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Risk factors associated with hand tractor related injuries among rice farmers in Thailand

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Abstract

Hand tractors are important machines used in the soil preparation process before sowing rice in the paddy's of Thailand. Previous research on injuries in rice farming indicated that working with a hand tractor may be one of main causes of injuries. This study investigated the prevalence of hand tractor-related injuries, their association risk factors and characteristic of injuries. The data were collected by face-to-face interview to 377 farmers from nearly all districts in Phra Nakhon Si Ayutthaya province. Among these rice farmers, the prevalence of injury was 41%. The most common type of injury was cuts (43.9%) and the most common source of injuries was stepping on a golden apple snail shell (33.1%). The bivariate Poisson regression models showed that self-reported normal working conditions that were associated with the risk of injury included sleeping problems (RR = 1.39), "Hustle Work (working quickly to complete plowing)" (RR = 1.48), feeling fatigue before work (RR = 1.60), and normal use of a leveler as attached plow equipment (RR = 1.41). However, a multivariate model showed only normal use of a leveler as attached equipment was associated with an increased use of injuries (RR = 1.47) after controlling for the other factors that were significant in the bivariate models. These results suggest that job stress protection should be recommended or redesign of the leveler attachment developed for hand tractors used in rice paddy fields.

Keywords

rice farmer; hand tractor; injury; safety; risk factor

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Introduction

In 2020, the National Statistical Office of Thailand estimated that there were 13.5 million agricultural workers in Thailand (National Statistical Office 2020). Among them, 3.8 million were rice farmers (National Statistical Office 2013). In Thailand, most agricultural workers are informal workers, which means very few are covered by occupational health and safety laws, they are not part of the social security system, nor do they have private health insurance (Siripanich et al. 2014). Also, because they work in the informal sector, most agricultural workers are not covered by the Workers Compensation Fund, and accident statistics are not being collected. However, a survey by the National Injury Surveillance System (NIS), Department of Epidemiology, Ministry of Public Health reported that there were about 17,000 agricultural injuries in 2002–2010, which lead to 96 deaths, with a fatality rate of 0.5 per 100 injured workers. The leading causes of injuries among agricultural workers were: struck by a falling object (12.2%), contact with agricultural machinery (9.6%), and foreign objects entering eye or skin (8.0%) (Siripanich et al. 2014; Nankongnab et al. 2020).

The hand tractor (also called a power tiller) is small machine which is designed for use in farm operations to replace an ox or buffalo to plow the field before planting. Hand tractors are widely used in the rural areas of developing countries, especially in South East Asia. The main components of the hand tractor consist of a gasoline or diesel engine, gear section, belt and pulley, handlebars, wheels and the attachments connected behind the motor, such as plow blade, rake, seeder, and leveler (Figure 1a–d) (Ericson 2010). Hand tractors have two functions; farming and transportation, as they can be used to pull a cart (Ericson 2010; Shridar et al. 2006). It is estimated that there are nearly 2 million hand tractors in Thailand. Little research has been done on the health and safety issues of using hand tractors and their associated risk factors. Machine vibration, exposure to belts and pulleys without guarding and loud noise have been reported as the main safety concerns (Ericson 2010). Exposure to solar radiation, dusty environments, and severe hand vibration were cited as the cause of occupational health problems among Indian power tiller users (Tiwari and Gite 2006). Tewari et al. (2004) described how farmers could avoid foot injuries when operating hand tractors by using an operator seat. However, they explained that using the operator seat in wet field conditions had adverse effect on the stability of the hand tractor increasing the risk of an accident. Moreover, farmers using hand tractors are exposed to hand-transmitted vibration causing pain and muscle fatigue, reducing performance and the ability to control the equipment and increasing the risk of errors and accidents. In Japan, Matsukawa and Yokoyama (2014) reported that most injuries from hand tractors were not serious, for example a farmer cut by a sharp object in the soil or by a plow blade. However, some injuries were life threatening, such as when a hand tractor rolled over onto a farmer or the farmer got caught in a moving part of the hand tractor.

