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A preliminary study on current agricultural practices among small-scale rice farmers in Kelantan, Malaysia

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Abstract. This study investigates the potential exposure parameters among small-scale rice farmers based on their current agricultural practices under submerged rice systems. Twenty-four rice farmers from the District of Tanah Merah in Kelantan, Malaysia were interviewed about various pesticide exposure parameters (November 2020), followed by the collection of pesticide application information using questionnaire surveys across the whole rice season (December 2020 – March 2021). Overall, the 15 selected rice farmers with small-scale farm sizes (≤ 2.0 hectares) applied maximum numbers of 4 pesticide products and 10 spray rounds during 3 – 13 spraying days across the whole rice season, using 12 – 18 L of motorised knapsack sprayers (median: 15 L). The 15 selected rice farmers removed pesticide leftovers in the sprayers using soap and/or water only at the end of a spraying day. Each individual applied one of three disposal methods of empty pesticide containers, comprising thrown in the field (7 individuals), collect and burn (6 individuals) and buried in the ground (2 individuals). During mixing/loading, spraying and sprayer washing activities, individuals applied some protective measures by wearing long sleeves and long pants and face masks (each 15 individuals) and (long/short) boots (11 individuals), and that of relatively fewer use of gloves (5 individuals). Study findings indicate potential pesticide exposure among small-scale rice farmers due to the use of pesticide mixtures, improper handling of pesticide wastes and improper use of protective measures.

1. Introduction

Rice farmers often rely on the use of pesticides to kill pests and control crop diseases, to ensure good grain appearance and high production yields, and to save labour costs and time [1, 2]. However, pesticides may pose a health risk to exposed humans due to their intrinsic toxicity. The level of pesticide risk on human health is typically proportional to the level of exposure, with higher pesticide risk due to occupational exposure than that of environmental exposure.

Occupationally, pesticide exposure can occur at all pesticides-related activities particularly during mixing/loading and spraying activities. There are a range of factors that may influence the level of pesticide exposure under actual field conditions, including the crop type, the type of pesticides applied and their physicochemical properties, the type of spraying equipment, the use of personal protective equipment (PPE), the storage place of pesticide products, the disposal of empty pesticide containers, and working behaviour and experience [3, 4]. In submerged rice systems, the rice plants are grown under the water (5 – 15 cm) throughout the rice season [5]. Therefore, pesticide exposure factors among rice farmers may be different from other crop types. However, monitoring of application practices and pesticide exposure in small-scale rice farming systems are seldom performed [6, 7].

In developing countries like Malaysia, there is currently no national system to routinely monitor pesticide uses [8]. In 2016, there was only 2.3% of total number of farms within the country were registered under the Good Agricultural Practice Malaysia (MyGAP) because good agricultural practices are often inhibited by the limited capital and incentives [9]. Meanwhile, an existing study proposed that pesticide overuses in rice farming is a continuous important problem in Malaysia [10]. The indiscriminate and unsafe uses of pesticides in line with rice intensification programmes have been associated with various health effects including allergies, eye and skin irritation, cough, dizziness, headache and nausea, stomach cramps, respiratory distress and wheezing [6, 11, 12]. For detailed risk assessment, interviews and survey methods are commonly used to collect information on various parameters associated with pesticide exposure [13].

This study investigates the current agricultural practices and associated occupational exposure parameters among small-scale rice farmers across the whole rice season. To do this, we selected 15 rice farmers with small-scale farms (≤ 2.0 hectares) from the District of Tanah Merah in Kelantan, Malaysia. The selected rice farmers involved in both personal interview and questionnaire surveys to provide contextual information about pesticide applications. Study findings can be used to identify major pesticide exposure factors in small-scale, submerged rice systems.

