Comparison of Alternative Methods with Intensive Method for Collecting insects and spider Data in Rice Field

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ABSTRACT

Diversity of arthropods in rice field is an important index for determining biodiversity, species richness and their balance. In order to collect data for calculating the biodiversity index, the conventional intensive method is not easy for general people because of its complexity. Hence, methods with fewer complexes that farmers can use for rapid health impact assessment need to be developed. This study aimed to compare the alternative methods for collecting arthropods data with the intensive method. A field experimental study was conducted in the wet and dry season during September 2007-April 2009. A sweep net sampling method was used to collect insects from three rice fields: untreated, treated with pesticide at recommended rate and double rate, in the following four methods: 1) Intensive method by the International Rice Research Institute, 2) Thai Farmer School method, 3) Randomly 3-points, and 4) Randomly 1-point in the centre of plot. Total of 19,200 samples were collected within 19,200 m^2 from the 12 sites of two northeastern provinces of Thailand. The species richness index (Esn) and the exponential Shannon index (exp H′) were computed by EcoSim. The Esn and exp H′ differences that were considered ecologically meaning. Sample sizes were equalized through rarefaction before comparison. Mean difference (MD) between groups with their 95% confident intervals were estimated using linear regression model. The results showed that Esn and exp H′ from the Thai Farmer School method was not significantly different from the Intensive method. This study demonstrated that the efficiency of Thai Farmer School method is comparable to the Intensive method, being easier, cheaper and more practical in farmer's opinion.

Key words: Rice field, Shannon-Wiener index, Rarefaction, Biodiversity

INTRODUCTION

Thailand has a strong tradition of rice production and is the world's top ranked rice exporters (10.22 million tons) in 2008. Moreover, Thailand has plans to further increase its land available for rice production, with a goal of adding 57.5 million rai to its already 58 million rai of rice-growing areas (AFSIS, 2009). The Thai Ministry of Agriculture expects rice production to yield around 529 kg/rai in wet season and 764 kg/rai in dry season for 2011 (AFSIS, 2009). Actually, in growing rice, pesticides may or may not be applied in rice field but pesticides are usually used for controlling pests such as brown planthopper *(Nilaparvata lugens)* (Escalada et al., 2009). Hence, the adverse effects arise from both direct and indirect human contacts (Huang et al., 2000). Especially indirect way, it impacts on diversity of plants, animals and microbe species (Ruayaree, 2002; Praneetvatakull and Waibel, 2006).

In order to collect data for calculating the biodiversity index and species richness, there are several intensive methods available including FARMCOP Suction machine (Cariño et al., 1979), Blower-vac machine (Arida and Heong, 1992), Yellow sticky trap, Water pan, Pitfall trap, Light trap, Yellow pan trap and Insect sweep net sampling method (International Rice Research Institute, 1981). Although highly efficient, these methods are difficult for general people due to their complexity, and some methods are expensive, labor- and time-consuming. Hence, other alternative methods which are more convenience to farmers and can be accepted by researchers in academics in sampling and collecting insects are needed to be considered.

Farmer school method, which was developed by Thai farmers, is a sweep net sampling method regularly used by farmers in Thailand. This method is relatively simple but its effectiveness has not yet been systematically evaluated. In this study, alternative sweep net sampling methods include Thai Farmer School Method that is more practical and cheaper than the intensive methods. In addition, the Thai farmer school method is more practical for farmer. Next, randomly 3-point method is currently used by academics in case of studying big area because of being time-saving and more comfortable to collect insects. Finally, randomly 1-point method in the center of the plot is the way that farmers tried to propose to collect insects in rice field because of being the most comfortable and the easiest method. Hence, the objective of this study was to develop alternative methods for collecting arthropods data and compare with the intensive method.

MATERIALS AND METHODS

Experimental sites

Six separate rice growing areas at Khon Kaen and Kalasin Province, Northeast of Thailand, were selected as experimental sites in the wet and dry seasons during September 2007-April 2009. Detailed descriptions of the experimental sites are presented in Table 1.