In Thailand, only a few studies have collected data on hand tractor-related injuries. For example, in a study of rice farmer injuries in Chiang Mai, the incidence rate of severe injuries was 2.1 cases/100 person-years and for non-severe injuries was 54.4 cases/100 person-years (Chino and Jiamjarasrangsi 2015). The most common type of injury was an open wound at the ankle or the foot, which was likely caused in the land preparation process

where hand tractors are used. Yaruang and Sukonthasarn (2016) also studied the safety behavior and health status of rice farmers in Chiang Rai, and found that nearly half of them (47%) had injuries but only 12% of the injuries were caused by hand tractors or harvesting machines. The majority (70%) of the reported injuries occurred during the rice transplanting process, and 81% occurred from stepping on the sharp shell of a golden apple snail. These snails are an important and common pest in rice patties, causing significant damage to the rice crop. Buranatreveth and Sweatsriskul (2005) found that the top three occupational health and safety problems among rice farmers in Pathumthani were pesticide exposure, musculoskeletal disorders, and injuries during various processes. For the injuries, the main causes were stepping on a shell (83%), injuries during operating hand tractor (38%), injuries from plow blades (35%), and injuries from the hand start of hand tractor (21%).

However, to date, no studies have focused on understanding which risk factors are associated with a higher prevalence of hand tractor injuries in rice farming. This study aims to describe the working conditions, as well as the hand tractor and worker characteristics associated with hand tractor injuries among Thai rice farmers. This information could be used by government agencies to develop policies and campaigns to reduce or eliminate hand tractor injuries and increase the efficiency of rice production in Thailand.

Material and methods

Population and sample recruitment

The population of this study was rice farmers in Ayutthaya Province where there were 17,837 farmer households registered with Department of Agricultural Extension (Information Technology and Communication Center 2016). However, this population also included hired farmers who were not residents of Ayutthaya province. The sample size was calculated for comparisons between farmers with and without hand tractor accidents using methods applied to clinical trials (Sullivan and Soe 2007). As a result, the goal was to recruit 400 farmers, assuming 10% would not complete the full survey. A convenience sampling method was used to recruit farmers *via* Agricultural Extension Office announcements in each district that asked the farmers to join the research. To avoid sample selection bias, we tried to recruit farmers from 15 of the 16 districts in Phra Nakhon Si Ayutthaya province equally (we did not include the provincial capital district which has very few rice fields). The data collection period was from June to December 2019. Our exclusion criteria were farmers with a sickness or disability that restricted them from doing the questionnaire including those who could not read or write the Thai language. Farmers had to have used a hand tractor in the last year for not less than 30 h. This research was reviewed and approved by the Board of Ethics in Human Research, Faculty of Public Health, Mahidol University (MUPH 2018–108).

Questionnaires

For this study, a questionnaire was developed by the researchers from related previous research questionnaires about agricultural injuries (Ibrahim 1999; Myers 2001). The questionnaire collected data on the personal demographics, current health problems, safety behaviors, and mechanical details of the hand tractor used. We also asked whether they

had had any hand-tractor-related injuries in the past 1 year and if so, the activity when the injury occurred, the specific cause of the injury, injury severity, and the body part injured. Moreover, we asked about the work environment conditions at the time of the injury. The questionnaire was reviewed by three experts from the Ministry of Agriculture and the index of item objective congruence (IOC) was calculated which was equal to 0.89. We also piloted the questionnaire with a small group of farmers in a non-study area and the questions were adjusted based on their comments.

Data collection and analysis

After informed consent had been signed, the face-to-face interview was administered by occupational health and safety graduate students who were trained in ethical human research and supervised by the lead researcher. The data from questionnaire were analyzed by the SPSS program version 18 (SPSS Co., Ltd., Bangkok, Thailand). The prevalence of injuries was calculated as the number of injured farmers divided by total number of farmers. The demographics of the farmers and their hand tractors were described by the mean, standard deviation, frequency, and proportion. The types of injuries and their causes, severity, body part injured and work environment characteristics when injuries occurred were described by their frequency and proportion. To investigate the association of hand tractor injures with various personal, hand tractor, and working condition risk factors we used a Poisson generalized linear model.

