide use in the indigenous reserve

2.2.1 Pesticide use

Pesticides were first introduced in the indigenous reserve in the late 1980s, early 1990s and its use has steadily increased ever since, in quantity as well as in variety (see Results, Graph 1). Shiroles is one of the villages where pesticides in plantain cultivation are the most extensively used, compared to the rest of the reserve. To be able to sell to the international market, and consequently to yield more family income, the plantain has to be of excellent quality and size. To be able to meet the demanded standards, chemicals are extensively used. Plantain that does not meet export standards is often sold on the national market, used as food for pigs, or thrown away. Even though not all plantain meets the international market criteria, it is still worth trying to meet the standards and thus continue the use of pesticides.

The pesticides that are regularly used in plantain cultivation are the fungicides mancozeb, propiconazole, difenoconazole and imazalil, the herbicides paraquat and glyphosate and the insecticides chlorpyrifos, terbufos and oxamil [8]. This study focuses on two groups of pesticides, the organophosphate insecticides chlorpyrifos and terbufos and the herbicides paraquat and glyphosate.

2.2.2 Organophosphate insecticides

Organophosphate insecticides represent the largest group of insecticides sold worldwide. Organophosphates inactivate the enzyme acetylcholinesterase, resulting in an accumulation of acetylcholine. Acetylcholine is a major neurotransmitter in the peripheral and central nervous system and overstimulation of its receptor results in increased sweating, bronchial secretion, broncho-constriction with consequent wheezing, coughing and shortness of breath, muscular twitching and several central nervous system effects [9]. Further stimulation results in inhibition of respiratory centers in brainstem and paralysis of respiratory muscles which eventually results in death. Respiratory health effects due to chronic exposure to low levels of organophosphates are still under debate. However, several animal studies have supported a link between chronic low-level exposure to organophosphates and airway hyper-reactivity [10, 11].

Dysregulation of autonomous control of airways as a result of acetylcholine accumulation predicts the onset of wheezing and plays a role in the occurrence of asthma [12]. Short term

respiratory symptoms following low-level exposure include chest pain, cough, wheezing and shortness of breath [13].

2.2.3 Paraquat

Paraquat is a highly toxic, non selective herbicide and is widely used throughout the world since its introduction in 1961. In high doses paraquat causes oxidative damage to the lung, pulmonary fibrosis, and respiratory failure; large oral doses often result in death [14, 15]. In laboratory animals, chronic lower doses result in lung injury for example in sheep [16]. The few published epidemiological studies investigating the respiratory effects of chronic paraquat exposure showed conflicting results. Paraquat exposure has been related to arterial oxygen desaturation in South African and Costa Rican farm workers [15, 17] and increased respiratory symptoms such as wheezing in Nicaraguan banana workers [18]. Other epidemiological studies in Sri Lankan and Malaysian plantation workers found no association with respiratory symptoms or changes in lung function parameters. However, these studies were flawed with small sample size or poor variable characterization [19-21]. In the AHS, the use of paraquat was associated with the occurrence of wheeze [10, 22].

2.3 The role of women in plantain cultivation

Most research on occupational pesticide exposure and its related health effects focuses on white males. Many effects of pesticides will be identical for men and women, but biologically distinct susceptibilities for certain chemicals may exist. A substantial number of women work in agriculture in many parts of the world. The Food and Agriculture Organization (FAO) estimated 44% of the total agricultural labour force in developing countries and 36% in developed countries to be female [23].

Occupational exposure in women may be different than in men. Women working in agriculture are typically found in lower-paid and lower-status jobs, with less access to information and safety measures [24]. The BriBri indigenous have largely succeeded in maintaining their culture and language alive. In the indigenous culture, women own the land and the line of heritage is through women [7]. Even though the indigenous culture in Shiroles has been diluted by the arrival of other immigrants, it is still very present. This means that many women in Shiroles own a plantain plantation and work on it, but not necessarily in lower-status jobs. Domestic exposure is recognized as an important source of exposure as well as re-entry into areas that have recently been treated with pesticides [25]. Exposure through re-entry typically is a frequent activity and may involve many more hours of exposure than the actual application itself [26].

There are few epidemiological studies regarding women and most focus on women's reproductive health. It has been pointed out that to properly address women's pesticide exposure and the related adverse health effects, gender sensitive research is needed [25].

In the reserve, very little product knowledge and safety awareness exists. During fieldwork it was observed that pesticides are generally handled with little caution and loaded, mixed and applied without the use of personal protective equipment. Exposure through re-entry is expected to be high since the plantations are small and located close together with limited infrastructure. This makes it hard to avoid contamination of other persons working nearby or to avoid crossing recently sprayed plantations in order to reach a certain plantation. All women who work on a plantation are therefore expected to be chronically high exposed and the contrast between the exposed and control group is expected to be high.

2.4 Respiratory health effects of pesticides

In general, exposure to pesticides has been associated with a range of health effects, including cancer, neurotoxic, reproductive, dermatological and respiratory effects [4]. Agricultural workers are generally exposed to several chemical substances. Previous studies in farmers have suggested a link between pesticide exposure during agricultural activities and an increased risk of respiratory symptoms, such as wheeze, chronic cough, shortness of breath and asthma [13, 15, 18, 22, 27-30].

Several of the pesticides that are commonly used in plantain cultivation are associated with the occurrence of respiratory symptoms. In the Agricultural Health Study (AHS), a large epidemiological study with farmers and their wives, exposure to organophosphates were associated with an increase in wheeze [10, 22]. However, most study participants were exposed to several pesticides, which makes it hard to contribute the respiratory effects to exposure to specific pesticides. All symptoms in the AHS were self reported using questionnaires.

Furthermore, the use of pesticides has been associated with reduced lung function, reflected in abnormal lung function variables [30-33]. However, other studies found no change in lung function variables [15, 17, 18, 21]. The studies that found a significant effect all had small study populations and therefore limited power. Significant decreases in both FVC and FEV_1 values were reported, associated with occupational pesticide exposure. Studies were conducted at all different continents, but the majority in hot tropical climates where work practice is similar to our study.

A higher incidence of atopy among exposed farmers has also been reported with some studies specifically associating exposure to chlorpyrifos with an increase in atopic conditions [10, 22, 34, 35]. In both the AHS and the European Community Respiratory Health Suvery (ECRHS), the occurrence of atopy was estimated through the use of questionnaires. In the ECRHS IgE antibody levels for common allergens were also measured [36]. A Greek study used skin prick tests for common allergens and measurements of IgE antibodies to define atopy [34]. Another small study identified persons with atopy according to information provided by their physicians and provided an overview of other immunological parameters [35].

3. Research objectives

3.1 General aim of study

To contribute to increased awareness of the health effects of pesticide use in general and to respiratory health effects in particular and to provide a better understanding of the importance of safety measures and caution while handling pesticides.

3.2 Main objective

To estimate whether chronic pesticide exposure, specifically to the pesticides chlorpyrifos, terbufos, paraquat and glyphosate can be related to changes in respiratory health in women of the BriBri indigenous reserve.

3.3 Research questions

- Which factors account for the variability in respiratory health parameters?
- Does more contact with pesticides lead to more respiratory complaints or decreased lung function parameters?
- Does the application of pesticides lead to more respiratory complaints or decreased lung function parameters?
- Does contact with chlorpyrifos, terbufos, glyphosate or paraquat lead to more respiratory complaints or decreased lung function parameters?

3.4 Hypothesis

Women who are higher exposed to pesticides are expected to have more respiratory complaints and lower FVC, FEV_1 and FEV_1/FVC lung function parameter values compared to non-exposed women.

3.5 Research output

While there is a vast amount of information available on the effects of pesticides and the way they affect human health, people that have to work with it generally have little knowledge about the harmful effects of these products. Focus group discussions in women from Shiroles showed that they are aware of the acute hazards of pesticide use and suspect that long-term health effects may exist as well, but they do not know what these effects may be [37]. Therefore it is important to increase knowledge and awareness of the people by communicating the general study results back to the study participants. At the same time it is necessary to find alternatives for pesticide use and to recommend low-cost behavioural changes that may reduce pesticide exposure. There is limited access to resources in the reserve and people have few options. To find sustainable and feasible solutions a participatory approach should therefore be used. The Universidad Nacional has recently organized participatory workshops in the reserve to demonstrate the use of alternatives.

It is also important to communicate the study results to the participants, because of the general distrust noticed during fieldwork. There is a widespread perception in the indigenous reserve that ‘outsiders’ do not act in the interest of the local residents, but in their own interest. People are eager to know what happens with the information they provide and what their benefits are. To respect the trust they displayed by deciding to participate, it is very important to show them the results of the study.

4. Subjects and methods

4.1 Study design

Study design was cross-sectional. Fieldwork was done in the BriBri indigenous reserve from half May until the end of June 2007. Shiroles was used as the main base from which to explore the other villages of the reserve, because of practical reasons. Shiroles is located close to the entrance of the reserve and relatively easily reached by bus. Also reasonable options for food, accommodation and communication could be found there.

4.2 Selection of study population

At the start of the fieldwork period all houses of the village of Shiroles were visited together with a familiar person from the community and informed consent from the participants was obtained. During the period of fieldwork additional participants were found using the same approach, mainly in the villages of Suretka and Amubri to obtain sufficient numbers in both exposed and control groups. In total 140 women were invited to participate in the study. There were n=4 (3%) women who refused to participate and n=3 (2%) who showed interest in the study but could not be contacted. There were n=6 (4%) women excluded from the data analysis because of pregnancy (n=1) or because they did not meet the age requirements (n=5).

The majority of the participants were from the village of Shiroles (n=81), the others were from Suretka (n=30) and Amubri (n=16). Because the majority of women in Shiroles are exposed to pesticides, it was difficult to find enough non-exposed participants. Amubri is known for its organic banana production and therefore women from Amubri were included in the control group.

The selection criteria were the following. All women between 24 and 58 years of age could participate in the study. A minimum age of 24 was set to ensure that the participants in the exposed group had been exposed for at least a few years. Furthermore, the spirometric variables of FVC and FEV_1 are still increasing between the ages of 18 and 24 and it is recommended to analyse this age group separately [38]. For the same reason the maximum age was set at 58 years. With increasing age, spirometric variables slowly decrease.