Table 1. Summary of experimental sites, Khon Kaen and Kalasin Provinces, Thailand

Sites	Location, elevation annual rainfall	Rain patterns	Cropping pattern	Sampling dates, plot size
Khon Kaen	17° 30′ N, 102° 25′ E 900 m above sea level 1,200 mm rain	Annual rainfall May-September	- Rice mixed with vegetables - Control Quantity of water by flowing open canal	*May 16-August 7, 2008 *(wet season)* *January 5-April 19, 2009 *(dry season)* 3,200 m^2
Kalasin	16° 26′ N, 103° 30′ E 152 m above sea level 1,200 mm rain	Annual rainfall May-September	- Rice mixed with vegetables - Control quantity of water by flowing open canal	*May 30-August 25, 2008 *(wet season)* *January 14-April 30, 2009 *(dry season)* 3,200 m^2

Sampling

Four methods of sweep net sampling, 1) Intensive method - the standard manual for testing insecticides on rice fields developed by the International Rice Research Institute, 2) Thai Farmer School method, 3) randomly 3-points, and 4) randomly 1-point in the centre of plot, were used to collect insects from the six rice fields under three pesticide treatments: untreated, treated pesticide at recommended rate and treated at double rate. Total of 19,200 samples were collected within 19,200 m^2 from the 12 sites, taken at weekly intervals. Sweep net sampling was replicated 10 times on each occasion at each site. Collected arthropods especially insects and spider were kept in vials of 70% ethanol. Samples in individual vial were sorted and counted together with farmers and then checked in the laboratory. The arthropods obtained from the samples were identified to species whenever possible. They were later grouped into guilds as used by Moran and Southwood (1982) and Heong et al., (1991).

Steps of collecting arthropods of 4 methods were as follows (see Fig. 1):

1) Intensive method (IM)

1.1 Hold the sweep net near the end of the handle;

1.2 Begin sweeping at the centre of the plot;

1.3 Swing the pole with both arms forming a semicircle. Keep the circular frame of the open end of the net perpendicular to the ground and pointing to the direction of the swing;

1.4 Walk normally and swing the net steadily, touching the leafy portion of the plant. Do not swing the net up and down. Close net opening as soon as sweeping action is completed;

1.5 Sweep 10 times per plot;

1.6 Put the collected insects in plastic bags and label with tags;

1.7 Keep in vials of 70% ethanol;

1.8 Identify and count the insects and spiders with farmers and in the laboratory.

2) Thai Farmer School method (THFM)

2.1 Begin sweeping at the margin of the plot to another;

2.2 Swing the pole with both arms;

2.3 Walk normally and swing the net steadily, touching the leafy portion of the plant;

2.4 Put the collected insects and spiders in plastic bags and labels with tags;

2.5 Put the insect and spiders bags in hot water;

2.6 Identify and count the insects and spiders suddenly with famers;

2.7 Keep in vials of 70% ethanol;

2.8 Identify and count the insects and spiders in laboratory.

3) Randomly 3-point method (TPM)

3.1 Hold the sweep net near the end of the handle;

3.2 Begin sweeping at the centre of the plot;

3.3 Swing the pole with both arms forming a semicircle. Keep the circular frame of the open end of the net perpendicular to the ground and pointing to the direction of the swing;

3.4 Walk normally and swing the net steadily touching the leafy portion of the plant. Do not swing the net up and down. Close net mouth as soon as sweeping action is completed;

3.5 Sweep 10 times per plot (from 4 corners and center of plot);

3.6 Put the collected insects and spiders in plastic bags and labels with tags;

3.7 Keep in vials of 70% ethanol;

3.8 Identify and count the insects and spiders with farmers and in the laboratory.

4) Randomly 1-point method- proposed from meeting with farmers (OPM)

4.1 Begin sweeping at the margin of the plot to another by three farmers per plot;

4.2 Swing the pole with both arms;

4.3 Walk normally and swing the net steadily, touching the leafy portion of the plant;

4.4 Put the collected insects and spiders in plastic bags and label with tags;

4.5 Put the insect and spiders bags in hot water;

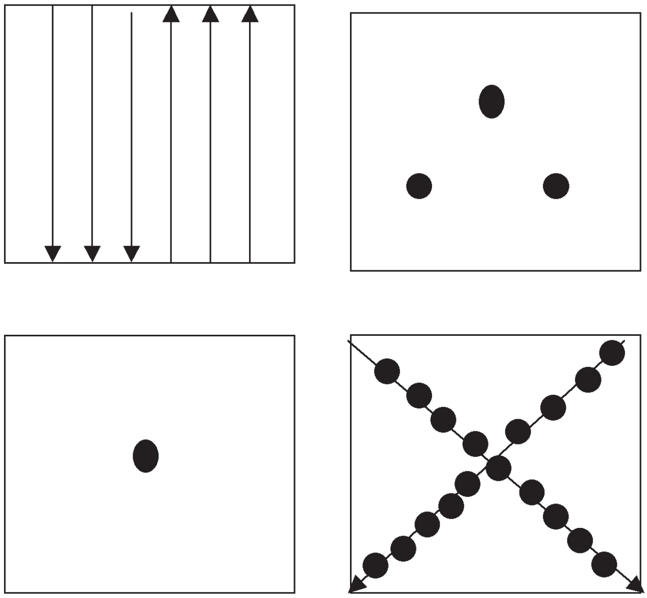
4.6 Identify and count the insects and spiders suddenly with famers;