Results

Characteristics of farmers

From Table 1, the total sample of 377 farmers, most of them were men (71%), more than 30 years old (min–max was 15–85 and mean was 54). Most were educated at primary school and had worked with hand tractors for more than 10 years (min–max was 2–60 years and mean was 22 years). Most were non active consumers of alcohol and worked over 5 d/week, less than 8 h/d. They mostly worked with hand tractors covering land not more than 10 Rai/d (16,000 m²/d). In relation to the risk of injury, only stress related factors significantly increased the risk of injury. Farmers who had sleep problems, felt fatigue before work and had “hustle work” defined as the farmer reporting they had to work quickly to finish soil preparation before sowing the rice had 1.79, 2.28, and 1.90 times higher accident risk than farmers who did not report these risk factors. “Hustle work” occurs because the farmer puts rice seeds into water to germinate before planting, but they must be transplanted within 2 d or the rice seeds will be damaged.

Characteristic of hand tractors

Farmers were likely to purchase a brand new hand tractor rather than second-hand unit. Most of the hand tractors had been used for less than 10 years (66.5%) (Table 2). The most common size was more than 10 horsepower (hp) (93.4%). Farmers were more likely to use push type handlebars compared to squeezed type, which helps the farmer change tractor directions more easily. The handlebar length was commonly more than 2 m to help the farmers change direction and keep them away from tools attached to the rear of the motor. More of the tractors had single and forward only transmission (55.7%) compared to those

that included backward transmission. Farmers were likely to use their hand tractor in the wet rice fields to till and level the land with a rake or rotary paddler and a leveler. They did not typically use the hand tractor in dry fields because the land was too hard, instead using a large tractor to plow the dry soil. Most of the hand tractors reported having safety equipment (70.3%) which including pulley guard, blade guard, and wheel cover. In relation to the risk of injury, only farmers who reported normally using the leveler attachment on the hand tractor had a statistically significant increased risk of injury (1.91 times that of farmers who did not normally use the leveler).

Hand tractor safety behavior of farmers

Most of famers did not have any hand tractor training (89.4%) or even read the tractor manual before use (63.6%) (Table 3). However, most of them (67.3%) reported they always used PPE, e.g., face and nose covering cloth and hat. Also, they always inspected the hand tractor before using (88.8%) but did not often maintain it after use (86.9%). None of these hand tractor safety factors were significantly associated with an increased risk of injury.

Hand tractor related injuries

Of the 377 farmers interviewed, 148 farmers or 41% reported they had a hand tractor-related injury in the past year. From Table 4, the most common injured body part was the foot/toe (40.5%) followed by the leg (14.9%) and arm/shoulder or finger (11.5%). The most common type of injury was a cut (43.9%), followed by a bruise (29.7%), however, severe injury e.g. amputation was reported by 1.4% ($n = 2$ farmers) and fracture or crushing were 0.7% ($n = 1$), and 8.8% ($n = 13$) respectively. Most of the injuries occurred from stepping on a golden apple snail shell (33.1%), followed by the hand tractor handlebar hitting the body (12.8%) and overturning of the hand tractor (10.8%). Injuries mostly happened during the use of an attached rake (42.2%) or rotary paddler (23.3%). For severity, 83.8% of the injuries were self- treated by the farmer, with 8.8% going to the local public clinic and 6.8% to a hospital. Most of injuries were minor and non-hospitalized (93.8%) although 9 farmers (6.2%) required hospitalization.

When looking into the injuries in more detail (Table A1 in Appendix), most of the cut injuries that occurred on the foot were caused by stepping on Golden Apple Snail. Most of the bruises that occurred on the arm, shoulder, and chest were caused by being hit by the tractor handlebar. However, the cuts from stepping on the snails and bruises from handlebar were not severe and farmers just applied first aid and returned to work the same day. However, injuries such as crushing when clamped or pulled by the tractor pulley or belt could be severe including dismemberment.