All participants gave their informed consent. The study design was approved by the medical ethical committee of the Universidad Nacional, Costa Rica.

4.3 Exposure assessment

Each participant was interviewed in her home at a for the participant convenient time, generally between 7:00h and 18:00h. To estimate pesticide exposure, a designed questionnaire was used (annex I). This questionnaire is partly based on questionnaires previously used by IRET to estimate exposure in Costa Rica, but new questions were designed and added. The questionnaire was never used before and has not been validated, but was pretested in the reserve.

The first few questions were designed to decide whether a participant belongs to the control or exposed group. For the control group the use of pesticides in and around the house was the only exposure variable of interest. For the exposed group, occupational pesticide exposure was estimated. There were questions regarding occupational history, such as working hours per week, number of years working with plantain and work-related symptoms. Questions about contact with pesticides during childhood, during washing and cleaning of clothes, pesticide use in and around the house and re-entry activities were being asked.

For women who apply pesticides themselves, special attention was given to the method of application, type of work clothes and use of personal protective equipment. The questionnaire focused on contact with either one of the pesticides chlorpyrifos, terbufos, glyphosate and

paraquat and centred around four different activities in which contact with these pesticides is believed to exist, to help facilitate the memory of the participants. This was done to estimate exposure as accurately as possible. In the reserve, pesticides are known by different names and often people are not sure which pesticides they work with or seem unaware they are actually working with pesticides. They do know however what kind of activities they do at their plantation. When focussed on these activities, contact with specific pesticides can still be estimated.

4.4 Effect assessment

4.4.1 Respiratory symptoms

Respiratory symptoms were assessed in a qualitative way using an edited version of the validated Spanish questionnaire from the European Community Respiratory Health Survey (ECRHS) (annex II). Words commonly used in Spain were changed for words that are more common in Central America. With these questions the occurrence of the respiratory symptoms wheeze, breathlessness, chronic cough and asthma was assessed. Questions regarding the presence of atopic disease (allergic rhinitis and eczema), work-related respiratory symptoms, the occurrence of acute high exposure events and pesticide poisoning were added. Confounding variables such as living in a humid house, cooking with wood and the use of cleaning agents were identified.

4.4.2 Interpretation of questionnaire results

Several criteria were used to define the presence or absence of the respiratory symptoms of interest. Wheeze was defined as having reported whistling sounds in the chest in the last year without having a cold or the flu. Breathlessness was defined as present when having reported waking up at night in the last year because of shortness of breath. Chronic cough was defined as having reported waking up at night in the last 12 months because of a cough attack and coughing for at least three consecutive months per year or coughing regularly in the rainy season. Definitions for asthma and atopy were similar as used in the ECRHS. Definition of asthma was based on the occurrence of an asthma attack in the last year or current use of asthma medication and confirmation of asthma by a doctor. To be defined as atopic, either symptoms of rhinitis or eczema or both in the last year had to be reported. Rhinitis was defined as the occurrence of two or more nasal symptoms, such as sneezing, runny nose or nasal itching, during the last 12 months, without having a cold or the flu. Eczema was defined as the appearance and disappearance of an itchy rash during 6 months in the folds of the elbows, behind the knees, around the ankles, under the buttocks or around the neck, ears or eyes.

4.4.3. Spirometry

Lung function consists of the ventilatory, circulatory and diffusion capacity of the lungs. Spirometry is a physiological test that measures how an individual inhales or exhales volumes of air as a function of time. It allows for the quantitative assessment of the ventilatory function of the lungs only. Spirometry is a widely used and accepted method for lungfunction measurements and its variables are among the most simple and reliable in lung function research. The basic parameters most often used to properly interpret lung function are (forced) vital capacity ((F)VC), forced expiratory volume in one second (FEV_1) and the FEV_1/(F)VC ratio. The FEV_1 is the maximal volume of air exhaled in the first second of a forced expiration. The forced vital capacity (FVC) is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration and is often used instead of VC, but is more dependent on flow and volume histories. Therefore it is thought that the FEV_1/VC ratio more accurately identifies obstructive defects [39]. However, in this study only the FVC was obtained.

Spirometry tests were done in the participant's home, after the interview. Before start of the spirometry test, the participants' height and weight were recorded, using a centimeter and a balance. All participants were examined with a MIR spirotel spirometer (Medical International Research, Rome, Italy) following the most recent guidelines [40]. The advantage of this spirometer is that it does not need calibration and supposedly works fine in hot and humid weather. Because it was impossible to check if the manoeuvres were acceptable (technically satisfactory) after each manoeuvre, each subject was asked to perform eight manoeuvres. In this way it was more likely that at least three acceptable manoeuvres were obtained. Some households were not in the possession of an immovable chair, in these cases any other available straight surface was used, for example a tree trunk or the stairs. Details of the test procedure and interpretation can be found in annex III.

4.4.4 Interpretation of spirometry

At the end of each day, all obtained spirometric curves were reviewed for test quality. Curves that did not meet the acceptable test criteria were deleted. From the remaining curves, the forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) were obtained and the FEV_1/FVC ratio was derived. The interpretation of spirograms was limited to these variables to avoid the problem of examining a multitude of variables to identify any abnormalities: a procedure known to lead to a high number of abnormal tests, even among the healthiest groups in a population [39].

The obtained values were then compared with reference values, derived from a healthy reference population. Because of ethnical differences it is recommended to use ethnic specific reference equations whenever available [39]. However, there were no reference equations available for the indigenous population of our study. Therefore reference equations were obtained from the third National Health and Nutrition Estimation Survey (NHANESIII). The equations from Mexican American females over 18 years were used [41].
The observed – reference value for each subject was calculated for the spirometric variables of interest. Values that are below the 5^{th} percentile of the frequency distribution of the values measured in the reference population, were considered to be below the expected 'normal' range [42].

There are two main categories of effects: obstructive and restrictive. An obstructive ventilatory defect is a disproportionate reduction of maximal airflow and implies airway narrowing during exhalation [39]. It is expressed by a reduced FEV_1/FVC ratio, below the lower limit of the normal range. The presence of a restrictive ventilatory defect may be suspected when VC is reduced, the FEV_1/VC is increased (85–90%) and the flow–volume curve shows a convex pattern. However, at the time of interpretation, all the curves were lost because of a computer crash. The pattern of a reduced VC and a normal or even slightly increased FEV_1/VC is often caused by sub maximal effort and a reduced VC alone does not prove a restrictive defect[39]. Total lung capacity (TLC) is necessary to confirm or exclude the presence of a restrictive defect when VC is below the LLN, but was not obtained. Therefore only obstructive defects could be identified.

4.5 Statistical Analysis

SPSS v12.0 was used for the main part of the statistical analysis. Data was explored and descriptive statistics were produced. Categorical variables were analyzed with the Pearson X_2 test, continuous variables were presented as means and with standard deviations (SD). Multivariate analysis was done to identify any variables that are associated with the occurrence of respiratory symptoms. These variables were then included in the logistic regression models. Groups were stratified for smoking and odds ratios were estimated for smokers and nonsmokers.

Dose- response relations were identified, using a semi-quantitative proxy for exposure. Exposed participants were classified as low or high exposed for years of exposure, frequency of exposure and cumulative exposure, calculated as years of exposure multiplied by frequency of exposure to the pesticides of interest. Adjusted odds ratios were calculated for respiratory symptoms, comparing controls with the low and high exposed groups.
SAS v 9.1 was used for the logistic regression modeling, controlling for age, smoking and other defined variables. For all statistical tests, a probability of 0,05 was taken as significant.

5. Results

5.1 Observations

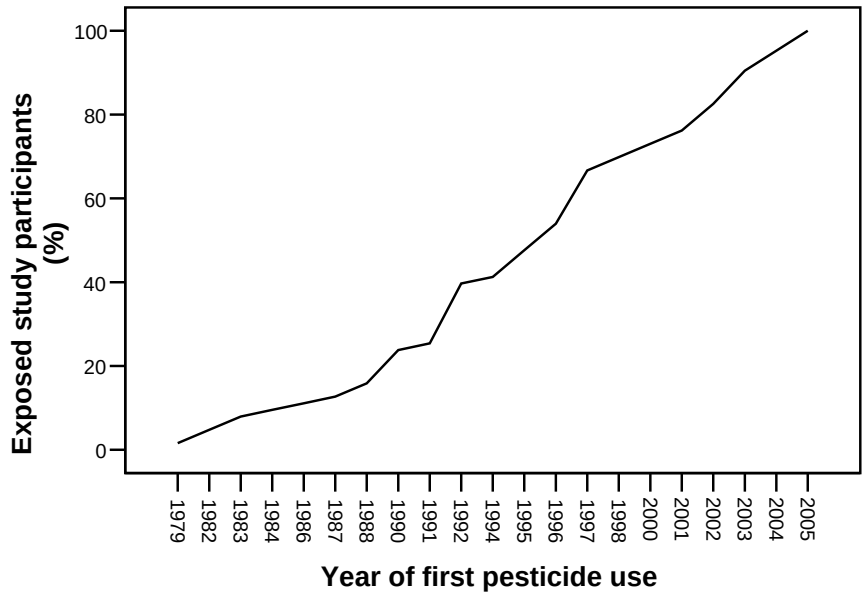
5.1.1. Description of a plantain plantation

The majority of the plantations are 1 hectare (36,8%), followed by 2 hectares (15,8%) and 3 hectares (13,7%) or more (29,7%). There are few very large plantations, with a size between 8 and 15 hectares (4%). The plantations are monocultural but usually divided in different plots of new plantain and old plantain. The plantain trees are planted in rows, with one meter distance in between. Cords are often used to give the plants extra stability. Most of the plantations have a little shed in the middle, where the people rest when it is too hot to work and prepare their lunch.

