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EVALUATION OF THE KNOWLEDGE AND ATTITUDE OF USING PERSONAL PROTECTIVE EQUIPMENT AMONG RUBBER FARMERS IN SOUTHERN THAILAND

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Abstract: *The objects of this study were to assess the knowledge and attitude of using personal protective equipment (PPE) among 307 farmers who own rubber wood plantation in Southern Thailand. The data were collected by using questionnaires and then the descriptive statistics were analyzed by using the SPSS program. The results showed that 187 farmers were male (60.9%) and 105 farmers (34.2%) were 41-50 years old. 120 farmers (36.5%) graduated from primary education. More than half of the farmers have an average monthly income lower than 500 U.S. dollars and 148 farmers (48.2%) handle rubber wood plantation of 1.61-3.20 hectares. The results concerning the farmers' knowledge of PPE demonstrated that 222 farmers (73.31%,* $\bar{x}$ *= 86.05, S.D. = 15.13, P≤0.01) had a good level and most farmers know that long-sleeved shirts, pants, and wing caps can protect the body from scratches and exposure to sunlight. Indeed, 220 farmers (71.66%) showed a moderate attitude level of PPE use and farmers agreed that they do not need to cover their mouths and noses while fertilizing or spraying pesticides due to using a small amount of chemicals. However, the overall attitudes of the participants in using PPE concerned the fact that it can protect users from accidents, animals, mosquitoes, and insects. These results should enable the development of a PPE handbook for rubber farmers who need to serve their plantation following the Forest Stewardship Council (FSC).*

Key words: *personal protective equipment; knowledge and attitude; health communication; rubber farmer; rubber wood plantation.*

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1. Introduction

Farmers are routinely exposed to high levels of plant protection products. They are widely used in agricultural production to control harmful pests, diseases, weeds, and other plant pathogens to reduce or eliminate yield losses and maintain high product quality [3]. Rubberwood (*Hevea brasiliensis* Müll. Arg.) is one of the wood species which can grow in tropical forest zone. It usually practices an initial growth phase generally from 5 to 7 years and the trees are tapped when their trunks attain 50 cm in girth to collect natural rubber [26]. The main object of utilization for this species is to harvest natural rubber. Generally, after 7 years of rubber plantation, farmers can tap rubber trees for resin until 25 years [25]. There is rubber plantation in Thailand especially in the southern part of the country, around 2,251,742 hectares in 14 provinces due to the climate of the tropical rainforest which is suitable for growing rubber trees [18]. In 2007, Thailand exported about 35% of the rubber produced worldwide such as concentrated latex, block rubber, and rubber smoke sheet [10], [23]. It is a fact that the occupation of Thai citizens in this area is farming, as they have rubberwood plantations. Rubberwood is one of the most significant species for Thai economics exclusively in rubber latex [22]. The farmers usually collect natural rubber by the tapping technique normally at about 3-6 am, from rubber trees that provide more resin product. Rubber trees are tapped to produce natural latex until the age of 20-25 years old, when it is cut for replantation. Thailand is a major exporter of rubberwood in Southeast Asia and approximately 97% of the world's natural rubber is shipped abroad, mainly from Thailand 31%, Indonesia 30%, and Malaysia 9% [12]. It is an enormously renewable and environmentally friendly natural material used for furniture, children's toys, and wood composite materials [24]. Nevertheless, forest plantation is a dangerous occupation. It is a so called "3D" job, which means a dirty, difficult, and dangerous job, and sometimes a fourth D is added, for deadly [2]. Some studies have reported that the safety climate can enhance worker safety behavior, reduce injuries, and may mitigate the negative health effects of other work organizational factors such as job insecurity [9], [17], [19]. Healthy and safe working conditions are the most important of all workers' concern for every workplace. When farmers or employees work in a hazardous workplace that can cause injury, they must have and use personal protective equipment correctly. Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to a variety of hazards [15]. The level of protection in rubber plantation provided by a specific PPE item depends on the farmers' jobs. Some studies concerning several PPE materials and designs lend further support to the effectiveness of PPE, although some of these studies also indicated variations due to fabrics and clothing design [1], [4], [13]. Hearing protector use such as earmuffs is the best to reduce noise exposure above 95dBA in lumber mills [8].

Due to the very low use of PPE by rubber farmers there are some problems which involve their health, life, and income. Therefore, the main objective of this study was to evaluate the knowledge

and attitudes of rubber farmers regarding the use of personal protective equipment in plantation. The general information of Thai rubber farmers was also collected, and Using PPE was determined in each duty of working. In addition, the data in this study will be developed to make a handbook of PPE for rubber farmers.