Risk factors associated with hand tractor injuries

In multivariable analysis, we included all statistically significant risk factors that were identified in bivariate analysis of normal working conditions: sleeping problems, “hustle work”, feeling fatigue before work, and using leveler attached to plow (Table 6). The model revealed that only the normal use of the leveler as attached equipment was a significant factor in the risk of hand tractor injuries, after controlling for the other factors.

Discussion

Injuries among Thai rice farmers are an important problem that others have previously identified (Chino and Jiamjarasrangsi 2015; Yaruang and Sukonthasarn 2016; Buranatreveth and Sweatsriskul 2005). However, few studies have investigated the factors associated with the injuries from hand tractor use. In this study, we found some important trends for risk factors, even if they were not statistically significant. For example, in term of farmer characteristics (Table 1), younger farmers (<30 years old) and farmers with less experience (<10 years) seemed to be at higher risk of injuries than older or more experienced farmers. Gender, education, and alcohol consumption had no effect on injury risk. More working days per week tended to increase the risk (RR = 1.25) but the number of working hours per day and amount of working area plowed had no effect. In addition, this study suggests that farming is a stressful occupation resulting in sleeping problems and fatigue which have a significant impact on the risk of accidents. Farmers who had sleeping problems or fatigue before work were significantly more likely to report an injury (RR = 1.39, 1.60 respectively).

In this study, farmers who used hand tractors were more likely to be male, which has also been the case for studies looking at the use of all types of agricultural machinery (Suwanno 2008). Most of the farmers we recruited were older, with a mean age was 54 years, which was similar to other studies of Thai farmers (Nankongnab et al. 2020; Kongtip et al. 2018). That may be because most of the rural young people have left to work in the city and will only return to do agricultural work at the peak planting and harvesting seasons. Most of farmers had used hand tractors for more than 10 years, which agrees with their age, as most of them started to use hand tractors when they were young (Kaewthumnukul et al. 2020). Although not significant, we found that the risk of injuries was higher among younger farmers and those with less experience. A study by Saglam et al. (2017) also found that the majority of farm tractor and agriculture machinery victims were young (age 21–30 years old). Farmers who worked with hand tractors reported they worked less than 8 h/d as they usually start in early morning and work until around 2 p.m. when they go back home to rest. They work more than 5 d/week or every day until the plowing job is done because they have a very short time to finish before they put the rice seed into the paddy. Farmers report plowing around 10 Rai/d, although some studies have shown that the rotary paddler working capacity is about 2 Rai/h (Sutthiwaree et al. 2006). Most of farmers report that hand tractor work was stressful and intense and Kaewthumnukul et al. (2020) showed that rice farmers report experiencing stress/anxiety, fatigue and thirst, and bodily pain. In this study, farmers who reported “hustle work”, defined as farmers reporting they had to work quickly to finish the soil preparation process in order to plant germinating seeds, had significantly higher risk of injury (RR 1.48) (Table 1). Moreover, farmers are exposed to solar radiation, dust and vibration resulting physiological and psychological fatigue (Tiwari and Gite 2006). These things may contribute to the farmer fatigue, setting the stage for mistakes and accidents (Keskin 2019). To help prevent injuries, farmers need to be encouraged to take rest breaks while working and spread out heavy physical work over more days.

The age of most of the hand tractors in this study was still quite new (60% less than 10 years old), with more than 90% having engines more than 10 hp. Previous studies reported

most farmers favored smaller engines of less than 10 hp (Suwanno 2008). Farmers may favor these newer models of hand tractor with more power to finish their job faster. For the handlebar survey, farmers still use long and push type handle bars which are quite hard to turn compared to the squeeze type, which has an assisting mechanism to help make turning easier. For transmission types, the tractors were split between the older single transmission with a forward gear only and newer multi transmission with a backward gear. From the information above, it is clear that Thai rice farmers are in transition period between new and old models of hand tractors. Although now even newer models are available with even higher horsepower and benches for sitting which may again impact the types of injuries seen. This study also showed that farmers used rakes, rotary paddlers and levelers as attached drag equipment more than plow blades. They did not use hand tractors to plow the dry soil but used larger ride upon tractors instead. The dry soil or clay was too difficult to plow with a hand tractor (Khaehanchanpong et al. 2007). For the risk analysis of hand tractor characteristics (Table 2), this study showed that newer hand tractors (<10 years) were associated with more risk of injury, as was using a higher horsepower tractor. The type and length of the handlebar seemed to have no effect on the risk. For transmission type, a tractor with a single forward only transmission resulted in more risk than a tractor with an adjustable transmission including a backward gear. However, the association of the factors above with accident risk was not statistically significant. For attached equipment, only the normal use of the leveler was associated with a statistically significant increased injury risk (RR = 1.41).