5.1.2. Cultivation process

Plantain cultivation can be divided in a few distinct phases, each requiring different activities and the use of different pesticides. A distinction can be made between new and old plantain. Six months after sowing, the first harvest is ready (new plantain). Plantain trees can be kept for a few years (old plantain), after which they fall down. Towards the end of their lifespan, production decreases and the farmer may decide to cut down the tree himself.
Trees are typically planted within one meter distance of each other. Several siblings tend to grow out of one seed, which makes it important to remove these siblings and replant them elsewhere. The trees need the right amount of shade and sun to allow for the best yield. Excessive foliage has to be removed on a regular basis. During growth the tree has to be kept free from weeds. This can be done with a machete, but typically backpack sprayers with paraquat or glyphosate are used. Paraquat kills the growing weed, while glyphosate affects the roots as well and kills systemically. Pesticide use in the reserve has increased in the last decade (*Graph 1*)

Graph 1: Observed pattern of first pesticide use among study participants



About a month to three weeks before harvest, the fruit is covered in chlorpyrifos impregnated bags. When the time has come to harvest, the racemes are cut from the tree and taken to the road, where the bags are removed. When sold for international markets, the plantains are also washed in a liquid to prevent them from maturing and to remove any stains. Next they are packed in cartons and loaded in a truck. For the national market, peeled plantain is sold as well. During the different phases of cultivation, different pesticides are used (Table 1).

Table 1: Pesticides used during plantain cultivation

Phase	**Activity**	**Frequency**	**Pesticide used***
Sowing	Plant new seed	Every three months	Terbufos
	Replant plantain	Every three months	Terbufos
Growth	Maintain trees free from weed	Every two months	Paraquat
	Maintain trees free from weed	Every six months	Glyphosate
	Cover fruits for protection	Every week	Chlorpyrifos
Harvest	Cut racemes and remove bags	Every 8 days	Chlorpyrifos

*Only the use of pesticides of interest for this study are included in the table.

5.1.3. Gender specific tasks

Of the exposed women, 25% (n=17) worked less than 16 hours per week. About 16% (n=11) of the women worked 30 hours a week, while 10% (n=7) worked 40 hours a week. There is no relation between the amount of worked hours per week and age (Pearson=0,05 p=0,66), as one might expect the younger women to work less because they take care of their children and the older women to work more. In the plantain cultivation process, gender specific tasks exist, with women typically doing the lighter chores (Table 2).

Table 2: Pesticide use by women in the exposed group (n=69)

Chlorpyrifos (only during harvest)	Terbufos and chlorpyrifos	Terbufos, chlorpyrifos and paraquat
19% (n=13)	51% (n=35)	30% (n=21)

When sowing, the men typically dig the holes in the ground, while the women wash the seeds and plant them, together with terbufos. The granulated terbufos weighs little and is therefore easy for women to handle. Because of the very strong smell of terbufos, it is important to work fast. A lot of women pointed out that the task of applying terbufos during sowing was more suitable for women, because they can work faster.

When spraying, the men usually apply with a backpack sprayer, while the women typically fetch the water from the river. Consequently most women stay in the plantation when it is being sprayed. The pesticide containers are kept at the plantations. There are no standard cups used to mix, people use whatever is available. The person who sprays, generally also mixes and cleans the equipment after each use. There are few women who spray on a regular basis. A reason for this is that the backpack sprayer is very heavy. Also, the type of backpack sprayer mostly used, has straps that are very tight around the chest. This makes it very difficult and uncomfortable for the women, who in general have a large BMI, to wear. However, there are several occasions in which women do spray. Sometimes a lot of work has to be done and to be able to finish in time, women spray as well. Sometimes no workers can be contracted to do this task or there is no money to contract workers. Single women are typically the ones who spray more, because they have no husband who can do it for them and have not enough money to pay someone else to do it. Also women who work as a paid labourer often have to spray.

When the fruits are growing, they are usually covered in chlorpyrifos impregnated bags. Most women have a lot of contact with the bags, through several activities. Some count all the

bags after buying, to check the amount. Some tie the bags in the right size at home or on the plantation. The men usually climb the ladder to put the bags around the racemes, while the women hold and pass the bags.

When harvesting, the men cut the racemes from the trees and transport them to the road, while the women take the impregnated bags off, wash the plantains and put them in boxes. In this way women have a lot of contact with the chlorpyrifos impregnated bags during harvesting. However, at this point the bags contain around 0,01 g/kg chlorpyrifos, as compared with 10 g/kg when they are new [43].

5.1.4. Personal protective equipment

Typical clothing worn when working on a plantation, for exposed and non-exposed women, are rubber boots and long pants or a long skirt with a sleeveless or short sleeved shirt (71%) or a long sleeve (17%). Some women wear rubber boots with shorts and sleeveless or short sleeved shirts (12%). No respiratory protection, masks or gloves are used when working with pesticides.

5.2 Descriptive data

This epidemiological study included 127 women, aged between 24 and 58 years with a mean age of 35. They were divided in two groups, an exposed (n=69) and a non-exposed group (n=58). The non-exposed group included all women who do not work with plantain, but who worked for example at school, in a store, at home or who worked with organic banana (n=22). The exposed group included all women who work with plantain, including women who only performed certain tasks such as packing (n=13).

The two groups were very similar in many aspects such as education, socioeconomic status and age (Table 3). Women in the exposed group were heavier than the non-exposed women (average 76 kg versus 70 kg) and had a higher BMI (31,5 versus 30,2). Wheezing was more prevalent in the exposed group (X^2 =3,4 p=0,07), while lung function was very similar. There were more smokers and ex smokers in the exposed group (X^2= 5,6 p=0,02). Most women grew up on a farm, some of them on a farm where pesticides were used, meaning they were exposed during childhood as well (n=17). There were a few non indigenous women from outside the reserve included in the study, most in the non-exposed group. Level of education was low and 13% of the total study population was illiterate. Pesticide use in and around the house was similar for the exposed and non-exposed group. All households used Racumin® (active ingredient: cumatetralyl 0,0375g) and Baygon® (active ingredient: cyfluthrin 0,15g), the available pesticides in the local stores. Because the town Suretka is situated close to the river, the incidence of rats there was higher and consequently use of Racumin® increased as well. Women who reported using terbufos in their house or kitchen to fight rats were all from Suretka.

Table 3: Descriptive data for exposed and non-exposed women

	Exposed (n=69)		**Non-exposed (n=58)**	
	Mean and range	Standard deviation	Mean and range	Standard deviation
Age (years)	35 (24-53)	8	35 (24-56)	9
Height (meter)	1,55 (1,46-1,69)	0,05	1,52 (1,37-1,63)	0,06
Weight (kg)	76 (46-111)	13	70 (51-100)	12
BMI	31,5(20,4-44,4)	4,9	30,2 (23-43,9)	5,0
FVC (l)	3,24 (2,06-4,34)	0,5	3,10 (1,77-4,36)	0,59
FEV_1 (l)	2,61 (1,27-3,36)	0,4	2,61 (1,34-3,48)	0,52
FEV_1/FVC	0,81 (0,44-0,94)	0,09	0,84 (0,58-0,95)	0,06
	Frequency		Frequency	
Level of education				
Less than primary	29% (n=20)		24% (n=14)	
Primary school	46% (n=32)		48% (n=28)	
More than primary	25% (n=17)		28% (n=16)	
Monthly salary[*]				
Less than €36	26% (n=18)		33% (n=19)	
€36 – €72	27% (n=19)		26% (n=15)	
€72 – €144	26% (n=18)		15% (n=9)	
> €144	9% (n=6)		10% (n=6)	
No response	12% (n=8)		16% (n=9)	
Respiratory symptoms				
Wheeze	20% (n=14)		9% (n=5)	
Breathlessness	36% (n=25)		26% (n=15)	
Chronic cough	10% (n=7)		10% (n=6)	
Asthma	10% (n=7)		10% (n=6)	
Atopy	29% (n=20)		31% (n=18)	
Other characteristics				
Non indigenous	6% (n=4)		15% (n=9)	
Smokers, ex smokers	7% (n=5), 17% (n=12)		2% (n=1), 7% (n=4)	

[*] Rate 100 colones: 0,14eurocent (wisselkoers.nl, visited 17/08/07)

5.3 Respiratory symptoms

Crude and adjusted odds ratios were calculated to compare the probability of the occurrence of the different respiratory symptoms for the exposed and non-exposed groups, stratified for smoking (Table 4). Different exposure variables were identified, first general exposure (exposed yes or no), then more specific exposure (the actual application of a specific pesticide). The crude odds ratio are presented for the respiratory symptoms of interest, then the adjusted odds ratio for smokers and nonsmokers.

Statistically significant elevated odds ratios were observed for the occurrence of wheeze and exposure to organophosphate insecticides. Borderline significance was observed for breathlessness and contact with the chlorpyrifos impregnated bags and terbufos. Statistically significant elevated odds ratios were observed for wheeze and chlorpyrifos among smokers, with borderline significance for breathlessness. A statistically significant very high odds ratio was observed for occurrence of atopy (defined as having reported either rhinitis, or eczema or both) among smoking paraquat applicators.

Table 4: Crude and adjusted odds ratios for the defined respiratory symptoms, stratified by smoking, where NS represents the non-smokers (n=105) and S represents the current and ex smokers (n=22). Statistically significant odds ratios are presented in bold.

* For nonsmokers , all odds ratios were corrected for age, living in a humid house, asthma and atopy.
For smokers, odds ratios were corrected for age and atopy.

