# CHAPTER V

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Conclusions

The important findings from the investigation of non-occupational pesticide exposure among 2-5 years children living in Bang Rieng vegetable farm community can be hierarchical concluded as follows.

1. The most crucial findings indicated that the potential non-occupational exposure pathways for the farm children consisted of four pathways including soil ingestion, hand mouthing, soil dermal contact, and surface residue contact. The average daily dose (ADD) estimated from hand mouthing route appeared to be the highest average level following by surface residue contact, soil ingestion, and soil contact, respectively.

2. Seasonal pesticide spraying was found to be an important factor of non-occupational pesticide exposure for the farm children. Pesticide spraying during the dry season most likely contributed to the children's overall pesticide exposure. In addition, the farm children were likely to have higher non-carcinogenic hazard of total exposure to OP pesticide than the reference children.

3. The farm children were found to be concerned for non-carcinogenic hazard of total exposure to OP pesticide with the total exposure hazard index (HI) of 1.51 above the acceptable index of unity. Considering the individual risk, the total exposure HI at high-end levels ranged from 2.83 to 3.44, indicating a great potential for adverse non-carcinogenic health impact to the farm children.

4. Based on biomonitoring data, the farm children were found to excrete the average concentrations of total dialkylphosphate (DAP) metabolites in their urine

during the dry season higher than excreting in the wet season (26.2 and 9.6 μg/g creatinine, respectively). There was no significant difference for the total DAP metabolites in the urine of the reference children across seasons (9.3 and 9.8 μg/g creatinine, respectively).

5. Household proximity to farmland was an important factor of the difference in the levels of DAP metabolites for the participating children. Decreased levels of DAP metabolites were found in children living farther away from the farmland. The highest the mean of total DAP metabolites in urine was found in the farm children who lived inside the fields, followed by the farm children living nearby the fields, whereas the reference children living outside the farmland had the lowest levels of total DAP metabolites.

6. Biologically based doses estimated from attribution of DAP metabolites related to each parent OP pesticides were also presented here. The finding supported the assumption of the study that the farm children were likely to have potential hazard from OP pesticide exposure through all routes higher than the reference children.

7. According to environmental and personal monitoring, OP pesticides of interest (dicrotophos, chlorpyrifos, methyl parathion, and profenofos) were found to be higher frequency of detection in all environmental and personal media of interest for the farm children than those of the reference during the dry season. The results also found that dicrotophos and profenofos were predominant OP pesticides which apparent in soil, floordust, and dermal wipe samples for the farm children during the dry season.

8. Children's activity information indicated that mouthing behaviors (both hand-to-mouth and object-to-mouth) significantly decreased with increasing age. Playing with dirt or soil activity found to be exhibited by older children rather than younger. For the farm children, most of the 3-5 year old children reportedly exhibited high percentage of specific behaviors related to pesticide exposure in the farm such as

walking and playing on the farm, walk barefeet on the farm, or accompanying with parents working into the farm.

9. Multiple regression analysis showed that the levels of dicrotophos measured on hands and profenofos on feet were significantly associated with increasing the levels of urinary metabolite ($p=0.006$). Some children's activities, putting hand into the mouth, playing in the field, and walking barefeet outside home, were significantly associated with the total of DAP metabolite concentrations for the farm children ($p=0.004$).

10. Frequencies of detectable of dicrotophos and profenofos in floordust were significantly correlated to the children's household construction during the dry season. It indicated that high levels of non-occupational pesticide exposure might be expected in the children living in temporary house construction rather than those living in the house with the permanent construction.

11. Considering the reference children, It can be noted that the reference children were likely to have less overall pesticide exposures compared to the farm children. The risk estimates also indicated that the non-carcinogenic hazards through soil ingestion, hand mouthing, soil contact, and surface residue contact did not appear to be a problem for them.

## 5.2 Work Limitations

1. A small number of detectable samples for some pesticides limited the analyses of the data. It can be noted that there was a wide variability of OP pesticide measurements for each child, resulted in the lack of correlation of OP pesticide in each environmental or personal media and urinary OP metabolite in the regression analysis.

2. Cross-sectional investigation was limited the determination of the correlation between environmental measurement and biological monitoring because of high variability within subject.

3. Child's activity reported by the parents was limited. The determinants of exposures with self-reported and recall may not reflect actual determinants. Therefore, the trends presenting needed to be interpreted with caution.

**5.3 Contributions of this work**

The results of this study presented the evidence of non-occupational exposure to OP pesticides among children living in an agricultural area as a small part of Thailand. Despite children's pesticide exposures have been addressed in several researches, most of them were conducted in the developed countries. This study, therefore, is an initial research that can provide the information or guidance to investigate the pesticide exposure among children in different agricultural settings in Thailand. Some of site-specific parameters relevant children's characteristics were estimated based on the default values for Thai children (e.g. age-specific body weight, skin surface area, and urine volume) so that this children's exposure could be representative for Thai children. The risk information obtained from this study can be further useful for risk management and risk communication performing in Bang Rieng agricultural community, and also provides baseline information served for initial making of local policy decision relevant to children's health risk. The risk management can be taken by considering to four processes as follows:

a) Risk Evaluation: This study has identified the potential non-carcinogenic hazard for the farm children. Hand-to-mouth exposure and surface residue contact were the predominant exposure pathways of concern, couple with the farm children frequently exhibited activities or behaviors relevant to the pesticide exposures. In addition, high pesticide spraying during the dry season contributed the overall pesticide exposures for the children.

b) Option Assessment:

- A child protection strategy is the main consideration in risk mitigation. Children should be protected from directly contacting with contaminated media by performing hygienic practices frequently (e.g. washing their hands and bathing, wear shoes when walking outside, or house cleaning). As indicated that the farm children exhibited frequent activities or behaviors relevant to pesticide exposures. Therefore, the parents should be urgent concerned in changing their child's behaviors which significantly related to the OP exposures.

- Risk communication approach is also used to return the risk information indicated by the findings to the exposed children or their parents in order to exchange the information and opinion among the participants or local organizations. The communication would lead to decisions, actions, or policies at controlling children's health risk. It can also help to promote changes in individual behaviors of children such as hand-to-mouth, contact to contaminated surface.

c) Option Implementation:

To reduce non-carcinogenic hazard for children living in the vegetable farm area, several local organizations must be involved. Children's parents should be mainly informed the risk information. Risk assessors and risk communicators should provide or develop the implementation of basic training to staffs of local health care, volunteers, and children's parents so that they can identify risk and improve their knowledge of environmental risk for the children. Farm workers should also be advised and convinced to change their pesticide application, such as using less toxic chemicals, or involving in IPM agricultural system.

d) Monitoring and Review:

Personal and biological monitoring need to be continually carried out in order to observe the levels of OP pesticide residues directly contacted to the children that could be decreased after the risk management has been taken.

**5.4 Recommendations for future work**

1. To date, studying in children's pesticide exposure is still little known particularly in Thailand. The information on pesticide exposure among children in other farm communities is limited. It is essential to investigate more in order to better understand the evidence of children's exposures and to explore the strategies for reducing such exposures.

2. This study focused only the pesticide exposure for preschool children. Exposure assessment based on age-specific developmental stage such as infant, toddle, and school age children would be needed, because the difference in their activities could be given the difference exposures and risk estimates.

3. In assessing children's behaviors, direct observations should be used in combination with parental-reports in order to provide more effective information.

4. Determination of urinary OP metabolites in general children population would be needed because it could be used as the acceptable level in comparing to the exposed children.