5. CONCLUSIONS

Organochlorine residues in eggs from free-range hens can be one of the most efficient bio-parameters used for biomonitoring programs of organochlorine residues in in the environment surrounding the hens' living space. There are several factors affecting pesticide bioaccumulation in hens' eggs. The findings in this study suggest that these could be the age and variety of hens, and especially the pesticide contents in hens' diet. However, due to lack of replication in this study, further detailed researches are recommended to determine which is the major factor as well as reveal other factors not included in this study ,e.g. factors owing to ecological and biological variability, and pesticide accumulation ratio.

In 64 domestic hens' eggs collected from Mae Rim, Hang Dong, San Kampaeng and Muang Districts, residues of eight organochlorine pesticides were detected in the following order of frequency: p,p'-DDE (in 100% of egg samples), p,p'-DDT (94%), p,p'-DDD and o,p'-DDT (88%), o,p'-DDE (77%), dieldrin (50%), cis-heptachlor epoxide (23%) and o,p'-DDD (19%). No residues of HCB, heptachlor, α-BHC, β-BHC, lindane, endrin, α-endosulfan, β-endosulfan, endosulfan sulfate were found. While the mean levels of dieldrin and cis-heptachlor epoxide residue were lower than the ERL, forty percent of the eggs exceeded the ERL of WHO for total DDT. Eggs surveyed from Mae Rim and Hang Dong are considerably more contaminated with DDT and its derivatives than those from Muang and San Kampaeng Districts ($p<0.001$). When the eggs were grouped according to areas or land-use type, the highest mean and individual values of total DDT residue were found in eggs from forestry and mountainous areas. The levels were lower in city areas ($p<0.01$). These findings indicate the extensive and intensive use of DDT in public health programs and for agricultural purposes in the study areas.

The ratio of p,p'-DDT to p,p'-DDE was found to be highest in Mae Rim District, followed by that in Muang, Hang Dong and San Kampaeng Districts. The high ratio was also found in the study areas where DDT is still in use ($p<0.01$). This ratio can be a good bio-index which demonstrates the current use of DDT in the study areas and it, therefore, can be applied in long term biomonitoring programs of DDT residues in the environment.

The mean amount of total DDT residue in eggs from free-range hens in Chiang Mai suburban areas in this study appeared to be higher than any reported level from other countries. More alarming, these levels were three times higher than the ERL of WHO and even exceeding the MRL of Thailand. Though these eggs may not be produced numberlessly and consumed directly by the villagers, the potential risk of DDT exposure to humans living in these areas should be strongly considered. Thus, there is a need to review the use of DDT, at least in parts of Thailand. Whether or not these compounds should be completely banned immediately is less easy to say. However, their importance in the control of vector-borne diseases and for improving food production has to be weighed against risks and adverse effects. Using another alternative pesticide which is safer to humans and the environment, environmental sanitation improvement, public education, training on properly pesticide application process were all necessary. The implementation of integrated pest management should be enhanced.

What future researchers are recommended to do include the following: (i) continue the long term biomonitoring programs of organochlorine residues in these areas by using the eggs from free-range hens as bio-samples; (ii) enlarge areas surveyed; (iii) study on organochlorine residues in human tissues (e.g. blood, breast milk) of people living in the high risk areas; (iv) construct a map showing the risk of organochlorine residues in the environment as well as the potential risk of organochlorine exposure to humans in Thailand.