	OR (95% CI)				
Exposed	wheeze	breathlessness	chronic cough	asthma	atopy
Crude	**2.7 (0.9-8.0)**	1.6 (0.8-3.5)	1.0 (0.3-3.1)	1.0 (0.3-3.1)	0.9 (0.4-1.9)
Adjusted* Nonsmokers (NS)	**8.2 (1.4-47.2)**	1.8 (0.7-4.6)	0.9 (0.2-3.7)	0.6 (0.2-2.4)	0.7 (0.3-1.7)
Adjusted* Smokers (S)	0.5 (0.1-4.0)	0.9 (0.1-7.7)	0.6 (0.0-9.5)	No valid model	1.3 (0.2-10.5)
Terbufos	wheeze	breathlessness	chronic cough	asthma	atopy
Crude	**2.3 (0.9-6.3)**	1.6 (0.7-3.3)	0.9 (0.3-3.0)	0.6 (0.2-2.2)	0.8 (0.4-1.8)
Adjusted* (NS)	**7.0 (1.5-33.2)**	**2.3 (0.9-6.0)**	0.6 (0.1-2.6)	0.7 (0.2-2.8)	0.6 (0.2-1.6)
Adjusted* (S)	0.1 (0.0-1.6)	0.4 (0.1-3.4)	2.0 (0.1-32.6)	0.3 (0.0-3.9)	1.0 (0.2-6.1)
Chlorpyrifos - new bags	wheeze	breathlessness	chronic cough	asthma	atopy
Crude	**2.7 (1.0-7.3)**	**2.2 (1.0-5.0)**	1.7 (0.5-5.5)	0.4 (0.1-2.0)	1.0 (0.5-2.4)
Adjusted* (NS)	**7.5 (1.7-34.0)**	**2.8 (1.0-7.7)**	1.3 (0.3-5.7)	0.8 (0.2-3.8)	0.8 (0.3-2.3)
Adjusted* (S)	**6.8 (1.7-27.5)**	**2.5 (0.9-6.7)**	1.4 (0.3-6.0)	No valid model	1.0 (0.2-5.6)
Chlorpyrifos – old bags	wheeze	breathlessness	chronic cough	asthma	atopy
Crude	**2.4 (0.9-6.6)**	1.6 (0.7-3.3)	1.5 (0.5-4.7)	1.5 (0.5-4.7)	1.0 (0.5-2.1)
Adjusted* (NS)	**8.2 (1.6-41.2)**	1.6 (0.6-4.0)	1.5 (0.4-6.0)	1.0 (0.3-3.9)	0.8 (0.3-1.9)
Adjusted* (S)	0.2 (0.0-2.4)	0.8 (0.1-6.7)	0.9 (0.1-13.4)	No valid model	1.2 (0.2-7.1)
Paraquat	wheeze	breathlessness	chronic cough	asthma	atopy
Crude	**2.6 (0.9-8.0)**	2.1 (0.8-5.3)	No valid model	0.9 (0.2-4.2)	**2.9 (1.1-7.4)**
Adjusted* (NS)	1.4 (0.3-7.7)	1.1 (0.3-4.5)	No valid model	0.7 (0.1-5.9)	1.6 (0.5-5.4)
Adjusted* (S)	1.9 (0.4-9.2)	7.2 (0.4-127)	No valid model	0.9 (0.1-15.5)	**14.9 (1.2-181)**

To identify dose-response relationships, exposed participants were divided in a low and high exposed group for each pesticide (Table 5). A semi-quantitative exposure proxy was used, multiplying frequency of exposure by years of exposure. A dose-response relation is observed for contact with organophosphates terbufos and chlorpyrifos and wheeze among non-smoking women. Women who are higher exposed to paraquat show higher odds ratios for atopy, compared to the lower exposed women.

Table 5: Adjusted odds ratios for the defined respiratory symptoms among high and low exposed non-smokers. Statistically significant odds ratios are presented in bold.

	OR (95% CI)				
TERBUFOS	wheeze	breathlessness	chronic cough	asthma	atopy
Exp-low (<22 x)	5.7 (0.7– 46.9)	1.4 (0.4 – 4.8)	0.4 (0.0 – 3.5)	1.2 (0.2 – 7.4)	0.2 (0.1 – 1.2)
Exp-high (>22 x)	**7.5 (1.3 – 42.3)**	2.7 (0.9 – 8.8)	0.7 (0.1- 4.4)	0.5 (0.1 – 4.7)	1.0 (0.3 – 3.2)
CHLORPYRIFOS – new	wheeze	breathlessness	chronic cough	asthma	atopy
Exp – low (<182x)	**7.2 (1.2 – 42.4)**	**4.6 (1.3-17.0)**	OR>0.8	0.8 (0.1-6.9)	1.1 (0.3-4.0)
Exp – high (>182x)	**10.5 (1.2-90.4)**	1.4 (0.3-6.1)	3.8 (0.7-19.5)	1.0 (0.1-8.9)	0.5 (0.1-2.5)
CHLORPYRIFOS – old	wheeze	breathlessness	chronic cough	asthma	atopy
Exp-low (<156x)	4.1 (0.6-27.8)	1.4 (0.4-4.4)	1.3 (0.2-7.3)	0.5 (0.1-4.3)	1.0 (0.3-2.8)
Exp-high (>156x)	**22.3 (2.5-197)**	2.1 (0.7-6.8)	1.7 (0.3-9.7)	1.9 (0.4-8.5)	0.7 (0.2-2.3)
PARAQUAT	wheeze	breathlessness	chronic cough	asthma	atopy
Exp-low (<12x)	0.7 (0.0-9.3)	0.4 (0.0-4.2)	OR>1.2	3.8 (0.3-44.6)	0.9 (1.5-5.3)
Exp-high (>12x)	0.8 (0.1-12.9)	2.3 (0.4-13.6)	OR>1.4	OR>1.5	3.1 (0.6-17.2)

5.4 Spirometry variables

The measured spirometric values were compared with the reference values according to the reference equation and presented as a percentage of the reference value (Table 6).

Table 6: Comparison of average measured and reference values for exposed and non-exposed women

	Exposed	Non-exposed
Mean FVC, % reference value	97%	96%
Mean $FEV_{1,}$ % reference value	93%	96%
Mean FEV_1/FVC, % reference value	96%	99%

A reference equation was also used to calculate the lowest value that can still be considered normal for FVC, FEV_1 and FEV_1/FVC ratio. All variables that were below the lowest level of normal, that is below the 5^{th} percentile of the frequency distribution of the values measured in the reference population, could be divided in 4 different categories (Table 7). No relationship between exposure and abnormal spirometric results was found.

Table 7: Classification of study participants with measured values lower than the lowest level of normal

FVC	FEV_1	FEV_1/FVC	Classification	Number of study participants
Normal	Reduced	Reduced	Obstruction	n=3
Reduced	Reduced	Reduced	Poor effort	n=2
Reduced	Reduced	Normal	Poor effort	n=7
Normal	Normal	Reduced	Unclear	n=5

Regression analysis was performed to see which variables could be related to the spirometric values found (Table 8). Regression coefficients found for age were similar to the reference equation used. No significant relationship between exposure and FVC or FEV_1 was observed. No relationship between duration and frequency of exposure and FVC or FEV_1 was found (results not shown). No significant effect of current smoking on FEV_1 was observed (p=0.56). Analysis with more quantitative smoking variables such as pack years was not performed.

Table 8: Regression coefficients for pesticide exposure and other predictors of FVC and FEV_1

	FVC	FVC	FEV_1	FEV_1
	Regression coefficient	p-value	Regression coefficient	p-value
Height	4.30308	<.0001	2.99483	<.0001
Age	-0.02499	<.0001	-0.02262	<.0001
Smoking	-0.05189	0.6025	-0.07269	0.4341
Exposure	0.03004	0.6992	-0.04239	0.5586

6. Discussion

6.1 Respiratory effects

The prevalence rates of respiratory symptoms in the exposed group were compared to other studies (Table 9). In our study, prevalence of breathlessness was very high, but only one question in the questionnaire was used to estimate prevalence of breathlessness. The prevalence rate of wheeze was very similar compared to other studies.

Table 9: Comparison of prevalence rates of respiratory symptoms in exposed workers

Respiratory symptom	Our study (n=69)	Faria et al (n=1379) [27]	Castro-Gutiérrez et al (n=134) [18]	AHS (n=2375) [10]	Chatzi et al (n=78) [34]
Wheeze	19%	18%	20%	21%	
Breathlessness	35%				
Chronic Cough	10%	6%	18%		
Asthma	10%	12%		5%	9%
Atopy	30%			11%	41%

All identified exposure variables led to a statistically significant increased odds ratio for wheeze for the non-smokers, but not for the smokers. Exposure to pesticides led to a statistically significant eightfold higher odds ratio for the non-smokers. Other exposure variables that were identified, are the actual application of different pesticides. These results are harder to interpret, because most women applied more than one pesticide (Table 2). However, most women are mainly exposed to organophosphates. Adjusted odds ratios were seven to eightfold higher for the use of organophosphates chlorpyrifos and terbufos. In the AHS the use of chlorpyrifos and terbufos has also been associated with an increase in wheeze [10, 22]. Even contact with the chlorpyrifos impregnated bags during harvest, led to a statistically significant increased odds ratio. However, there were only n=13 women in this group who had contact with the bags during harvest only, the others also have contact with the bags at other points in time, when they are new. The constructed exposure proxy revealed higher odds ratios for wheeze among the high exposed group, compared to the low exposed group for both chlorpyrifos and terbufos. The largest difference in odds ratio is observed for the group that has contact with the old impregnated bags during harvest only. Women in the low exposed group for this exposure variable, are lower exposed in general, whereas the high exposed group are exposed to other pesticides as well, resulting in the observed large difference. For the use of paraquat the crude odds ratio for wheeze was also increased, with borderline significance, but the adjusted odds ratio was not significantly elevated. This is probably due to the small number of paraquat applying women. Among Nicaraguan banana workers and Costa Rican plantation workers an increase in wheezing was observed among paraquat exposed workers [15, 18]. No difference was observed between odds ratios for the high and low exposed groups.

The odds ratio for breathlessness and contact with chlorpyrifos impregnated bags was statistically significantly elevated for non-smokers, with borderline significance for smokers. For non-smokers who apply terbufos the odds were elevated as well, with borderline significance. It seems that contact with organophosphates, and chlorpyrifos in particular, can be associated with a higher odds for breathlessness. However, only one question was used to assess this symptom.

No association between exposure and chronic cough was found. Odds ratios for chronic cough were not increased for the smokers as compared to the non-smokers, even though chronic cough is a well-known consequence of smoking. Higher odds were observed for smokers who applied terbufos, but not significant. Because of the small number of participants with chronic

cough, a lot of times logistic regression models could not be constructed. No dose-response relation could be identified.

Exposure to organophosphates has previously been associated with asthma [44]. However, in this study no association was found. Good internal consistency was observed within the study population between the reporting of asthma and the reporting of wheeze. Reported asthma rates were similar to other smaller studies, but higher when compared to the AHS [10, 27, 34].

Exposure to chlorpyrifos has previously been associated with an increase in atopic conditions [22, 35]. In this study no association was observed. Women who are higher exposed to chlorpyrifos have similar or lower odds ratios for atopy, compared to women who are lower exposed to chlorpyrifos, for all identified exposure variables (data not shown). The use of paraquat however does lead to a statistically significant increase in atopy among smokers, but not among non-smokers. Most women who applied paraquat also smoked and applied chlorpyrifos frequently and were higher exposed to pesticides in general. However, in a recent study among Greek grape farmers, the use of paraquat was related with a significant increase in atopy [34]. Our study results indicate the same, but should be interpreted with caution because of the small number of paraquat spraying women. A dose-response relation was observed for years of exposure and occurrence of atopy (data not shown). The constructed exposure proxy for contact with paraquat also led to a higher odds ratio for the higher exposed.