4.7 Keep in vials of 70% ethanol;

4.8 Identify and count the insects and spiders in laboratory.

Thai Farmer School method

Randomly 3- points method



Randomly 3- points method

Intensive method

Figure 1. Four methods of collecting Arthropods

Insecticide application

Thiamethoxam 25% WG (Ac\tara®) was used to control insect pests in the sprayed rice field in the ratio of 10 grams per 20 litres of water (Maienfisch, 2006). Application timing was related to brown planthopper migration and at two stages of rice development. In wet season, the pesticide was first applied at vegetative stage in July 5, 2008 and then at reproductive stage in July 25 and July 31, 2008. In dry season the applications were done at vegetative stage in February 12, 2009 and at reproductive stage in March 10 and March 25, 2008.

Site Selection

Six sites were divided into three groups for Khon Kaen and Kalasin provinces as 1) untreated pesticide[1] or control group, 2) treated pesticide at recommended rate, and 3) treated at double rate. In group 2 and 3 various pesticides have been used thiamethoxam, cipermethrin, indoxacarb, monocrotophos on rice field more than 10 years. The reasons that we chose these sites because 1) there are both organic and conventional sites together. 2) there are good irrigation systems i.e. open canal that farmers can use water all the year. 3) these sites are continuously used for planting two times per year.

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[1]This site has stopped using pesticide for seven years and qualified as an organic farm under standard EU2092/91 No. CU 019946 for European countries and OMIC No. 1262 for Japan (2002- present) under which agricultural product are imported from European countries.

Quality control

1) Sweepers were well-trained with experience in the sweep method and insect identification.

2) The following factors were equally assigned to all experiment groups.

- Soil type: Silt-loam
- Fertilizer 15:15:15 (N:P:K)
- Fertilizer rate: 80 kg. per 1,600 m^2
- Type of rice cultivation: direct seeding
- Rice variety: KDML105
- Size of experimental area: 1,600 m^2
- Cultural practice: land preparation, seed germination

Data analysis

The indices that were used in this study were as follows:

1. Rarefaction

Rarefaction techniques were used to avoid sample size sensitivity by computing species richness. The less sample size sensitive indices with more discriminating abilities were used for comparison. The formula is as following:

$$Esn = \sum\left\{1 - \left[\frac{\binom{N-Ni}{n}}{\binom{N}{n}}\right]\right\}$$

Where E_{sn} = the expected number of species in the rarefied sample

n = standard sample size

N = the total number of individuals recorded in the sample to be rarefied

Ni = the number of individuals in the ith species in the sample to be rarefied

Remark: the term $\binom{N-Ni}{n}$ and $\binom{N}{n}$ are 'combinations' which are as follows:

$$\binom{N}{n} = (N!)/\ [n!*\ (N\text{-}n)!]$$

N! is a factorial. For example 4! = 4*3*2*1 = 24

2. Shannon diversity index (H′)

The formula for calculating the H′ is

$$H' = -\sum pi*\ln pi$$

Where *pi*, the proportional abundance of the ith species = *(ni/N)*

In calculating, exp H′, the exponential Shannon index, was transformed by taking exponential to Shannon-Wiener index before doing the comparison in order to provide more discriminating abilities (Magurran, 1988).

The functional biodiversity indices were analyzed using indices computed by EcoSim (Gotelli and Entsminger, 2005) -null model software for ecology.

Finally, mean difference (MD) between groups with 95% confident intervals was estimated by linear regression model.

RESULTS

The total of 4,830 arthropods were found in the experimental rice fields with intensive method which was a standard and could be sorted into 4 guilds as herbivores (41.57%), predators (23.98%), parasitoids (19.03%) and detritivores (15.42%) (Table 2). Although the number of herbivores or pests was very high in all method of collecting insects, the total number of beneficial insects and spiders including predators, parasitoids and detritivores was still higher than pests. It meant that the beneficial insects could control pests in these rice fields in both Khon Kaen and Kalasin provinces. During sorting, thrips, beetles and hoppers were found as the most herbivorous insects. The most of predaceous arthropods were spiders, hemipterans and beetles. The most of detritivorous arthropods were dipterans. According to this result, this rice field ecosystem was likely to be good for the food chain because it contained the beneficial insects especially predators and parasitoids, which are secondary consumers that feed on primary consumers. For example, lady beetle *(Micraspis discolor)* consumes brown planthopper *(Nilaparvata lugens)*, and long-jawed spider *(Tetragnatha spp.)* eats both green leafhopper *(Nephotettix virescens)* and white leafhopper *(Cofana spectra)*. These relationships created a balance among the remaining species.