Unlike previous work which found that 90% of hand tractors had no safety equipment (Suwanno 2008), we found that most (70%) of the hand tractors had safety equipment such as a plow blade guard and wheel covers. However, not all had belt and pulley covers, which is the most dangerous part of the hand tractor. Other studies have described that injuries usually occurred when the farmer did not have or removed these type of guards (Keskin 2019). For the analysis of hand tractor safety behavior (Table 3), farmers showed good safety behavior with 67% reporting they always wore personal protective equipment (PPE) and 89% reporting they always inspected the hand tractor before use. However, most of the PPE (hat, face and nose cover, long pants and shirts, and gloves) were primarily intended to prevent heat stress and radiation from sun. This aligns with other studies that show more than 80% of farmers always or sometimes use PPE especially long sleeves shirt, long pants and a cloth that covered their face and nose (Kaewthumnukul et al. 2020; Kongtip et al. 2018). However, most of them did not wear hearing protection even though some studies show farmers are exposed to time-weighted average noise levels of over than 90 dBA (Beheshti and Ghandhari 2015). Other studies have shown that the equipment inspection behavior of farmers is a normal habit (Kaewthumnukul et al. 2020). However, farmers rarely do maintenance after daily use. They just cleaned the hand tractor and planned to inspect it later. Farmers do major maintenance on their hand tractor after finishing the season in preparation for the next season. Most farmers reported that they did not read the manual that came with the hand tractor (Jongrungsakul et al. 2019). Most of them explained that they already knew how to operate the hand tractor very well. Moreover, farmers did not receive safety training from the tractor manufacturer (Jongrungsakul et al. 2019).

Government agencies should consider requiring manufacturers to include a training course as part of the purchase package.

This study showed 41% of farmers reported injuries during the use of a hand tractor in the field. This prevalence of injuries is quite similar to others who have reported that the combination of both non-severe and severe injuries of rice farmers in Thailand was 56%, where most of injuries occurred in the soil preparation process (Chino and Jiamjarasrangsri 2015). Table 4 analyzed the types of injuries that occurred while working with a hand tractor. We found that foot and leg were the major body parts that had injuries from hand tractor use, which aligns with many other studies which have shown foot injuries were the major problem of rice farmers (Keskin 2019; Kaewthumnukul et al. 2020). We and others have found that stepping on a Golden Apple Snail was a major cause of foot injuries (Yaruang and Sukonthasarn 2016). The next most common injury was bruising, which was most often caused by being hit by the tractor handlebar. This injury usually occurred when turning the hand tractor and handlebar rebounds hitting the body. This is supported by other studies of hand tractor accidents that found they frequently happen when turning the tractor (Hanchangchai 1996). This study showed that when a rake was the attached equipment injuries were increased (RR 1.08). Stepping on a snail shell may occur because when using a rake, the farmer had to walk in the field instead of sitting on a seat or standing board as may happen when using a rotary paddler or standing on a leveler. Farmers tend to be barefoot when having to walk in the field, explaining that boots get “stuck” in the paddy mud. This study also revealed farmers who report normally using a leveler as attached plow equipment had a statistically significant higher risk of injury (RR 1.47 in multivariable model). The leveler is normally used at the last step where the soil has been prepared, so the farmer will drive faster than using a rotary paddler, plow, or rake. Moreover, to use a leveler the farmer had to stand on the leveler board which may differ from other attached equipment where farmer will sit on a bench over equipment or walk behind. As a result, the farmer may easily lose their balance and fall from the equipment. Even though there were high number of injuries, most of them were minor injuries where the farmers could do self-treatment instead of going to a hospital or clinic. Other studies have also reported mainly minor injuries (Jongrungrotsakul et al. 2019; Chino and Jiamjarasrangsri 2015). In this study 16.3% of the injuries required a visit to the clinic or hospital (6% hospitalization) under the universal health care coverage scheme. Most of hospitalized injuries were caused by being clamped or pulled by tractor pulleys/belts, cuts by blades of attached equipment or being hit by the engine starting hand tool. Farmers especially mentioned injuries from the starter hand tool that easily came off when spinning the engine to start it.