6.2 Spirometry

Since there was no reference equation available for the study population, we used the Mexican American equation from the NHANES III study [41]. The average measured values were a little lower but very close to the predicted values and we concluded the equation was accurate. However, there were very few abnormal spirometric values found and there was no relationship between pesticide exposure and spirometric abnormalities. If exposure to pesticides produced respiratory symptoms, either mediated by obstructive or restrictive disease, one would expect to see corresponding spirometric abnormalities. But the observed frequency of abnormal spirometric values were similar compared to other Costa Rican plantation workers [15]. Regression analysis showed no influence of exposure on the identified spirometric variables. Also no effect of smoking on FEV_1 was found.

Other studies did observe a relation between pesticide exposure and spirometric variables. Among Sri Lankan farmers (n= 47) a significantly lower FVC among farmers exposed to organophosphates was found [32]. Among pesticide factory workers in Lebanon (n=19), a lower FVC was found as well as a lower FEV_1/FVC ratio [30]. Duration of occupation in the pesticide factory was significantly correlated with abnormal respiratory measures [30]. And in Ethiopia among state farm workers (n=102) a significantly reduced FVC and FEV_1 was found in workers 15-24 years of age [33]. In our study this age group was not included.

Working and environmental conditions on the plantain plantations were probably the most similar to the working conditions in the Nicaraguan study with banana plantation workers. Among Nicaraguan banana workers (n=134) no relation between paraquat exposure and lower spirometric variables could be identified [18]. The sample size of our study could be too small to identify a relation between exposure and spirometric variables, but in that case a non-significant trend would be expected, which is not observed. The other studies did not specify to which pesticides the study participants were exposed, so it could be that study participants in the other studies were exposed to different organophosphates than in our study. Also it is possible that other lung function variables such as the FEF_{25-75} would be affected, as seen in other studies [28, 30]. These values were not measured in our study. Recently it has been suggested that paraquat

exposure affects carbon monoxide diffusion capacity resulting in arterial oxygen desaturation [15, 17]. Women in our study were also exposed to paraquat, but such tests were not performed.

6.3 Strengths and weaknesses of the study

6.3.1 Study population and study design

The main limitation concerning study population is the small sample size. The majority of the inhabitants of the villages Shiroles and Suretka was included in the study, but it is likely that a few heavily exposed subjects were not included in the study population. Women who work a lot, are always working and therefore never home during the day but only after dark. Also women who live away from the village center inside a plantation were not included. Both groups could not be included because it was unsafe to be outside after dark or to walk in the plantations alone, even during the day.

A cross sectional study design is useful when the health effects of interest started occurring from the first moment of exposure and the population has been exposed long enough to expect health effects. Pesticide use in the reserve increased in the last 11 years (see Graph 1) and about 20% of the exposed group have just started using pesticides in the last five years. As a result, relationships might have been missed when these exposures have not yet led to effects. However, it is questionable which study design would be able to pick this up. A prospective study could be started in the region, but might be difficult due to logistic and organizational reasons.

6.3.2 Use of questionnaires

Interviews were held, based on a predesigned questionnaire. Existing knowledge of the region was more limited than expected and in the reserve different words and expressions were used than in the central valley. Therefore both the exposure and respiratory questionnaire were extensively pre-tested in the region, before data collection started, to ensure comprehensiveness and completeness of the questionnaires. Most women needed some time to familiarize themselves with the situation, therefore the introduction was rather long and the formal part of the interview was not started until later.

During the interviews it was noticed and often remarked that time is used in a different way in the indigenous culture than in western culture. Often the women found it hard to estimate and their estimations concerning time or quantity were very broad. For example, they would say they used pesticides since 10 or 20 years, or they packed 20 or 100 boxes each time. Because the questionnaires were used as guidance and the major part of the interviews was conversational, this problem could be overcome to refer to other plantations of similar size to estimate quantity or refer to major life events to estimate the start of pesticide use.

People would sometimes start with very careful estimations of exposure and adjust their answers later. This changing of answers shows that a persons' memory is not the most accurate way of obtaining information on exposure. The sole use of questionnaires to estimate exposure has already been questioned and appeared to be an inaccurate way to measure exposure [45]. However, in this study it was not possible to estimate exposure in another way.

Re-entry was thought to be a very important source of exposure. It was observed that exposure through re-entry was high but it was not possible to quantify this further. Because of the similarities in work practice, we assumed that exposure through re-entry was the same for the exposed group and non-existent for the non-exposed group.

The respiratory questionnaire was based on the validated European Community Respiratory Health Survey (ECRHS II) questionnaire and similar criteria for definition of respiratory effects were used [36]. The respiratory symptoms reported showed great internal consistency and obtained results were similar to other studies. The definition for eczema as used

in the ECRHS II probably was not suitable for this study population. Because of the heat and humidity there is a lot of prickly heat, which could be easily confused with eczema. The question about breathlessness should have been asked to estimate the occurrence of wheeze with shortness of breath and not as a separate respiratory symptom, to maintain similarity with the ECRHS and to be able to compare with other studies.

6.4 Conclusion

After stratification of data, the odds ratios for all respiratory symptoms were lower for smokers than for non-smokers. Pesticide exposure was statistically significantly associated with a higher odds ratio for wheeze, especially for exposure to organophosphates chlorpyrifos and terbufos. All the women in the exposed group worked with several pesticides, but were mainly exposed to the organophosphates chlorpyrifos and terbufos. There was little difference within the exposed group concerning the use of personal protective equipment, work practice or equipment used for application. Exposure intensity within the exposed group varied, with some women working or applying more than others. Higher odds ratios were observed for higher exposed women, for application of terbufos and chlorpyrifos and the occurrence of wheeze. Similar results have been observed in other studies.

The use of paraquat could be associated with a statistically significantly elevated odds ratio for atopy in smokers. The majority of paraquat applicators smoked. Due to small number of paraquat applying women, no dose-response relation could be observed. There were no differences in spirometric values between the exposed and non-exposed group.

6.5 Recommendations for future study

The indigenous in Costa Rica are often overlooked, which makes it important to include them in epidemiological studies. Gender specific research in women is very much needed in agricultural developing countries, since many agricultural workers are female. This study should therefore be repeated with a larger study population. However, during fieldwork it was noticed that men were also exposed, maybe more than women. During the interviews it was often mentioned that the men worked more at their own plantation and applied more paraquat than women. Also more men worked as a paid labourer than women. A lot of the women reported that their husbands did suffer from several health effects, while they themselves did not. Therefore it is also recommended to repeat the study in men.

Future studies should estimate exposure in several ways, not only through the interviews in a qualitative way but also in a (semi) quantitative way.

6.6 Recommendations for the study participants

Pesticides are hazardous for the human health and exposure should be reduced whenever possible. The most obvious recommendations to lower exposure are to use personal protective equipment when applying and to lower exposure through re-entry activities.

However, this is easier said than done. There are two main reasons for the fact that almost no personal protective equipment is used: climate and poverty. Because of the heat and humidity, it is very uncomfortable to wear face masks or other respiratory protection. Some people wear shawls to cover their mouth and nose, but this makes it harder to breathe and they complain it slows them down. Some say when they work slower, they get other complaints such as headaches or nausea, because of the increased exposure time. Therefore they prefer to work faster and consequently without any protection. Poverty is another main cause for the absence of personal protection. There is little protective equipment available in the region. Most people have little money to spend and are therefore not able to invest in their own health. Because of a lack of information on the consequences of pesticide exposure, people may not realize the importance of

it. But pesticide sprayers need to be sensitized to the hazardous consequences for their health and should be encouraged to wear personal protective equipment during their work.

The re-entry activities are a very important source of exposure. Some women remarked that they would like to stay home after the plantation was sprayed or other pesticides were applied, but they simply could not afford not to work for a few days. Most people work 6 days a week and only have a day off when they are too sick to work. Some women stayed home for a day or two after their plantation was sprayed, but their men continued to work every day. The infrastructure of the plantations is such that often you have to cross other plantations in order to reach a certain plantation. When other people are spraying there is no other option but to pass it. Therefore the problem of re-entry is very difficult to overcome.

We recommended the study participants to use a separate set of clothing for their work at the plantation, which they would only use to work in. Work clothes should always be washed separately. Also, people should try to use some protection to cover their nose and mouth when spraying paraquat or working with terbufos. Alternatives for pesticide use are available and workshops have recently been organized in the area by the Universidad Nacional to increase awareness, improve application methods and to reduce pesticide use.

Acknowledgements

Thanks to Gerardina and Kathia for introducing me in Shiroles, thanks to Jan-Paul Zock for the respiratory questionnaire, thanks to Ana Maria Mora for helping with the translation of the questionnaire and the search for essential spirometer parts, thanks to Dick Heederik for his advice on spirometry related issues, thanks to Hans and Berna for their advice and discussion.

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ANNEX I

Cuestionario del proyecto "Contacto con plaguicidas y la salud respiratoria de las mujeres de la reserva indígena BriBri"

Contacto con plaguicidas

Fecha _____ **Hora inicio _____**
Hora final _____

Nombre _____

Apellidos _____

Número de cédula_____

Fecha de nacimiento _____

	NO	SÍ
¿Usted sabe leer y escribir?	☐	☐

¿Cuál es su nivel de escolaridad?

Año de primaria	☐
Año de secundaria	☐
Colegio	☐
> Colegio	☐

Ahora me gustaría hacerle unas preguntas sobre el contacto que tenga usted con plaguicidas. Tome el tiempo que considere necesario para pensar bien sus respuestas. La información que usted aporte es confidencial y solo se utilizará para nuestro estudio.

PASADO GENERAL

	NO	SÍ
1. ¿Cuándo era niña (menos de 15 años) ayudaba en la finca de sus padres? **Si la repuesta es "no", pase a la pregunta 6**	☐	☐

	PERIODO Y AÑOS
2. ¿A qué edad empezó a ayudar en la finca?	☐

	NO	SÍ
3. ¿Cuándo era niña usaron plaguicidas o venenos en la finca?	☐	☐

4. ¿Quién les aplicó?