All arthropods were collected by four methods as an intensive method, Thai farmer school method, randomly 3-point method, and randomly 1-point method. The results are shown in Table 2. The exp H′ and the E_{sn} of the arthropods guilds in Thai farmer school method were not significantly different from those indices in the intensive method and showed mean difference (MD) of the exp H′ and E_{sn} (rarefaction) of the overall arthropods guilds which was classified by functional group of arthropods.

The maximum of MD of exp H′ in intensive method andThai farmer school method was shown in detritivores between dry season and treated pesticide with double rate in Khon Kaen which was 0.32 (0.21 to 0.43); means (M) ± standard deviation (SD): 3.58 ± 0.29 and 3.26 ± 0.23, respectively. Indices of both of the randomly 3-point and 1-point method were significantly different from the intensive method. The maximum of MD was shown in herbivores between wet season and untreated pesticide in Khon Kaen which was 1.05 (0.99 to 1.11); M ± SD: 9.34 ± 0.32 and 8.29 ± 0.23, respectively, for randomly 3-point method, and the maximum of MD was 3.87 (3.72 to 4.02); M ± SD: 9.34 ± 0.32 and 5.47 ± 0.97, respectively; $p<0.001$ for randomly 1-point method (Table 3).

Regarding the E_{sn} (rarefaction), the maximum of MD in intensive method and Thai farmer school method was shown in parasitoids between wet season and untreated pesticide in Khon Kaen which was 0.3(-0.01 to 0.61); means (M) ± standard deviation (SD): 26.0 ± 1.03 and 25.7 ± 0.83, respectively; p=0.059. The maximum of MD of randomly 3-points and 1-point methods, was shown in pests between dry season and treated pesticide with recommended rate in Kalasin which was 4.1(3.11 to 5.09); M ± SD: 19.1 ± 0.74 and 15.0 ± 4.11, respectively; p<0.001 for randomly 3-points method, and the maximum of MD was 8.8(7.71 to 9.89); M ± SD: 19.1.6 ± 0.74 and 10.3 ± 4.57, respectively; p<0.001for randomly 1-point method (Table 3).

DISCUSSION AND CONCLUSION

The results showed that the distribution pattern of insects per hill of rice plant has a general tendency to be aggregated or contagious. Kuno (1963), Kuno and Dyck (1985) and Kusmayadi et al., (1990) studied the population of brown planthoppers (BPHS) in the paddy fields of Japan, Philippines, and West Java, respectively, and found to be of non-random distribution. This is because the adult BPHS lay eggs as egg masses and several egg masses may be successively laid on the same hill. It is understandable that the distribution of offsprings would become patchy, even though the initial distribution of their parents is random (Kuno, 1968, 1977).

There was a tendency that nymphs distribute themselves more contagiously than adults (Kuno, 1968; Kusmayadi et al., 1990) because of no permanent wings to fly. Among adults, the degree of aggregation was higher in macropters than in brachypters. This difference may be a consequence of the density-dependent manner of wingmorph determination. The proportion of brachypterous form among emerging adults would be higher in hills which have been occupied by a small number of nymphs whereas the macropterous form would become dominant among hills with high nymphal density (Kisimoto, 1965; Kusmayadi et al., 1990; Barclay, 1992). These reasons were supported by the results from randomly 1-point and 3-points methods which showed relatively wide range of 95% CI of E_{sn}. The pattern of E_{sn} was unpredictable. It was low when farmers swept net in contagious hills of rice plant with facing adult stage so they could fly to the other hills. But sometimes E_{sn} was high when sweepers faced the aggregated hills with nymph and brachypterous stage. Hence, both randomly 3-point and 1-point methods were significantly different from the intensive method which E_{sn} was quite contagious. In the same ways, E_{sn} was contagious in Thai farmer school method which looks like intensive method because farmers could randomly sweep net in all rice fields.