There were several limitations related to this study. For example, the questionnaire asked about the farmer experience of injuries during the past 1 year and may have been subject to recall bias related to the time frame and details of the injury. Injuries were self-reported with no validation via medical records, even for those who reported treatment beyond home first aid. Also, if farmers had more than one injury, the questionnaire asked them to choose only the most severe one to answer in more detail, so the injury prevalence may be underestimated and the severity rate overestimated.

Based on this study, we recommend several changes in work practices that could reduce the risk of accidents when working with a hand tractor. First, we suggest that farmers always wear boots or other protective footwear to protect from cuts due to objects in the soil or from equipment. Getting plenty of sleep and avoiding rushing during land preparation would also help reduce accidents. Local Agricultural Extension Centers and Farmers Health Clinics could implement an educational campaign to encourage farmers to take these precautions. Equipment manufacturers should redesign the hand tractor leveler to reduce the risk of injury by removing the need for the farmer to stand on the leveler board (perhaps by developing a seated leveler) or developing other equipment to achieve this purpose.

Conclusion

Over 40% of Thai rice farmers reported injuries during use hand tractors in the field. The feet and legs were the major body part that was injured, most frequently by cuts caused by stepping on a Golden Apple Snail. The next most common injury was bruising from the handlebar hitting the body. Even though most of injuries were minor, accidents such as crushing when clamped or pulled by the tractor pulley or belt could be severe including dismemberment. Fatigue and sleeping problems and “hustle work”, defined having to finish the soil preparation process quickly increased the risk of injury from hand tractors as did the normal use of attached equipment on the plow such as the leveler.

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Appendix

Table A1.

The relationship between type of activities that resulted in injury while rice farming and type of injuries, body part injured and severity of injuries.

Type of activity that resulted in injury while rice farming	Type of injuries									Body part				
	Amputation	Bruises	Burns	Cut	Crush	Fracture	Sprain	Dizziness	Head/neck	Finger	Palm	Arm/shoulder	Chest	
Overturning	0	7	0	2	2	0	5	0	0	0	1	4	2	
Falling from hand tractor	0	5	00	10	2	0	0	1	0	1	1	1	3	
Clamped by a pulley or belt, or	2	7	0	1	1	0	0	0	0	9	0	1	0	

Type of activity that resulted in injury while rice farming	Type of injuries									Body part				
	Amputation	Bruises	Burns	Cut	Crush	Fracture	Sprain	Dizziness	Head/neck	Finger	Palm	Arm/shoulder	Chest/bod	
other rotating components														
Cut by stepping on Golden Apple Snails	0	2	0	47	0	0	0	0	0	1	0	0	0	
Cut by attached equipment	0	1	0	9	0	0	0	0	0	0	3	0	0	
Hit by another hand tractor	0	2	0	1	2	0	0	0	0	0	2	2	1	
Burn due to contact with hot surfaces	0	0	3	1	0	0	0	0	0	1	0	2	0	
Fainting due to heat	0	0	1	0	0	0	1	3	3	0	1	0	0	
Slips or trips	0	4	0	0	2	0	2	0	0	0	0	0	0	
Body hit by handlebar	0	9	0	0	4	1	5	0	0	0	0	6	5	
Finger squeezed by handlebar control rod	0	2	0	1	0	0	1	0	0	2	2	0	0	
Hit by starting hand tool	0	5	0	3	1	0	0	0	1	3	1	1	1	
Total	2	44	4	65	13	1	16	3	4	17	10	17	10	

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(a)



(b)



(c)



(d)

Figure 1.
The hand tractor with various attached equipment (a) plow Blade (b) Rake (c) Rotary Paddler and (d) Leveler.