Papá, mamá, hermanos	☐
Yo	☐
Peón	☐

5. ¿Cuáles plaguicidas o venenos aplicaron?

Bolsas (para proteger la fruta) ☐
Granulados / Counter ☐
Liquido con bomba contra mala hierbas ☐
Otro ☐
No me acuerdo ☐

LA FINCA

NO SÍ

6. ¿Tiene una finca o un terreno? ☐ ☐

Si la repuesta es "no", pase a la pregunta 11

7. ¿Quién es el dueño de esta finca?

Yo ☐
Mi esposo / compañero ☐
Ambos tenemos una finca ☐
Otra persona (indica quién) ☐

8. ¿Cuál(es) producto(s) se cultiva(n) en la(s) finca(s)? MARCAR SOLA UNA CASILLA

Plátano ☐
Banano ☐
Café ☐
Otra ☐

HECTÁREAS

9. ¿Cuántas hectáreas? ☐

10. ¿El cultivo se usa para? MARCAR SOLA UNA CASILLA

Uso propio ☐
Vender al mercado nacional ☐
Vender para la exportación ☐
Otra ☐

TRABAJO EN LA FINCA

NO SÍ

11. ¿Usted trabaja en una(s) finca(s)? ☐ ☐

Si la repuesta es "no", pase a la pregunta 12

NO SÍ

12. ¿Usted ha trabajado en una finca? ☐ ☐

PERIODO Y AÑOS

13. ¿Durante cuánto tiempo ha trabajado en una finca? ☐

NO SÍ

14. ¿Ayuda actualmente en otras fincas? ☐ ☐
Si la repuesta es "no", pase a la pregunta 48

PERIODO y AÑOS

15. ¿Desde cuando ayuda en esta(s) finca(s)? ☐

NO SÍ

16. ¿Usa(ba)n químicos o venenos en las fincas donde usted trabaja? ☐ ☐
Si la repuesta es "no", pase a la pregunta 18

PERIODO y AÑOS

17. ¿Desde cuando usa(ba)n químicos? ☐

Durante los últimos 12 meses (o el último año que trabajó en la finca)

DÍAS

18. ¿Cuántos días por semana ha trabajado en la finca? ☐
¿O cuántos días por mes? ☐

HORAS

19. ¿Cuántas horas por día ha trabajado en la finca? ☐

HORAS

En total: Cuántas horas por semana ha trabajado en la finca ☐

RE-ENTRY

Durante los últimos 12 meses (o el último año que trabajó en la finca)

20. ¿Cuántos días por semana/mes ha estado en la finca mientras aplicaron venenos, granulados o bolsas impregnadas con veneno en esta misma finca?

VECES

¿Días por semana? ☐
¿Días por mes? ☐

21. ¿Cuántos días por semana o mes ha estado en la finca mientras los vecinos aplicaron venenos, granulados o bolsas impregnadas con veneno?

VECES

¿Días por semana? ☐
¿Días por mes? ☐

22. ¿Cuántos días por semana o mes ha pasado por una finca donde aplicaron venenos, granulados o bolsas impregnadas con veneno?

VECES

¿Por semana? ☐
¿Por mes? ☐
¿Por año? ☐

23. ¿Generalmente, cuánto tiempo después de que apliquen venenos usted reingresa a la finca?

MARCAR SOLO UNA CASILLA

No salgo de la finca	
Horas después	
Día siguiente	
Dos días después	
Una semana después	
Quince días después	
Otro	

24. ¿Eso siempre ha sido igual?

	NO	SÍ	MAS contacto que antes	MENOS contacto que antes
¿El año pasado?				
¿Los cinco años pasados?				
¿Los diez años pasados?				

APLICACIÓN DE PLAGUICIDAS

NO SÍ

25. ¿Actualmente, usted misma aplica químicos / venenos, o bolsas o granulados? | | |

Si la repuesta es "no", pase a la pregunta 27

PERIODO

26. ¿Desde hace cuánto? |

NO SÍ

27. ¿Antes, usted misma aplicó químicos / venenos o bolsas o granulados? | | |

Si la repuesta es "no", pase a la pregunta 73

PERIODO Y AÑOS

28. ¿Por cuánto tiempo? |

GRANULADOS

NO SÍ

29. ¿Usted aplica(ba) Counter durante la siembra o a la mata ya crecida? | |

PERIODO Y AÑOS

30. ¿Desde hace cuánto usa(ba) estos granulados (el Counter) ? |

PERIODO Y AÑOS

31. ¿Cuáles granulados usa(ba)?

Counter 10G	
Counter 15G	
Counter no se cual	

MARCAR SOLO UNA CASILLA

32. ¿Cómo lo aplica(ba) (el Counter)?

Mano	
Galón con huecos	
Aplicador	
Otro	

33. ¿Con qué frecuencia lo usa(ba) Counter?

Cada semana	
Cada dos semanas	
Cada tres semanas	
Cada mes	
Cada 3 meses	
Cada 4 meses	
Cada 6 meses	
Otra	

34. ¿Cuántas **horas** necesita(ba) para aplicar Counter en su finca?

¿Cuántos **días**?

35. ¿Cuánto Counter usa(ba) cada vez que lo aplica en su finca?

36. ¿Qué ropa usa(ba) cuando usted aplica Counter? (Marcar con X)

1. Pantalón corto	4. Camisa manga larga	7. Descalzo	10. Anteojos
2. Pantalón largo	5. Botas de hule	8. Pañuelo	11. Guantes
3. Camisa manga corta o tirantes	6. Otro zapato	9. Gorra / sombrero	12. Otro

37. ¿Alguna vez ha notado algún problema después del trabajo con Counter?

	NO	SÍ
Se mareó		
Dolor en la cabeza		
Brote de piel		
Otro		

EMPACAR

38. ¿Usted empaca(ba)? NO ☐ SÍ ☐

39. ¿Desde hace cuánto empaca(ba)? PERIODO ☐ AÑOS ☐

40. ¿Con qué frecuencia empaca(ba)?

	NO	SÍ
Cada semana	☐	☐
Cada dos semanas	☐	☐
Cada tres semanas	☐	☐
Cada mes	☐	☐
Otra	☐	☐

41. ¿Más o menos cuántos racimos empaca(ba) usted cada vez? NÚMERO ☐

42. ¿Toca(ba) las bolsas con la mano? NO ☐ SÍ ☐

43. ¿Cuántas **horas** necesita(ba) para empacar cada vez? HORAS ☐
¿Cuántos **días**? ☐

44. ¿Qué ropa usa cuando usted empaca(ba)? (Marcar con X)

1. Pantalón corto	4. Camisa manga larga	7. Descalzo	10. Anteojos
2. Pantalón largo	5. Botas de hule	8. Pañuelo	11. Guantes
3. Camisa manga corta o tirantes	6. Otro zapato	9. Gorra / sombrero	12. Otro

45. ¿Lava(ba) los plátanos con champú usando sus manos directamente? NO ☐ SÍ ☐

46. ¿Piensa que este champú contiene plaguicidas? NO ☐ SÍ ☐

47. ¿Alguna vez ha notado algún problema después el empaque?

	NO	SÍ
Se mareó	☐	☐
Dolor en la cabeza	☐	☐
Brote de piel	☐	☐
Otro	☐	☐

48. ¿Qué hace/hacía con las bolsas después de haberlas quitado del plátano?

MARCAR SOLA UNA CASILLA

Las entierran ☐
Las queman ☐
Las dejan en la finca ☐
Las recogen y las ponen en una bolsa por la carretera ☐
Otro uso ☐

BOLSAR

NO SÍ

49. ¿Usted tiene/ ha tenido contacto con las bolsas? ☐ ☐

PERIODO AÑOS

50. ¿Desde hace cuanto pone/ponía las bolsas, o las pase/pasó? ☐ ☐

51. ¿Con que frecuencia las pone/ponía o las pase/pasó? MARCAR SOLO UNA CASILLA

Cada semana ☐
Cada dos semanas ☐
Cada tres semanas ☐
Cada mes ☐
Otra ☐

HORAS

52. ¿Cuántas **horas** necesita(ba) para poner las bolsas en su finca? ☐
¿Cuántos **días**? ☐

NÚMERO

53. ¿Mas o menos cuántas bolsas usa(ba) cada vez que las pone/ponía en su finca? ☐

54. ¿Qué ropa usa(ba) cuando usted pone/ponía las bolsas? (Marcar con X)

1. Pantalón corto	4. Camisa manga larga	7. Descalzo	10. Anteojos
2. Pantalón largo	5. Botas de hule	8. Pañuelo	11. Guantes
3. Camisa manga corta o tirantes	6. Otro zapato	9. Gorra / sombrero	12. Otro

NO SÍ

55. ¿Alguna vez ha notado algún problema después este trabajo?

Se mareó ☐ ☐
Dolor en la cabeza ☐ ☐
Brote de piel ☐ ☐
Otro ☐ ☐

FUMIGAR

NO SÍ

56. ¿Usted fumiga(ba)? ☐ ☐

PERIODO Y AÑOS

57. ¿Desde cuando fumiga(ba)? ☐

58. ¿Qué químico usa(ba) para fumigar?

	MARCAR	FRECUENCIA
Clorpirifos (Bioquim chlorban 48 EC)		
Glifosatos (Rodeo Glifosato 35.6 SL, Rimaxato 35.6 SL, Bioquim Biokil 35.6 SL)		
Paraquat (Bioquat 20 SL, Gramoxone)		
2,4 D (Bioquim 2.4-D 60 SL, Bioquim herbikil 48 SL)		
Biometafos 60 (Methamidophos 60%)		
Diazinon (Bioquim Biokim Dianzinon 60 EC)		
Malation (Bioquim Biokim malation)		
Mancozeb (Bioquim Bioman Aceite 43.5 SC)		
Urea diuron (Bioquim Bioron 48 SC)		
Triazol Propiconazole (Bioquim Propicon 25 EC)		
No me acuerdo cuál		

59. ¿Con que frecuencia tiene/tenía que fumigar? (Indicar también en la pregunta 58)

MARCAR SOLO UNA CASILLA

Cada semana ☐
Cada dos semanas ☐
Cada tres semanas ☐
Cada mes ☐
Otra ☐

HORAS

60. ¿Cuántas **horas** necesita(ba) para fumigar su finca? ☐
¿Cuántos **días**? ☐

CANTIDAD

61. ¿Más o menos cuánto veneno usa(ba) cada vez que fumiga(ba) su finca? ☐

62. ¿Qué ropa usa cuando usted fumiga? (Marcar con X)

1. Pantalón corto	4. Camisa manga larga	7. Descalzo	10. Anteojos
2. Pantalón largo	5. Botas de hule	8. Pañuelo	11. Guantes
3. Camisa manga corta o tirantes	6. Otro zapato	9. Gorra / sombrero	12. Otro

NO SÍ

63. ¿Alguna vez ha notado algún problema después el trabajo?