2. Materials and Methods

2.1. Participants

This study was a survey research using questionnaires for the evaluation of the knowledge of using personal protective equipment (PPE) by rubber farmers and the assessment of the farmers' attitudes after using PPE. The participants are farmers involved in silviculture, plantation, rubber tapping, and tree cutting. 307 participants were selected as landowners located in Surat Thani, Thailand. The members are 18-60 years old, Thai speakers who participated voluntarily.

2.2. Tools and Evaluation of the Study

The questionnaire was designed and referenced in previous studies. It was investigated by three specialists for content validity, then come contents were improved following comments, before using Cronbach's alpha coefficient: $\alpha = 0.637$.

The questionnaire of the study has three parts, namely: 1) General information; 2) Knowledge information of using PPE; and 3) Opinion information of using PPE. The general information included gender, age, marital status, education, income, and rubber plantation information such as job criteria, experience, location, and time of work a day. The knowledge information of using PPE involves Yes-No questions regarding the use of PPE in rubber plantation, scoring as good (80-100%), moderate (60-79%), and poor (≤59%). The opinion information of using PPE has positive and negative attitudes following the Likert scale which has 5 levels that assume positive attitudes as Strongly agree = 5 points, Agree = 4 points, Neither agree nor disagree = 3 points, Disagree = 2 points, and Strongly disagree = 1 point. On the other hand, the negative attitudes score is reversed points from 1 to 5 points [11].

2.3. Data Collection

Firstly, e contacted the subdistrict headman of Kanchanadit District, Surat Thani province, located in Southern Thailand, to inform the objects of our research, then made an appointment to promote our activities there. Next, we made an official letter for permission to work and collect the data from the rubber farmers. The team presented the information and explained the objects of this study to people who participated in the program. Afterward, they filled in the questionnaire for about 10-20 minutes. Finally, corrections were made in the questionnaires before all the data was collected.

2.4. Data Analysis

Statistical analyses were performed using SPSS Version 22. Descriptive statistics were used to describe the basic features of the data in the study. The measures of central tendency of data included the mean, median, and mode, while the measures of variability included the standard deviation. The distributions of data were also displayed in percentages. The analysis of variance

(ANOVA) was used to analyze the significant differences among the knowledge and the attitudes of using personal protective equipment using XLSAT in Microsoft Excel 365®. The data were statistically analyzed at a confidence level of the p-value = 0.05.

3. Results and Discussion

The study of evaluation of the knowledge and attitudes of using personal protective equipment of rubber farmers who applied for the management of rubber plantation in Figure 1 was investigated by using questionnaires. The questions were separated into five parts in each process of silviculture, namely planting, tree maintenance, protection against disease and insects in rubberwood, resin tapping, and tree cutting. The results displayed the general information in Table 1. The data collected included gender, marital status, age range, ownership, education, income/month, areas, experience, and time of working/day. The outcomes showed that the participants were mostly male (60.9%), married (78.2%), and landowners (71.7%). There were participants (4.9%) who have an education in graduated level or above. The income/month of Thai rubber farmers is an average of 15,000 baht (~453 US dollars). Their areas of work are around 1.61 - 3.20 hectares/person (48.2%) of rubberwood plantation. Moreover, their experience is over 10 years for 71.5% of the participants and 87.9% of the participants have mostly worked for over 4 hours.

Table 2 demonstrated that there are five duties of activities in the plantation, specifically: 1) planting; 2) tree maintenance; 3) protection against disease and insects; 4) tapping; and 5) cutting. Almost all participants have worked in the tapping process (93.16%) which involves three main tasks: tapping, collecting, and transportation [22].

Fig. 1. *Characteristics of rubber tree in rubber plantation in Southern Thailand*

The general information of participants Table 1

General information	Quantity [n]	Percentage [%]	General information	Quantity [n]	Percentage [%]
Gender			**Marital status**		
Male	187	60.9	Single	39	12.7
Female	109	35.5	Married	240	78.2
Unwilling to answer	11	3.2	Divorced or widowed	23	7.5
			Unwilling to answer	5	1.6
Age range			**Ownership**		
18-20	1	0.3	Landowner	220	71.7
21-30	31	10.1	Relative land owner	11	3.6
31-40	83	27.0	Labor	75	24.4
41-50	105	34.2	Unwilling to answer	1	0.3
51-60 years old	87	28.3			
Education					
None					
Primary school					
Junior High	7	2.3	**Income/month**		
School	112	36.5	≤ 10,000 Baht	92	30.0
Senior High	95	30.9	10,000-15,000	94	30.6
School	63	20.5	15,001-20,000	80	25.4
Undergraduate	13	4.2	20,001-25,000	32	10.4
Graduated or	15	4.9	25,001-30,000	9	2.9
over	2	0.7	≥30,001 Baht	2	0.7
Unwilling to answer					
Areas			**Experience**		
≤ 1.60 hectares	107	34.9	≤ 1 year	4	1.2
1.61 - 3.20	148	48.2	1 - 5 years	26	7.9
hectares	41	13.4	5 - 10 years	65	19.1
3.20 - 4.80	11	3.6	≥ 10 years	211	71.5
hectares			Unwilling to answer	1	0.3
≥4.81 hectares					
Time of working/day					
≤ 4 hrs.	34	11.1			
4 - 6 hrs.	144	46.9			
6 - 8 hrs.	99	32.2			
≥ 8 hrs.	27	8.8			
Unwilling to answer	3	1.0			

