CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The conclusion from this study can be drawn as follows:

5.1.1 Soil properties

Soil properties of seventy eight soil samples including soil pH, organic matter content (OM) and oxidation-reduction potential (ORP) the results obtained: soil pH varied from 5.79 to 8.07; organic matter contents (OM) ranged from 0.52 to 4.16 %; oxidation-reduction potential (ORP) ranged from -291.1 to 347.9 mV, respectively. The mean value of soil pH in this area is 7.29 and median value is 7.34 showing a mildly alkaline pH and suggested that the parent material in this area is calcareous soil

5.1.2 Cadmium and Zinc in soil

Total concentrations of Cd by total digestion, varied from 0.8819 to 291.36 mg/kg while the mean Cd concentration of four different single extraction procedures are 4.59, 3.44, 1.39 and 1.03 mg/kg for the BCR1, EDTA, DTPA and $CaCl_2$, respectively. It can be seen that from different method of extraction, available Cd in soil are in order of BCR1 > EDTA > DTPA > $CaCl_2$ due to BCR1 was the strongest extractant while $CaCl_2$ is the weakest extractant. For Zinc, the mean total concentration of Zn is 528.48 mg/kg while the same trend as in Cd concentration was found for the available Zn obtained from the four methods, BCR1, EDTA, DTPA and $CaCl_2$, (132.08, 66.19, 19.51 and 2.09 mg/kg, respectively).

5.1.3 Cadmium and Zinc in sugarcane

The average concentrations of Cd in each parts of sugarcane followed the descending order: root > top > underground > bagasse > leave > juices, which are 5.1919, 1.5244, 1.4081, 1.1986, 1.0991 and 0.2289 mg/kg, respectively.

For Zn, the average concentrations in sugarcane are found the highest value in top part at 79.7031 mg/kg and followed by, root > underground > leave > bagasse and juice which are 61.51, 47.43, 36.23, 23.76, 4.5255 mg/kg, respectively where juice showed the lowest for both Cd and Zn.

In the present study, the accumulation of Cd and Zn and their distribution in the sugarcane were found different. From the results, the concentration of Cd in root is higher than in other parts, which may be due to the metal toxicity, complexation and structures in sugarcane and unavailable for translocation to other parts. In contrast, Zn concentration found the highest in top may be due to Zn is an essential element in maintaining plants growth. Then, the concentration of Cd and Zn in each parts of sugarcane are averaged in whole sugarcane by ratio of dry weight. The results showed the mean value of Cd concentration was 0.5813 mg/kg and Zn concentration was 14.8488 mg/kg. This result can be ascribed to their ratio of each part in whole sugarcane affect Cd and Zn concentration in sugarcane.

In this study, the amount of Cd and Zn accumulated in each part as compared to in the whole sugarcane was determined. The results revealed that bagasse showed the highest amount of both Cd and Zn (0.1638 and 2.7550 mg, respectively). The reasons for this were mainly ascribed to Cd and Zn are accumulated in sugarcane depended on ratio of each part in whole sugarcane. Overall, the amount of Cd has shown following order: bagasse > juice > leave > top > underground and root. For Zn has shown following order: bagasse > leave > juice > top > underground and root.

5.3 Correlation analysis

The correlation coefficient analysis was performed by bivariate technique using SPSS version 11.5. Normal distribution of the data has been investigated by non-parametric test and the results showed that all p value was less than 0.05. In this case, Spearman correlation coefficient was determined by correlating total metal contents in soil and sugarcane with extractable metals from soil by four different extraction procedures.

From the results, the significant positive ($p < 0.01$) correlation of total Cd in soil between BCR1, total Cd-EDTA, and total Cd-DTPA were existed ($r = 0.663^{**}$, $r = 0.935^{**}$ and $r = 0.628^{**}$, respectively), meaning that these three single extractant were correlated with the total Cd in soil. EDTA showed the highest correlation coefficients, indicating the most suitable method under this study. However, the correlation non-significant and weak positive between total Cd in soil and $CaCl_2$ was obtained ($r = 0.227$).

For Zn, the correlation analysis between the total Zn concentration in soil and the extractable Zn by four single extractants showed significant positive ($p< 0.01$) correlations at 99% confidence level (except for in case of total Zn- $CaCl_2$). Results showed the same trend as for Cd in which the positive significant relationships between total Zn and BCR1, total Zn-EDTA and total Zn-DTPA were obtained ($r = 0.328^{**}$, 0.619^{**} and 0.392^{**}, respectively). Total Zn was most correlated with the EDTA ($r = 0.619^{**}$). However, this is not the case for total Zn concentration and $CaCl_2$ ($r = -0.053$) which showed non-significant and weak negative correlation, meaning that correlation has not been found between total Zn and $CaCl_2$.

The correlation analysis between total Cd in sugarcane parts (root, underground, bagasse, juice, top and juice) and four extraction procedures were significant positive ($p < 0.01$) correlation with Cd-BCR1 ($r = 0.459^{**}$) and Cd-EDTA ($r = 0.376^{**}$) whereas, non-significant and weak positive correlations were existed between total Cd in sugarcane with DTPA and $CaCl_2$ extraction procedures ($r = 0.191$ and 0.146, respectively). This suggests that the extractable Cd in sugarcane parts was correlated with BCR1 and EDTA but for other two extraction procedures (DTPA and $CaCl_2$).

Alternatively, the extractable Zn in sugarcane parts showed significant positive correlations with BCR1, Zn-EDTA, Zn-DTPA and Zn-$CaCl_2$ ($r = 0.554^{**}$, 0.583^{**}, 0.304^{**} and 0.364^{**}, respectively).

In the present study, the results revealed that the metals (Cd and Zn) extracted with BCR1 and EDTA extraction procedure have shown most efficient extractant for bioavailability of Cd and Zn contaminated in this area.

5.2 Recommendations

1. Since this study had been conducted in the real planting sites, there are several factors beyond the control and the surrounding conditions are complex, to obtain more precise information, the experiment pot under control factors may be further study in order to examine clearly result for some aspects.

2. The study for both soil and sugarcane samples from area located in the zone contaminated with Cd at different level should be should be further investigated for comparison.

3. Other soil properties rather than soil pH, organic matter content and oxidation reduction potential such as Cation Exchange Capacity (CEC), type and chemical speciation of elements that are the major factor influencing the mobility of metals should be also investigated.

4. To obtain better result for the statistic analysis, the soil and sugarcane samples should be higher number from this study. This might help to provide a better the good correlation coefficient between total metals (Cd and Zn) in sugarcane and four different extraction procedures (BCR1, EDTA, DTPA and $CaCl_2$). The experiment data of soil properties should also be analyzed to investigate the effect of soil properties on the different extraction procedures (BCR1, EDTA, DTPA and $CaCl_2$).

5. The unclear source of contamination, between natural and man made origins rendered it difficult to claim accountability from zinc mines in the area. Farmers have strong cultural beliefs and values around rice and rice growing processes that they have been reluctant to change their agricultural practices. Therefore, there is a need for all stakeholders to take into account for alternative ways to manage health risks more participatory, economically, socially and culturally acceptable.