In aspect of ecological meaning of the E_{sn} difference, three ecologists, 1) Assist.Prof.Dr. Adcharaporn Pagdee 2) Assist. Prof. Sam-ang Homchurn and 3) Dr. Kong Luen Heong, said that this difference was small and acceptable in Thai farmer school method but it was much different in randomly 3-point and 1-point method because 1) It's possible that farmers swept insects at different growing

Table 2. Comparison of methods of collecting arthropods by using exp Shannon-Wiener index and species richness in rice field in 2 provinces

Methods	Exp H′[1]			E_{sn} (rarefaction)[1]		
	Mean ± SD (adjusted)	**MD[2]**	**95% CI of MD**	**Mean ± SD (adjusted)**	**MD[2]**	**95% CI of MD**
1) Herbivores				**N = 1630**		
- Intensive method (n = 2008)	8.18 ± 2.70	0		32.72 ± 14.72	0	
- Thai farmer school method (n = 2025)	8.37 ± 2.79	-0.19	-0.36 to -0.02	32.69 ± 14.69	0.03	-0.98 to 1.04
- Three point method (n = 1818)	7.80 ± 2.73	0.38	0.21 to 0.55	32.18 ± 15.11	0.54	-0.48 to 1.56
- One point method (n = 1630)	6.95 ± 2.62	1.23	1.06 to 1.40	30.83 ± 15.84	1.89	0.84 to 2.94
2) Predators				**N = 843**		
- Intensive method (n = 1158)	8.37 ± 3.69	0		25.52 ± 15.75	0	
- Thai farmer school method (n = 1108)	8.33 ± 3.68	0.04	-0.26 to 0.34	25.5 ± 15.77	0.02	-1.49 to 1.53
- Three point method (n = 965)	8.03 ± 3.63	0.34	0.03 to 0.65	25.03 ± 15.71	0.49	-1.01 to 1.99
- One point method (n = 843)	7.39 ± 3.45	0.98	0.66 to 1.29	24.06 ± 14.87	1.46	-0.003 to 2.92
3) Parasitoids				**N = 637**		
- Intensive method (n = 919)	7.95 ± 3.36	0		17.46 ± 11.74	0	
- Thai farmer school method (n = 846)	8.28 ± 3.59	-0.33	-0.65 to -0.01	17.4 ± 11.75	0.06	-1.23 to 1.35
- Three point method (n = 802)	8.08 ± 3.54	-0.13	-0.46 to 0.19	17.22 ± 11.72	0.24	-1.05 to 1.53
- One point method (n = 637)	7.39 ± 3.39	0.56	0.22 to 0.90	16.52 ± 11.46	0.94	-0.34 to 2.22
4) Detritivores				**N = 575**		
- Intensive method (n = 745)	4.72 ± 1.86	0	13.29 ± 5.71	0		
- Thai farmer school method (n = 721)	4.69 ± 1.85	0.03	-0.16 to 0.22	13.3 ± 5.67	-0.01	-0.66 to 0.65
- Three point method (n = 650)	4.35 ± 1.70	0.37	0.18 to 0.56	12.95 ± 5.89	0.34	-0.33 to 1.01
- One point method (n = 575)	3.84 ± 1.79	0.88	0.68 to 1.08	12.43 ± 5.92	0.86	0.19 to 1.53

[1]Analyzed by EcoSim (Gotelli and Entsminger, 2005)
[2]MD=Mean Difference after rarefaction
Remark: n in Table 2 showed number of all insects and spiders.

Table 3. Highlight of maximum of mean difference in alternative methods comparing with intensive method under every conditions by using exp H′ and E_{sn} (rarefaction) in rice field

Methods	Exp H′[1]				E_{sn} (rarefaction)[1]		
	n	**Mean ± SD (adjusted)**	**MD[2]**	**95% CI of MD**	**Mean ± SD (adjusted)**	**MD[2]**	**95% CI of MD**
1) Herbivores		***In wet season*** **Khon Kaen province Untreated site**			***In wet season*** **Khon Kaen province Untreated site** (n = 115)		
- Intensive method	193	9.34 ± 0.32	0		22.2 ± 0.63	0	
- Thai farmer school method	204	9.46 ± 0.41	-0.12	-0.19 to -0.05	22.3 ± 0.67	-0.1	-0.27 to 0.69
- Three point method	152	8.29 ± 0.23	1.05**	0.99 to 1.11	22.3 ± 0.48	-0.1	-0.25 to 0.06
- One point method	115	5.47 ± 0.97	3.87**	3.72 to 4.02	19 ± 3.9	3.2	2.47 to 3.93
2) Predators					n = 108		
- Intensive method	135	6.37 ± 0.19	0		53.7 ± 0.48	0	
- Thai farmer school method	127	6.12 ± 0.53	0.25	0.15 to 0.34	53.8 ± 0.42	-0.1	-0.27 to 0.69
- Three point method	129	6.13 ± 0.28	0.24	0.18 to 0.29	52.4 ± 1.5	-0.1	-0.25 to 0.06
- One point method	108	4.19 ±1.81	2.18	1.87 to 2.48	45.8 ± 4.29	3.2	2.47 to 3.93
3) Parasitoids					n = 70		
- Intensive method	132	6.37 ± 0.19	0		**26.0 ± 1.03**	**0**	
- Thai farmer school method	126	6.12 ± 0.53	0.25	0.15 to 0.34	**25.7 ± 0.83**	**0.3***	**-0.01 to 0.61**
- Three point method	125	6.13 ± 0.28	0.24	0.18 to 0.29	25.8 ± 0.42	0.2	-0.06 to 0.46
- One point method	70	4.19 ±1.81	2.18	1.87 to 2.49	22.1 ± 2.69	3.9	3.22 to 4.58