	NO	SÍ
Se mareó	☐	☐
Dolor en la cabeza	☐	☐
Brote de piel	☐	☐
Otro	☐	☐

64. ¿Quién prepara(ba) los químicos para aplicar? MARCAR SOLA UNA CASILLA

Yo mismo	☐
Otra persona	☐

65. ¿Quién limpia(ba) o lava(ba) la bomba? MARCAR SOLA UNA CASILLA

Yo mismo	☐
Otra persona	☐

66. ¿Cada cuánto limpia(ba) o lava(ba) la bomba? MARCAR SOLA UNA CASILLA

Cada vez que lo utilizo	☐
Cada dos días	☐
Cada semana	☐
Cada 15 días	☐
Cada mes	☐
Nunca	☐

67. ¿Cuando la bomba se daña(ba), qué hace? MARCAR SOLA UNA CASILLA

Lo repara(ba) con la mano	☐
Lo repara(ba) con un herramienta	☐
Lo seguimos utilizando dañado	☐
Lo desechamos y se reemplaza(ba)	☐
Otro	☐

DESPUÉS DEL TRABAJO EN LA FINCA

68. ¿Cuánto tiempo después del trabajo con químicos se baña(ba) o lava(ba) las manos?

MARCAR SOLA UNA CASILLA

Inmediatamente después, en el trabajo	☐
Horas después, cuando llego a la casa	☐
Día siguiente	☐

69. ¿Cuánto tiempo después el trabajo con químicos se cambia(ba) la ropa?

MARCAR SOLA UNA CASILLA

Inmediatamente después, en la finca	☐
Horas después, cuando llego a la casa	☐
Día siguiente	☐

70. ¿Cómo se lava(ba) la ropa que usó para aplicar?

MARCAR SOLA UNA CASILLA

Separado	☐
Juntos con otra ropa	☐
Otra	☐

71. ¿Dónde se lava(ba) la ropa que usó para aplicar?

MARCAR SOLA UNA CASILLA

Casa ☐
Río ☐

72. ¿Estas labores las ha hecho siempre igual?

	NO	SÍ	MAS contacto que antes	MENOS contacto que antes
¿El año pasado?				
¿Los cinco años pasados?				
¿Los diez años pasados?				

OTRAS FORMAS DE CONTACTO CON PLAGUICIDAS

NO ☐ SÍ ☐

73. ¿Aparte del trabajo en su finca trabaja/ha trabajado en otro lugar?

Si la repuesta es "no", el cuestionario ha terminado

NO ☐ SÍ ☐

74. ¿En este lugar, tiene contacto con venenos?

Lugar	¿Cuál químico?	Con que frecuencia (días por semana)	Cual es la duración (horas por día)	Desde cuando (años)
	Clorpirifos / Terbufos/ Paraquat / Glifosato/ Otro			
	Clorpirifos / Terbufos/ Paraquat / Glifosato/ Otro			
	Clorpirifos / Terbufos/ Paraquat / Glifosato/ Otro			
	Clorpirifos / Terbufos/ Paraquat / Glifosato/ Otro			

75. ¿Qué usa en o cerca de la casa para matar moscas, cucarachas y ratones?

Forma o manera	Con qué frecuencia (días por semana o mes)	Por cuánto tiempo (minutas o horas por día)	Desde hace cuánto (años)
Baygon			
Ratomin			
Machete o algo sin químicos			
Counter (terbufos)			
Otra			

CONTROL

76. ¿Dónde trabaja?

MARCAR UNA CASILLA

Casa ☐
Tienda ☐
Otro lugar ☐

77. ¿En su trabajo, está en contacto con químicos o venenos, o lo estaba antes? NO ☐ SÍ ☐

Trabajo	Cuál químico	Con qué frecuencia (días por semana)	Cuál es la duración (horas por día)	Desde hace cuanto (periodo y años)
	Clorpirifos / Terbufos/ Paraquat / Glifosato/ Otro			
	Clorpirifos / Terbufos/ Paraquat / Glifosato/ Otro			
	Clorpirifos / Terbufos/ Paraquat / Glifosato/ Otro			
	Clorpirifos / Terbufos/ Paraquat / Glifosato/ Otro			

¿Qué usa(ba) en o cerca de la casa para matar moscas, cucarachas y ratones?

Plaguicida	Con qué frecuencia (días por semana o mes)	Por cuánto tiempo (minutas o horas por día)	Desde hace cuanto (periodo y años)
Baygon			
Racumin			
Machete o algo sin químicos			
Counter (terbufos)			
Otra			

ANNEX II

Cuestionario del proyecto "Contacto con plaguicidas y la salud respiratoria de las mujeres de la reserva indígena BriBri"

Salud Respiratoria

Fecha _____

Hora inicio _____
Hora final _____

Nombre _____
Apellidos _____

Fecha de nacimiento _____

	NO	SÍ
¿Usted sabe leer y escribir?	☐	☐

¿Cuál es su nivel de escolaridad?

Año de primaria	☐
Año de secundaria	☐
Colegio	☐
> Colegio	☐

Ahora me gustaría hacerle unas preguntas sobre su salud respiratoria. Tome el tiempo que considere necesario para pensar bien sus respuestas. La información que usted aporte es confidencial y solo se utilizará para nuestro estudio.

INTRODUCIÓN

	NO	SÍ
1. ¿Tiene problemas para respirar?	☐	☐

Si la repuesta es "no" pase a la pregunta 3
Si la repuesta es "sí" responda la siguiente pregunta:

2. ¿Con qué frecuencia tiene problemas para respirar? MARCAR SOLO UNA CASILLA

Nunca respira totalmente bien	☐
A menudo, pero siempre se recupera completamente	☐
Sólo de vez en cuando	☐
Sólo cuando trabaja	☐

SILBIDOS EN EL PECHO

NO SÍ

3. ¿Ha tenido silbidos (suena) o pitillos en el pecho durante el último año? ☐ ☐

Si la repuesta es "no" pase a la pregunta 6
Si la repuesta es "sí" responda las siguientes preguntas:

NO SÍ

4. ¿Ha tenido estos silbidos o pitillos sin estar resfriada? ☐ ☐

NO SÍ

5. ¿Ha tenido falta de aire cuando están presentes los silbidos o pitillos? ☐ ☐

NO SÍ

6. ¿Se ha despertado por la noche por que le falta el aire en el último año? ☐ ☐

TOS

NO SÍ

7. ¿Se ha despertado por un ataque de tos alguna vez en el último año? ☐ ☐

NO SÍ

8. ¿Tose frecuentemente al levantarse por la mañana, cuando están las lluvias? ☐ ☐

NO SÍ

9. ¿Tose frecuentemente de día o de noche, cuando están las lluvias? ☐ ☐

Si la repuesta es "no" pase a la pregunta 11
Si la repuesta es "sí" responda la siguiente pregunta:

NO SÍ

10. ¿Ha tenido esta tos al menos 3 meses cada año? ☐ ☐

ASMA

NO SÍ

11. ¿Tiene o ha tenido alguna vez asma? ☐ ☐

Si la repuesta es "no" pase a la pregunta 19
Si la repuesta es "sí" responda las siguientes preguntas:

NO SÍ

12. ¿Ha sido confirmado por un médico? ☐ ☐

AÑOS

13. ¿Qué edad tenía cuando tuvo su primer ataque de asma? ☐

AÑOS

14. ¿Qué edad tenía cuando tuvo su último ataque de asma? ☐

NO SÍ

15. ¿Ha tenido algún ataque de asma en el último año? ☐ ☐

Si la repuesta es "no" pase a la pregunta 17

Si la repuesta es "sí" responda la siguiente pregunta:

Nº DE ATAQUES

16. ¿Cuántos ataques de asma ha tenido en el último año? ☐

NO SÍ

17. ¿Toma actualmente algún medicina (incluyendo inhaladores, o aerosoles o pastillas) para el asma? ☐ ☐

Si la repuesta es "no" pase a la pregunta 19
Si la repuesta es "sí" responda la siguiente pregunta:

18. ¿Cuál medicina usa para el asma?
Nombre del medicina _____
Dosis _____
Frecuencia _____

PROBLEMAS NASALES

NO SÍ

19. ¿Tiene usted alguna alergia en la nariz, incluyendo la rinitis? ☐ ☐

Si la repuesta es "no" pase a la pregunta 21
si la repuesta es "sí" responda la siguiente pregunta:

EDAD

20. ¿Qué edad tenía cuando empezó a tener alergias en la nariz o rinitis? ☐

NO SÍ

21. ¿Alguna vez ha notado que tiene problemas de estornudos, moquera o nariz trancada (tapada) cuando no estaba resfriada o con gripe? ☐ ☐

NO SÍ

22. ¿Este problema de nariz ha estado acompañado por picor en los ojos o lagrimeo? ☐ ☐

Si la repuesta es "no" pase a la pregunta 24
Si la repuesta es "sí" responda la siguiente pregunta:

NO SÍ

23. ¿Ha tenido este problema durante el último año? ☐ ☐

MEDICAMENTOS

24. ¿Ha utilizado algún medicina para tratar problemas de alergias en la nariz? NO ☐ SÍ ☐

Nombre del medicina _____
Dosis _____
Frecuencia _____

25. ¿Ha usado en alguna ocasión un medicina para respirar mejor durante el último año? NO ☐ SÍ ☐
(píldoras, cápsulas, pastillas, jarabes, hierbas, medicinas tradicionales, inyectables, medicinas inhaladas)