Table 1.Farmer characteristics ($N = 377$) and bivariate analysis of risk factors associated with hand tractor injuries.

Categories	Total		Injuries		No injuries		RR	95%CI	p Value	
	N	%	N	%	N	%				
Gender										
Man	270	71.6	109	40.4	161	59.6	1	0.7	1.43	.999
Woman	107	28.4	43	40.2	64	59.8				
Age										
30 years	17	4.5	11	64.7	6	35.3	1.7	0.92	3.14	.090
>30 years	360	95.5	141	39.2	219	60.8				
Education										
Primary school	203	54	84	41.4	109	58.6	1.09	0.79	1.51	.586
Higher than primary school	174	46	68	39.1	106	60.9				
Hand tractor experience										
10 years	111	29.6	52	46.8	59	53.2	1.26	0.89	1.76	.182
>10 years	266	70.4	100	37.6	166	62.4				
Alcohol consumption										
Active drink	151	40.1	61	40.4	90	59.6	0.96	0.69	1.34	.830
Non active	226	59.9	91	40.3	135	59.7				
Number of working days per week										
5 d/week	156	41.7	55	35.3	101	64.7				
>5 d/week	218	58.3	95	43.6	123	56.4	1.25	0.89	1.75	.186
Number of working hours per day										
8h/d	322	85.6	127	39.4	195	60.6				
>8h/d	54	14.4	24	44.4	30	55.6	1.05	0.66	1.65	.835
Amount of working area										
10 Rai/d	259	68.9	105	40.5	154	59.5				
>10 Rai/d	118	31.1	47	39.8	71	60.2	.96	0.67	1.36	.815
Sleep problems										
Yes	112	30.4	56	50.0	56	50.0	1.39	1.07	1.79	.011**
No	257	69.6	91	35.4	166	64.6				
“Hustle work”^a										
Yes	177	47.5	87	49.2	90	50.8	1.48	1.14	1.90	.003**
No	196	52.5	64	32.7	132	67.3				
Feeling fatigue before work										
Yes	279	74.4	125	44.8	154	55.2	1.60	1.12	2.28	.009**
No	96	25.6	26	27.1	70	72.9				

^a“Hustle work” means having to work quickly to finish soil preparation before sowing the rice seeds. This is because the farmer can put rice seeds into water to germinate for a maximum of 2 d before planting.

** Statistical Significance at level .05

Table 2.

Hand tractor characteristics and bivariate analysis of risk factors associated with hand tractor injuries.

Categories	Total		Injuries		No injuries		RR	95% CI		p Value
	N	%	N	%	N	%				
Age of hand tractor										
10 years	250	66.5	109	43.6	141	56.4	1.37	.95	1.97	.088
>10 years	127	33.5	43	33.9	84	66.1				
Horse power										
10hp	25	6.6	9	36	16	64				
>10hp	352	93.4	139	39.5	213	60.5	1.10	0.56	2.15	.788
Type of handlebar										
Push type	229	60.9	93	40.6	136	59.4	1.02	0.79	1.32	.852
Squeeze type	147	39.1	59	40.1	88	59.9				
Length of handlebar										
2 m	120	31.9	48	40.0	72	60.0	1.02	0.78	1.34	.862
>2 m	256	68.1	104	40.6	152	59.4				
Transmission type										
Single transmission (Forward only)	210	55.7	88	41.9	122	58.1	1.16	0.90	1.50	.242
adjustable transmission (include backward)	167	44.3	64	38.3	103	61.7				
Attached equipment normally used										
Plow blade										
Yes	118	31.6	52	44.1	66	55.9	1.19	0.85	1.67	.302
No	255	68.4	97	38.0	158	62.0				
Rake										
Yes	288	77.0	118	41.0	170	59.0	1.08	0.79	1.47	.615
No	86	23.0	33	38.4	53	61.6				
Leveler										
Yes	159	42.2	75	47.2	84	52.8	1.41	1.10	1.81	.007**
No	218	57.8	77	35.3	141	64.7				
Rotary paddler										
Yes	203	54.1	74	36.5	129	63.5	.803	0.58	1.11	.181
No	172	45.9	77	44.8	95	55.2				
Safety equipment										
Yes	265	70.3	99	37.4	166	62.6				
No	112	29.7	53	47.3	59	52.7	1.24	0.91	1.79	.150

** Statistical Significance at level .05

Table 3.