[1]Analyzed by EcoSim (Gotelli and Entsminger, 2005)
[2]MD=Mean Difference after rarefaction
* The maximum of MD in Farmer school method comparing with intensive method by using both exp H′ and E_{sn} (rarefaction)
** The maximum of MD in randomly 3-points method and randomly 1-point method comparing with intensive method by using both exp H′ and E_{sn} (rarefaction)
n = number of arthropods in rice field
Remark: n in Table 3 showed number of insects and spiders in specific condition which showed highlight of maximum only.

4) Detritivores					n = 63		
- Intensive method	68	3.53 ± 0.27	0		22.3 ± 0.82	0	
- Thai farmer school method	67	3.50 ± 0.28	0.03	-0.06 to 0.12	22.2 ± 1.03	0.1	-0.23 to 0.43
- Three point method	65	3.39 ± 0.32	0.14	0.04 to 0.24	22.0 ± 0.94	0.3	-0.01 to 0.61
- One point method	63	1.28 ± 0.35	2.25	2.14 to 2.36	20.3 ± 2.58	2	1.32 to 2.68
1) Herbivores		***In dry season,* Khon Kaen province -Treated site with double rate**			***In dry season,* Kalasin province -Treated site with recommended rate** n = 202		
- Intensive method	173	7.43 ± 0.21	0		**19.1 ± 0.74**	**0**	
- Thai farmer school method	171	7.42 ± 0.21	0.01	-0.03 to 0.05	19.2 ± 0.42	-0.1	-0.22 to 0.02
- Three point method	165	7.23 ± 0.13	0.2	0.16 to 0.24	**15.0 ± 4.11**	**4.1****	**3.11 to 5.09**
- One point method	159	7.14 ± 0.24	0.29	0.24 to 0.34	**10.3 ± 4.57**	**8.8****	**7.71 to 9.89**
2) Predators					n = 50		
- Intensive method	45	7.39 ± 0.17	0	14.5 ± 0.71	0		
- Thai farmer school method	31	7.33 ± 0.16	0.06	-0.02 to 0.14	14.6 ± 0.52	-0.1	-0.35 to 0.15
- Three point method	24	7.19 ± 0.14	0.2	0.12 to 0.29	13.9 ± 0.86	0.6	0.29 to 0.91
- One point method	19	7.17 ± 0.14	0.22	0.13 to 0.31	13.9 ± 1.45	0.6	0.15 to 1.05
3) Parasitoids					n = 61		
- Intensive method	38	7.30 ± 0.16	0		14.4 ± 0.69	0	
- Thai farmer school method	26	7.24 ± 0.15	0.06	-0.02 to 0.14	14.3 ± 0.67	0.1	-0.14 to 0.34
- Three point method	35	7.36 ± 0.14	-0.06	-0.13 to 0.01	14.2 ± 0.92	0.2	-0.09 to 0.49
- One point method	22	7.17 ± 0.24	0.13	0.03 to 0.23	14.1 ± 1.10	0.3	-0.02 to 0.63
4) Detritivores					n = 31		
- Intensive method	54	3.58 ± 0.29	0		13.5 ± 0.71		
- Thai farmer school method	43	3.26 ± 0.23	0.32*	0.21 to 0.43	13.4 ± 0.52	0.1	-0.13 to 0.33
- Three point method	40	3.11 ± 0.17	0.47	0.37 to 0.57	13.3 ± 0.95	0.2	-0.11 to 0.51
- One point method	31	3.07 ± 0.21	0.51	0.39 to 0.63	13.0 ± 1.33	0.5	0.11 to 0.89