2. Methodology

This study was conducted using personal interviews and questionnaire surveys based on a voluntarily basis, which were assisted by the agricultural officers from the Department of Agriculture, District of Tanah Merah in Kelantan, Malaysia. Before the rice season began in November 2020, a focus group meeting was held with 24 rice farmers comprising a briefing session about pesticide survey and informed consent, and one-to-one personal interviews using the structural interview questions to collect contextual information (e.g., personal and farm characteristics, sprayer information, pesticide storage, disposal of empty containers, and the use of PPE). Then, the participating rice farmers were provided with questionnaire surveys to record their daily pesticide usages across the whole rice season (December 2020 – Mac 2021). All rice farmers received a cash compensation for their participation in both interview and questionnaire surveys. This study used descriptive analysis to summarise and explain the information collected from the 15 selected rice farmers (i.e., RF01 – RF15).

3. Results and Discussion

Table 1 shows the 15 selected rice farmers aged between 21- and 60-year-old had different farming experience in rice ranged from one year up to 30 years. Of the 15 selected individuals, ten were full-time rice farmers but only two of them attended pesticide-related training/course in recent years. Typically, experienced farmers prefer to use their past experiences when handling pesticides rather than attending pesticide trainings and courses [14].

All the 15 selected rice farmers applied pesticides using motorised knapsack sprayers with different tank sizes (12 – 18 L; median: 15 L), average number of spray rounds per day (3 – 10 spray rounds; median: 5 rounds) and average times spent per spray round (10 – 30 minutes; median: 20 minutes). Knapsack sprayers are commonly used in developing countries, particularly in small-scale farming systems [1]. The use of knapsack sprayers has been associated with high level of pesticide exposure compared to other sprayer types such as broom sprayer and aerial applicators [15]. Due to the use of knapsack sprayers, legs are primary sites of exposure because of indirect contact with treated crops, spray drift during spraying and leaking knapsack sprayer [16, 17].

At the end of a spraying day, the 15 selected rice farmers washed or rinsed away pesticide leftovers in the sprayer tanks using either soap and water (9 individuals) or water only (6 individuals). For the storage of pesticide products, twelve of them had a proper store to keep pesticide products. In this study, three disposal methods of empty pesticide containers were identified: thrown in the field (7 individuals), collection and burn (6 individuals) and buried in the ground (2 individuals) (Table 1). Therefore, it is important to conduct pesticide awareness and recycling programmes on how to properly manage the empty containers and other pesticide wastes [18].

Table 1. Summary of pesticide exposure parameters that collected from the 15 selected small-scale rice farmers.

Rice farmer	Occupation	Age	Year of farming	Farm area (ha)	Type of knapsack sprayer	Size of sprayer tank (L)	Average time spent per spray round (minutes)	Average number of spray rounds per day	Sprayer washing	Pesticide training/ course	Pesticide store	Disposal of empty container
RF01	Part-time	26	7	2.0	Motorised	15	15	10	Soap and water	Yes	No	Collection & burn
RF02	Part-time	60	10	2.0	Motorised	14	30	5	Water	No	Yes	Thrown in field
RF03	Part-time	58	30	2.0	Motorised	12	15	6	Soap and water	No	Yes	Thrown in field
RF04	Full-time	58	8	0.7	Motorised	12	20	4	Water	No	Yes	Thrown in field
RF05	Full-time	47	8	1.0	Motorised	15	30	4	Soap and water	No	No	Collection & burn
RF06	Part-time	57	20	1.0	Motorised	12	20	5	Water	No	Yes	Thrown in field
RF07	Full-time	57	10	2.0	Motorised	18	30	4	Soap and water	Yes	Yes	Collection & burn
RF08	Full-time	21	2	2.0	Motorised	15	15	5	Soap and water	No	Yes	Collection & burn
RF09	Full-time	48	1	0.6	Motorised	18	20	3	Soap and water (herbicide)/water (insecticide)	No	Yes	Buried in the ground
RF10	Full-time	55	5	2.0	Motorised	15	20	10	Soap and water	No	Yes	Collection & burn
RF11	Full-time	25	3	2.0	Motorised	15	10	4	Soap and water	Yes	Yes	Collection & burn
RF12	Full-time	28	2	1.6	Motorised	15	15	6	Soap and water	No	Yes	Buried in the ground
RF13	Full-time	40	3	2.0	Motorised	15	15	6	Soap and water	No	Yes	Thrown in soil
RF14	Part-time	49	6	1.3	Motorised	16	15	5	Water	No	Yes	Thrown in field
RF15	Full-time	59	3	1.6	Motorised	12	30	4	Water	No	No	Thrown in field
Median	-	49	6	2.0	-	15	20	5	-	-	-	-