Nombre del medicina _____
Dosis _____
Frecuencia _____

PROBLEMAS CUTÁNEOS

26. ¿Alguna vez ha tenido algunos salpullidos o granos o ronchas con picazón que aparece o desaparece durante al menos 6 meses? NO ☐ SÍ ☐

Si la repuesta es "no" pase a la pregunta 29
Si la repuesta es "sí" responda las siguientes preguntas: NO SÍ

27. ¿Este grano con picazón se produjo en el último año? ☐ ☐

28. ¿Este salpullido o grano con picazón le ha afectado uno de estos puntos:

parte interna de los codos, detrás de las rodillas, parte de delante de los tobillos, debajo de las nalgas (trasero), alrededor del cuello, orejas u ojos? NO ☐ SÍ ☐

29. ¿Ha tenido alguno de los siguientes problemas de piel en el último año? NO SÍ

Las manos o los dedos enrojecidos e hinchados	☐	☐
Las manos o los dedos enrojecidos y con grietas (o rajadas)	☐	☐
Ampollas (bulbos con agua, bombita) en las manos o entre los dedos	☐	☐
Las manos o los dedos ásperos o despellejados y con grietas (o rajadas)	☐	☐
Picazón en las manos o los dedos y con grietas	☐	☐

Si ha contestado todas las 5 preguntas con "no", pase a la pregunta 33

Si por lo menos una repuesta es "sí", responda las siguientes preguntas:

NO SÍ

30. ¿Alguno de estos problemas duró más de tres semanas? ☐ ☐

NO SÍ

31. ¿Tuvo alguno de estos problemas más de una vez? ☐ ☐

NO SÍ

32. ¿Fue a ver un médico por estos problemas de piel? ☐ ☐

INHALACIONES AGUDAS

NO SÍ

33. ¿Ha tenido un accidente en el trabajo, en casa u otro lugar que causó la inhalación de gran cantidad de vapores, gas o humo? ☐ ☐

NO SÍ

34. ¿Ha tenido un accidente en el trabajo, en casa u otro lugar que causó contaminación de la piel? ☐ ☐

NO SÍ

35. ¿Se ha intoxicado con plaguicidas por accidente alguna vez? ☐ ☐

Si la repuesta es "no" pase a la pregunta 39
si la repuesta es "sí" responda las siguientes preguntas:

36. ¿Hace cuánto tiempo le ocurrió este accidente? MARCAR SOLO UNA CASILLA

Menos de 1 año ☐
Entre 1 y 5 años ☐
Más de 5 años ☐

NO SÍ

37. ¿Notó molestias para respirar en las primeras 24 horas después De que ocurrió el accidente? ☐ ☐

NO SÍ

38. ¿Tuvo que ir al hospital o ver a algún médico por estas molestias? ☐ ☐

SÍNTOMAS RESPIRATORIOS RELACIONADOS CON SU TRABAJO EN LA FINCA

NO SÍ

39. ¿Alguna vez su trabajo en la finca le ha provocado problemas de respiración? ☐ ☐

40. Cuando trabaja en la finca MARCAR SOLO UNA CASILLA

No tengo síntomas respiratorios ☐ Pase a la pregunta 47
Los síntomas respiratorios son iguales ☐ Pase a la pregunta 47
Los síntomas respiratorios mejoran ☐ Pase a la pregunta 47
Los síntomas respiratorios empeoran ☐ Pase a la pregunta 41

NO SÍ

41. ¿ Considera que estos problemas respiratorios se deben a alguna sustancia en concreto o a alguna tarea específica de su trabajo? ☐ ☐

Si la repuesta es "no" pase a la pregunta 43
Si la repuesta es "sí" responda la siguiente pregunta:

42. ¿De qué sustancia o actividad se trata?

Plaguicidas ☐
Aplicación de plaguicidas ☐
Otra ☐

43. ¿Desde el momento en que empieza su trabajo en la finca, ¿cuánto tardan en aparecer o empeorar estos problemas respiratorios?

Minutos ☐
Horas ☐

44. ¿Durante cuánto tiempo persisten estos problemas respiratorios después su trabajo en la finca?

Minutos ☐
Horas ☐

45. ¿Se encuentra mejor de estos problemas respiratorios Durante el fin de semana? NO ☐ SÍ ☐

46. ¿Se encuentra mejor de estos problemas respiratorios Cuando no trabaja? NO ☐ SÍ ☐

47. ¿Cuántos días de trabajo ha perdido por culpa de problemas respiratorios?

Ningún día ☐
Número de días ☐

SU HOGAR

48. Por lo general, ¿qué usa usted para cocinar? MARCAR SOLO UNA CASILLA

a) leña? ☐
b) gas? ☐
c) electricidad/luz? ☐

49. ¿Cuántas veces cocina con leña por semana? MARCAR SOLO UNA CASILLA

1 vez ☐
2 -3 veces ☐
3 – 4 veces ☐
5 – 6 veces ☐
Todos los dias ☐

AÑOS

50. ¿Desde hace cuánto tiempo cocina usted con leña? ☐

AÑOS

51. ¿Hace cuánto tiempo dejó de cocinar con leña? ☐

NO SÍ

52. ¿Cocina dentro de la casa? ☐ ☐

53. ¿Con qué limpia la casa y cuantas veces por semana?

Cloro	☐	1 vez	☐
Canfin	☐	2-3 veces	☐
Cera	☐	3-4 veces	☐
Desinfectante	☐	5-6 veces	☐
Otra	☐	Todos los días	☐

54. Durante este último año ¿han salido manchas, moho o humedad dentro su casa? (Por ejemplo en las paredes o techos) NO ☐ SÍ ☐

Si la repuesta es "no", pase a la pregunta 56
Si la repuesta es "sí" responda la siguiente pregunta:

NO SÍ

55. ¿Este moho apareció durante el último año? ☐ ☐

56. ¿Cuántas veces come carne por semana? MARCAR SOLO UNA CASILLA

1 vez	☐
2 -3 veces	☐
3 – 4 veces	☐
5 – 6 veces	☐
Todos los dias	☐

57. ¿Aproximadamente cuánto gana usted al mes? MARCAR SOLO UNA CASILLA

menos de 10.000	☐
10.000 – 25.000	☐
25.000 – 50.000	☐
50.000 – 100.000	☐
100.000 – 200.000	☐
> 200.000	☐

FUMADO

NO SÍ

58. ¿Fuma actualmente (como mínimo desde hace un mes)? ☐ ☐

NO SÍ

59. ¿Fuma o ha fumado durante más de un año? ☐ ☐
[' SI' significa: al menos 20 paquetes de cigarrillos en toda su vida,
o al menos 1 cigarrillo al día a la semana durante un año***]***

Si la repuesta es "no" pasa a la pregunta 67
si la repuesta es "sí" pase a la siguiente pregunta: AÑOS

60. ¿A qué edad empezó a fumar? ☐

61. ¿Cuántos cigarrillos fuma al día actualmente en promedio (mas o menos)? NÚMERO
número de cigarrillos al día ☐
número de paquetes al día ☐

NO SÍ

62. ¿Ahora fuma menos que antes? ☐ ☐

Si la repuesta es "no" pase a la pregunta 64
si la repuesta es "sí" pase a la siguiente pregunta: AÑOS

63. ¿Hace cuanto tiempo empezó a fumar menos? ☐

NO SÍ

64. ¿Ha dejado de fumar? ☐ ☐

Si la repuesta es "no" pase a la pregunta 66
si la repuesta es "si" pase a la siguiente pregunta: AÑOS

65. ¿Por cuantos años dejó de fumar? ☐

66. Durante todo el tiempo que fumó (antes de que lo dejara o fumara menos), ¿cuántos cigarrillos fumaba x día? (mas o menos) NÚMERO
número de cigarrillos al día ☐
número de paquetes al día ☐

67. ¿Durante el último año, usted ha estado expuesta al humo del tabaco de otras personas la mayoría de días o noches? NO ☐ SÍ ☐

HORAS

68. ¿Cuántos horas por día? ☐

ANNEX III

Protocol spirometry

The purpose of spirometry is to record an accurate forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) from every subject. Subjects that have smoked a cigarette in the last hour or used inhalers in the last hour, are not allowed to perform the manoeuvre and the appointment has to be rescheduled.
All forced expiratory manoeuvres should be performed with the subject: sitting on a straight surface, with legs uncrossed, the head slightly elevated and tight clothing loosened. Noseclips are not used.

Manoeuvre
The manoeuvre consists of four phases: the positioning of the mouthpiece, a maximal inspiration and a subsequent 'blast' of exhalation which continues until the end of the test. A technically satisfactory (acceptable) manoeuvre is characterized by a maximum inspiration, a good start, smooth continuous exhalation and maximum effort.
A technically unsatisfactory manoeuvre is defined as:
1) an unsatisfactory start of expiration, characterised by excessive hesitation
2) early termination of manoeuvre (total time of manoeuvre less than six seconds)
3) coughing during the manoeuvre, thereby affecting the measured FEV_1 value
4) Valsalva Manoeuvre (glottis closure) or hesitation during the manoeuvre
5) a leak in the system or around the mouthpiece
6) an obstructed mouthpiece, e.g. the tongue or teeth in front of the mouthpiece
7) extra breath being taken during the manoeuvre
If a manoeuvre is performed with poor compliance, the subject should be encouraged to produce a better manoeuvre. The only criterion for unacceptable performance is when fewer than two technically acceptable curves are produced [46].

Test procedure
1) Demonstrate the manoeuvre to all subjects once (more often if she appears uncertain or does not understand).
2) Ask the subject to carry out the FVC manoeuvre
3) Record the FEV_1 and FVC from at least three technically satisfactory manoeuvres
4) If the subject has failed to produce two technically satisfactory manoeuvres after four attempts, show them again how to conduct the manoeuvre and allow them four more attempts (maximum number of tries is 8 [40].
5) Any subject who is unable to produce two technically satisfactory manoeuvres after eight attempts should not be tested further and no FEV_1 / FVC data should be recorded

Interpretation of results
An adequate test requires a minimum of three technically satisfactory (acceptable) manoeuvres. All technically unsatisfactory manouevres are rejected, after which the largest FVC and the largest FEV_1 from the recorded acceptable curves are selected, even if they do not come from the same curve. The selected (largest) FVC and FEV_1 values should be within 0.150 liter of the next largest values.