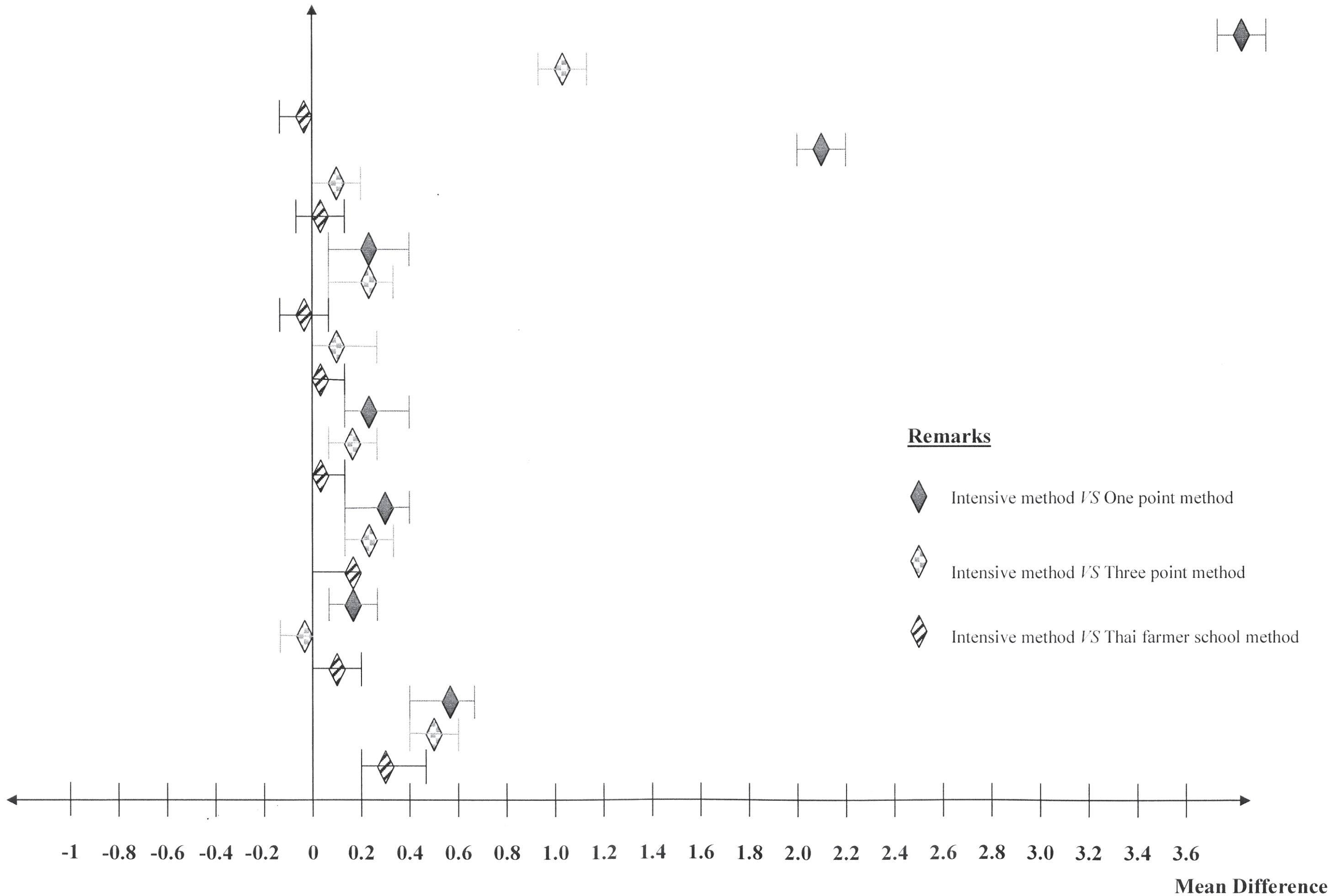

Figure 2. Highlight of mean differences of methods of collecting arthropods by using exp Shannon-Weiner index in rice field