Figure 1 shows the 15 selected farmers different number of spraying days ranged from 3 up to 13 days across the whole rice season. Meanwhile, an existing study reported only one to three times of pesticide application per rice season [19]. This is because the total number of pesticide applications can be affected by a wide range of factors including the market price of pesticides, the reasons of cultivation and pesticide application [20, 21]. Therefore, it is important to review the existing pesticides and to control the entry of new pesticides into the market, where restructuring of local pesticide markets may be necessary [22].

Meanwhile, five of the 15 selected rice farmers had at least one spraying day with maximum number of four products applied while majority had applied two products per day (11 individuals) (Figure 2). The use of multiple products on a single spraying day (in mixtures or separately) can lead to aggregate or combined exposures to multiple active substances with similar toxicological endpoints. This can cause higher toxicities than that posed by a single active substance alone [23]. In mixtures, individual active substances may cause different health effects due to different interactions between substances such as synergistic and additive interactions [24]. A previously conducted study proposed that chronic exposure to organophosphate mixtures can cause at least 2-fold of increase in DNA damage [25]. What is more, rice famers' take-home pesticides can pose a health risk to their families [6].

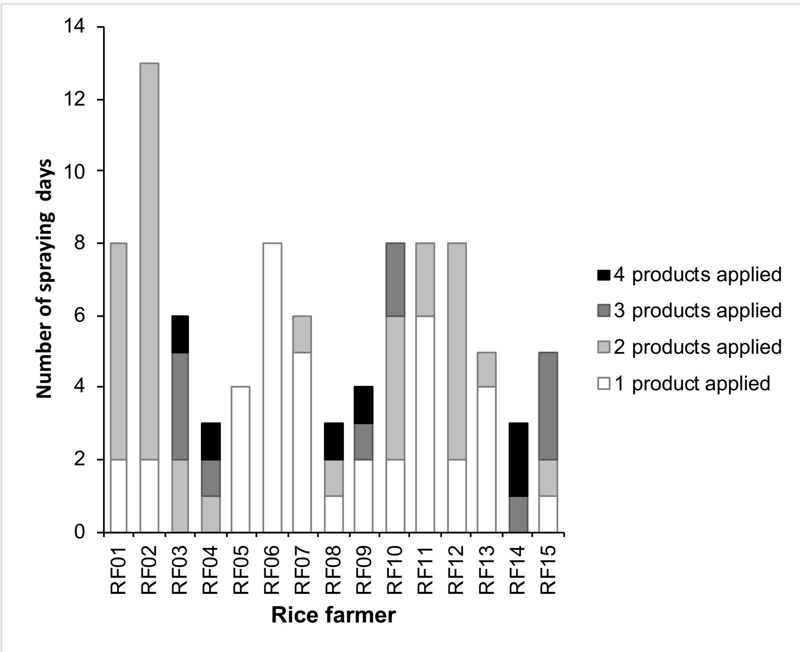

Figure 1. Total numbers of pesticide products applied by the 15 selected rice farmers across the whole rice season.

Figure 2 shows the 15 selected rice farmers had at least a protective layer of clothes (long sleeves and long pants) and face masks during pesticide mixing/loading, spraying and sprayer washing. To a lesser extent, there were also the uses of (long/short) boots and (plastic/cotton) gloves (11 and 5 individuals, respectively). Depending on the water level in rice fields, the wearing of waterproof (long/short) boots is important to protect legs contact from contaminated paddy water and soil [26]. However, improper use of PPE is a common issue in tropical countries particularly due to the hot and humid climates, PPE inaccessibility and financial constrains [27]. There is also weaker legislative protection in developing countries compared to the developed countries, leading to poor compliance with the recommended application dose and PPE use [6].