It is a fact that fewer rubber farmers know how to cut and transport rubber trees to sawmills. This process is one of the most dangerous of silviculture in rubber plantation because farmers who use chainsaws to cut the trees must have skills and experience as showed in Figure 2. Therefore, the rubber owners often hire an expert and a professional lumberjack in tree cutting as a different occupation.

Job description of rubber farmers in plantation (participants can select more than one choice) Table 2

Job description of rubber farmers	Quantity [n]	Percentage [%]
1. Planting	153	49.84
2. Maintenance	145	47.23
3. Protection against disease and insect	97	31.60
4. Tapping	286	93.16
5. Cutting	19	6.19

Fig. 2. Cutting rubber plantations:

a. *no PPE using in tree cutting process; b. machines and laborers used in cutting rubber plantation*

The quantity and percentage of rubber farmer regarding the knowledge and attitudes of using personal protective equipment are shown in Table 3. There are three levels of evaluation in percentages as good (80-100%), moderate (60-79%), and poor (≤59%). The result of the farmers' knowledge of using PPE determined that 222 farmers (73.31%, $\bar{x}$=86.05, S.D.=15.13, Max=100, Min=12.5) showed in a good level and most farmers know that long-sleeved shirts, pants, and wing caps are able to protect the body from scratches and exposure to sunlight. The knowledge of the Thai rubber farmers had a significant difference in high score of using PPE (P≤0.01). The results of the farmers' attitudes of using PPE appeared in score levels as 0.99 - 2.32 score = poor, 2.33 - 3.66 score = moderate, and 3.67 - 5.00 score = good. The score level is mostly moderate which has 220 (71.66%) participants and showed a significant difference between groups (P≤0.01). Indeed, there are 20.20% of participants who have a good attitude in using personal protective equipment. As a result, if farmers were aware of their health, they could change their attitude. However, PPE such as protective clothing can lose its efficiency of use after pesticide sprays and multiple washes [5]. Some studies demonstrated that the pesticide formulation at different concentrations could affect the protection of the protective clothing [20].

The quantity and percentage of rubber farmers regarding the knowledge and the attitudes of using personal protective equipment Table 3

The knowledge of using personal protective equipment	Quantity (n), [%]	The attitude of using personal protective equipment	Quantity (n), [%]
Good (80-100%)	222 (73.31)*	Good (score 3.67 - 5.00)	62 (20.20)
Moderate (60-79%)	64(20.85)	Moderate (score 2.33 - 3.66)	220 (71.66)*
Poor (≤59%)	21 (6.84)	Poor (score 0.99 - 2.32)	25 (8.14)

Notes: * Highly significantly different (P ≤ 0.01).

The attitudes of the participants in this study of using PPE were evaluated by using 10 questions in the questionnaire as the contents shown in Table 4. The results showed that virtually all participants found moderate scores in the questions. There are about 80% of farmers who have concerns about wearing a mask or respirator when using fertilizer or insecticide. Previous studies showed that the exposure to pesticides can be reduced by wearing PPE [14]. Nevertheless, they have ignored wearing balaclava knitted hats (66.45%) because they can make them feel hot, slightly wet, and itching. This cover can protect farmers from mosquitos, which is a vector that can cause several diseases especially in tropical forest zones. As reported in 2016, there were an estimated 216 million cases of malaria worldwide [16]. This vector will bite farmers when they are working in rubber plantation especially in the tapping process.

Personal protective equipment of rubber farmers Table 5

Job description	**Examples of dangerous considerations**	**PPE**
Planting	Sun light, rocks, twigs, snakes, centipedes	long-sleeved shirts, pants, wing caps, gloves, and rubber boots.
Tree maintenance	Fertilizer, rocks, sun light	long-sleeved shirts, pants, mask, goggles, gloves, and rubber boots.
Protection against disease and insects	Insecticide, chemicals	long-sleeved shirts, pants, respirator, goggles, gloves, and rubber boots.
Tapping	Mosquitoes, snakes, centipedes, tapping knife	balaclava knitted hat, head torch, long-sleeved shirts, pants, gloves, and rubber boots.
Cutting	Chainsaw, logs, snakes	safety helmet, safety glasses/full face shield, ear plugs/ear muffs, close-fitting long sleeves, leather gloves, and logging boots/shoes