Hand tractor safety behavior of farmers and bivariate analysis of risk factors associated with hand tractor injuries.

Categories	Total		Injuries		No injuries		RR	95%CI	p Value	
	N	%	N	%	N	%				
Hand tractor training										
Yes	40	10.6	18	45.0	22	55.0				
No	337	89.4	130	38.7	206	61.3	0.86	0.52	1.41	.548
Read manual										
Yes	136	36.4	51	37.5	85	62.5				
No	238	63.6	95	39.9	143	60.1	1.06	0.81	1.39	.647
PPE use										
Always	253	67.3	99	39.1	154	60.9				
Sometimes or never	123	32.7	49	39.8	74	60.2	1.02	0.72	1.43	.918
Inspection before use										
Always	334	88.8	133	39.8	201	60.2				
Sometimes or never	42	11.2	15	35.7	27	64.3	0.90	0.53	1.53	.689
Maintenance after use										
Always	49	13.1	26	53.1	23	46.9				
Sometimes or never	326	86.9	122	37.4	204	62.6	0.70	0.46	1.08	.106

Table 4.Hand-tractor-related injuries during working on farm ($N = 148$).

Characteristic of injuries	<i>N</i>	%
Injured body part		
Head/neck	4	2.7
Finger	17	11.5
Palm	10	6.8
Arm/shoulder	17	11.5
Chest/body	10	6.8
Back	1	0.7
Leg	22	14.9
Knee	3	2.0
Foot/toe	60	40.5
Mouth/teeth	4	2.7
Type of injuries		
Amputation	2	1.4
Bruises/blood hematoma	44	29.7
Burns	4	2.7
Cut	65	43.9
Crush	13	8.8
Fracture	1	0.7
Sprain/strain	16	10.8
Dizziness	3	2.0
Type of activity that resulted in injury while rice farming		
Overturning	16	10.8
Falling from the hand tractor	8	5.4
Clamped/pulled by a pulley or belt, or other rotating components	11	7.4
Cut by stepping on golden apple snails	49	33.1
Cuts by plow blades or other attached equipment	10	6.8
Hit by another hand tractor	5	3.4
Burns due to contact with hot parts of hand tractor such as engines, exhaust pipes	4	2.7
Fainting due to heat	5	3.4
Slips or trips	8	5.4
Handlebar hit the body	19	12.8
Handlebar control rod squeezed the finger	4	2.7
Hit by engine starting hand tool	9	6.1
Equipment attached to hand tractor when injured		
Plow blade	22	15.4
Rake	62	42.2
Leveler	18	12.3
Rotary paddler	34	23.3
Severity of injury		

Characteristic of injuries	<i>N</i>	%
No hospitalized	139	93.8
Admitted to the hospital for 1–3 d	2	1.4
Admitted to the hospital for >3 d	5	3.4
Amputation admitted to hospital >14 d	2	1.4
Treatment facilities		
Self-treatment	124	83.8
Sub-district health promoting hospital (primary care clinic)	13	8.8
District hospitals	6	4.1
Provincial hospital	4	2.7
Private clinic	1	0.7

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Table 5.

The multivariate analysis of risk factors associated with hand tractor injuries.

Farmers' self-reported normal working conditions	RR	95%CI		<i>p</i> Value
Sleeping problems	1.28	.90	1.81	.166
"Hustle Work"	1.34	.95	1.89	.098
Feeling fatigue before work	1.51	.953	2.394	.079
Leveler attached to plow	1.469	1.054	2.046	.023**

** Statistical Significance at level .05

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