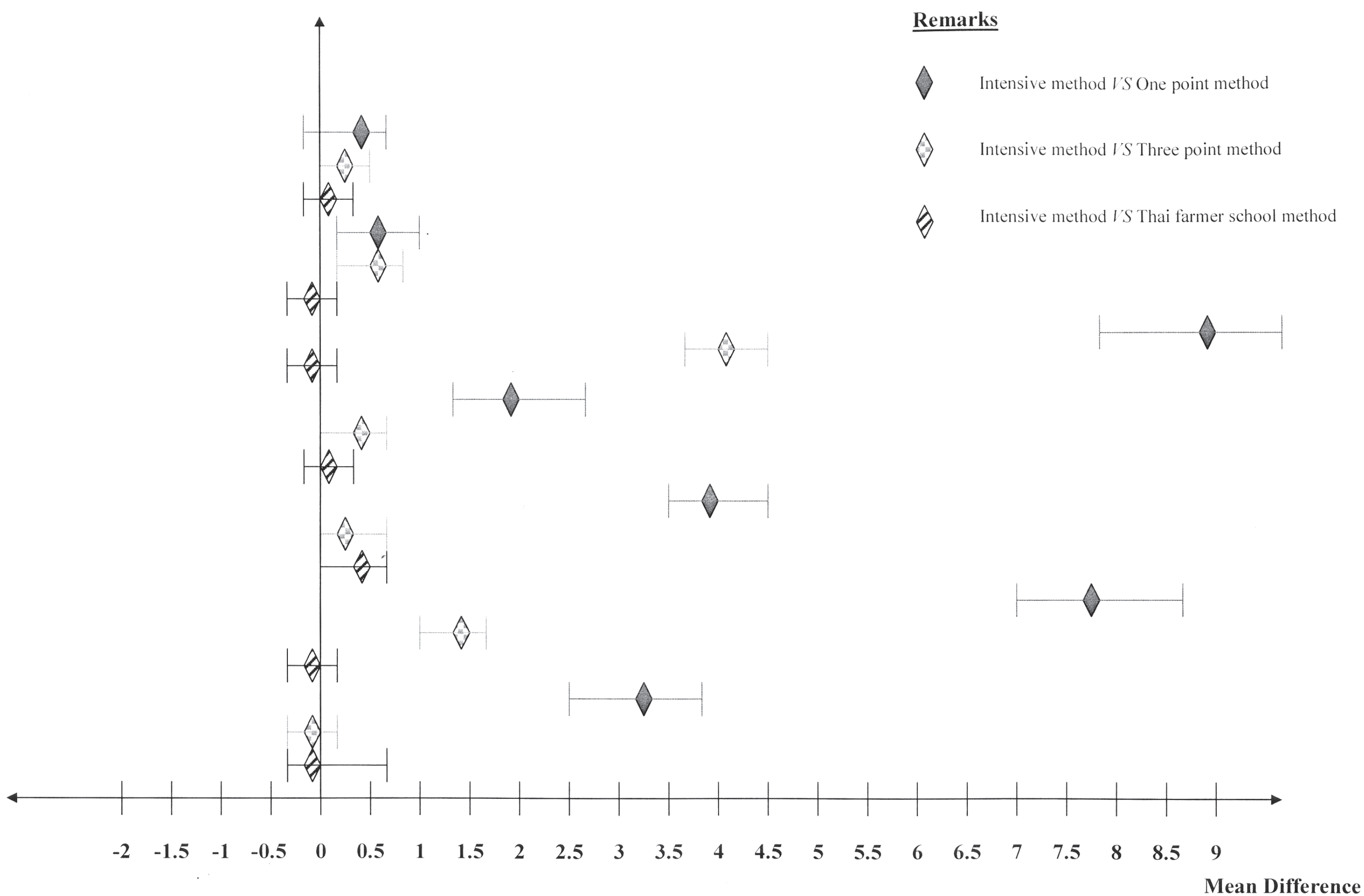

Figure 3. Highlight of mean differences of methods of collecting arthropods by using E_{sn} (rarefaction) in rice field

stages on the same rice hills for randomly 3-point and 1-point methods so there was no pattern of E_{sn}; 2) If the farmers swept aggregated hills, the E_{sn} will be high. If it is not, E_{sn} will be low. Hence, it would be better if the farmers used Thai farmer school method that would sweep insect many times and in all areas to ensure that farmer would face both aggregated and contagious hills.

In terms of species richness; E_{sn} (rarefaction) from previous study of Heong et al., (2005) entitled “the changes in pesticide use and arthropods biodiversity at IRRI research farm” in 1989 and 2005 following IPM policy, the arthropods were obtained by insect sampling equipment, one type of intensive methods. They showed that E_{sn} and exp H′ increased after reducing pesticide in rice field as follow: in 1989, E_{sn} of herbivores, predators, parasitoids and detritivores were 13.6, 37.6, 17.1 and 5.6., respectively. In 2005 after conducting IPM policy, E_{sn} increased and were 36.0, 65.0, 38.0 and 30.0, respectively. The data of exp H′ in 1989 and 2005 also showed the same tendency.

Moreover, the farmers expressed their opinions after collecting insects and spiders that they concerned about the distance and steps of walking that were not stable and also worried about whether they walked straightly or not for the intensive method. Regarding Thai farmer school method, it was convenience, not expensive, and they could make friends with other farmers who had rice fields close to theirs. They could share idea when facing problems and felt happy when they had activities together. This method was easier way to collect arthropods in their community. Therefore, the farmer school method is an alternative due to reasons that it’s simpler, cheaper and more practical as compared to the intensive method.

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