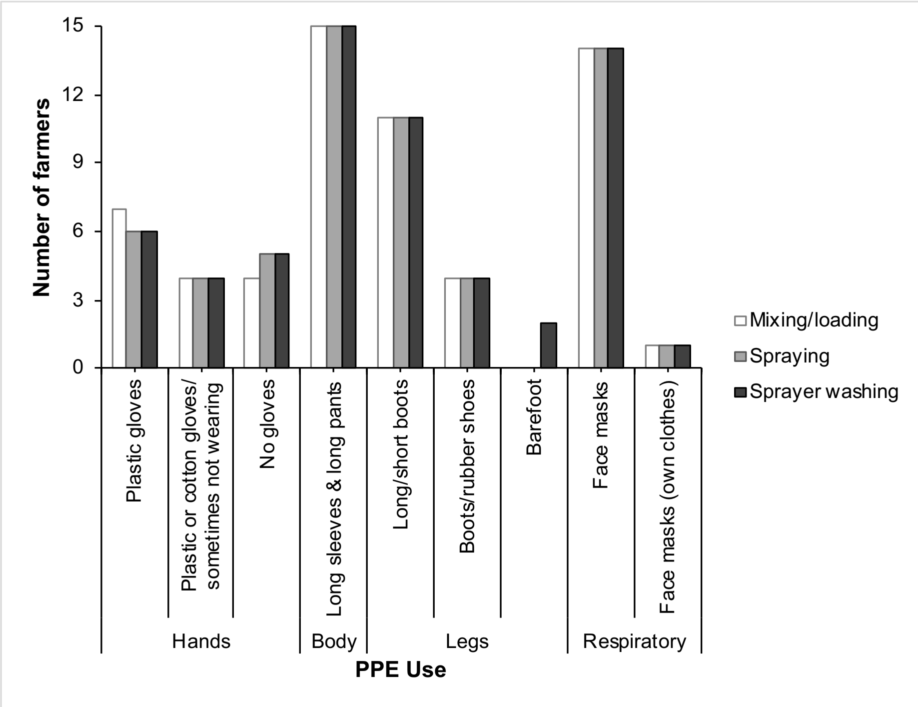

Figure 2. The use of personal protective equipment (PPE) among the 15 selected rice farmers.

As a whole, rice farmers' exposure to pesticides are mainly influenced by the use of knapsack sprayer and associated spraying practices under submerged farming systems [28]. This includes the potential pesticide over-application due to uneven distribution using knapsack sprayers and the implementation of rice intensification programmes [29, 30]. While the use of PPE is essential at pesticide-related activities, education and trainings in managing pesticide wastes could be more important in minimising pesticide risk [18, 31].

A few constraints were encountered due to the COVID-19 pandemic with the restrictions of group meetings and travels to collect questionnaire surveys. Therefore, the present study did not take into account the representativeness of random sampling and sample size, which can be considered in the future studies for statistical significance. Typically, high variations of pesticide usages and exposure levels among farmers require larger number of samples or repetitions in establishing exposure databases and predictive models [32, 33].

4. Conclusion

This study indicates the common use of motorised knapsack sprayers among the 15 selected rice farmers under submerged rice systems, where (long/short) boots can minimise pesticide exposure via legs contact with contaminated paddy water. While proper PPE use needs some improvements during mixing/loading, spraying and sprayer washing activities, the use of multiple pesticide products on single spraying days and improper disposal of empty pesticide containers may cause higher pesticide risk among the selected rice farmers. Study findings indicate education and awareness programmes on proper agricultural practices and PPE use are important to reduce pesticide risk among small-scale rice farmers.

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