Table 5 illustrates the personal protective equipment of rubber farmers that is appropriate in Southeast Asia where there are rubber trees such as Thailand, Malaysia, Vietnam, Laos, and Cambodia [6]. This study found data of PPE that normally farmers have used and requited for the responsible management

of forest plantation. For example, when rubber farmers go to tap resin in rubber plantations, they should wear balaclava knitted hats, head torches, long-sleeved shirts, pants, gloves, and rubber boots to protect them from tapping knives and animals such as mosquitoes, snakes, or centipedes. It is assumed that wearing PPE will considerably limit exposure [7]. Furthermore, in the cutting process which is the most dangerous of the production, the laborers must protect themselves from accidents by using PPE, for instance safety helmets, safety glasses or full face shields, ear plugs or ear muffs, close-fitting long sleeves, leather gloves, and logging boots or shoes.

4. Conclusions

The data in this study provide a description of farmers' behaviors in the use of PPE, which showed that rubberwood farmers had good knowledge (73.31%, $\bar{x}$ = 86.05, S.D.=15.13, P≤0.01) but there is a moderate attitude (71.66%) regarding the requirement of PPE. Most of the participants have experience in rubber plantation of over 10 years, the average age is 41-50 years old, and they handle rubberwood plantations of 1.76-3.20 hectares. The time of working for tapping rubber as a routine is 4-6 hours/day. They are concerned about the danger of their jobs, but they wear some PPE such as a respirators when they spray insecticide or some chemical products that they thought has very low content.

Moreover, some farmers did not wear knitted hats that can protect as a face shield because they are not comfortable, they feel hot, damp, and itching.

Therefore, the data of this research has a fact that suggests rubber farmers to be aware of using PPE in plantation silviculture. Furthermore, the landowners and rubber farmers who need to serve their plantation following the Forest Stewardship Council (FSC) should develop a handbook of PPE for rubber farmers and workers.

Author Contributions

The manuscript was written through the contributions of all authors. All authors have given their approval for the final version of the manuscript.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

The results of quantity, percentage, mean and standard deviation of the participants' attitudes Table 4

Contents	Total (n)	Strongly agree (n), [%]	Agree (n), [%]	Neither agree nor disagree (n), [%]	Disagree (n), [%]	Strongly disagree (n), [%]	$\overline{X}$, (S.D.)	Resulting	Ranking
1. Wearing a balaclava knitted hat causes a hot, slightly wet, and itching feeling	304	38 (12.50)	202 (66.45)	23 (7.57)	39 (12.83)	2 (0.66)	2.26 (0.925)	Poor	10
2. Wearing a safety helmet is extravagant equipment in the tree cutting process	303	23 (7.49)	82 (27.06)	60 (19.80)	127 (41.91)	11 (3.63)	3.10 (1.114)	Moderate	4
3. Wearing a safety helmet makes an uncomfortable point in the workplace	307	26 (8.47)	124 (40.39)	38 (12.38)	115 (37.46)	4 (1.30)	2.86 (1.114)	Moderate	7
4. Sunglasses can be used as goggles	303	49 (16.17)	178 (58.74)	18 (5.94)	55 (18.15)	3 (0.99)	2.34 (1.058)	Moderate	9
5. It is unnecessary to wear ear plugs or earmuffs when using a brush cutter or lawn mower	305	14 (4.59)	138 (45.26)	26 (8.52)	112 (36.72)	15 (4.92)	2.94 (1.119)	Moderate	6
6. It is unnecessary to wear a mask or respirator when using fertilizer or insecticide	305	21 (6.89)	43 (14.10)	14 (4.59)	183 (60.00)	44 (14.43)	3.63 (1.120)	Moderate	1
7. Wearing a cloth mask has the same efficiency as a respirator	305	31 (10.16)	82 (26.89)	36 (11.80)	131 (42.95)	25 (8.20)	3.14 (1.211)	Moderate	3
8. A respirator is expensive equipment and irregular maintenance	303	16 (5.28)	69 (22.77)	91 (30.03)	116 (38.28)	11 (3.63)	3.16 (1.025)	Moderate	2
9. When applying manure,it is unnecessary to wear a mask and gloves	304	22 (7.24)	98 (32.24)	37 (12.17)	137 (45.07)	10 (3.29)	3.08 (1.126)	Moderate	5
10. Wearing gloves causes slightly wet hands and feels uneasy in work	305	19 (6.23)	168 (55.08)	32 (10.49)	74 (24.26)	12 (3.93)	2.67 (1.070)	Moderate	8

Strongly agree = 5 points, Agree = 4 points, Neither agree nor disagree = 3 points, Disagree = 2 points, and Strongly disagree

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