

CHAPTER I

INTRODUCTION

1.1 Introduction

Some of the paddy fields in Mae Sod District have been found to be contaminated with heavy metals of Cd and Zn. The government and non-government organization have paid a great deal of attention on these particular areas especially on the adverse impact of heavy metals to human health and ecosystem. In 2003 the government has issued a request to the rice farmers in these areas which cover more than 10,000 rais to suspend their farming activities. Compensation had been paid to the farmers by the government. To alleviate the social subsistence and various projects of non-edible crop have been introduced to replace all kinds of edible crops. Sugarcane is one among those and believed to be the most suitable crops as it will be used only for the production of biofuel or ethanal.

Heavy metals in soils are generally bound to organic and inorganic soil constituents, or alternatively present as insoluble precipitates, a large proportion of metal contaminants are unavailable for plants uptake. For plant uptake, heavy metals must first be disassociated from soil components into a soil solution which is known as "bioavailable metals". Determination of available metals in soil is one of the most important parameter since it can indicate the metal uptake and accumulate in plants.

Chemical extraction schemes are most frequently used to fractionate trace metals in soils, sewage sludge and composts. Within this frame work, the availability of methods able to provide direct information on the contamination of the investigated sites would be highly valuable. Single and sequential extraction procedures have been developed and widely used in order to achieve a better evaluation of the elements pollution levels (Shiowatana et al., 2001). Single step extraction procedures are mainly applied to soil samples to identify the "bioavailable" fraction, using a number of different reagents able to extract all, or part of the metals from soil (Zemberyova et al., 2007)

The extractants commonly used include H_2O , KNO_3 , $Na_4P_2O_7$, EDTA, and HNO_3 . Each extractant is targeted on a single form of each metal, for example H_2O for soluble, KNO_3 for exchangeable, $Na_4P_2O_7$ for organic matter bound, EDTA for carbonate and sulfide precipitated and HNO_3 for residual form of each metal. Various one-step extraction methods are frequently used for bioavailability evaluation because of simplicity and ease of operation. In this study, four different extraction procedures were conducted to compare for the plant availability of cadmium and zinc. The compared methods are (i) EDTA; (ii) DTPA; (iii) $CaCl_2$; and (iv) the first-step of the Community Bureau of Reference (BCR, now is the Standards, Measurements and Testing Programme of the European Committee). Ethylenediamine tetraacetic acids (EDTA) act as a chelating agent and can form stable chelates with metal ions. The Diethylenetriamine-pentaacetic acid (DTPA) extraction method is chosen to minimize dissolution of carbonates and the use of $CaCl_2$ is also recommended due to the ability of Ca^{2+} to extract other adsorbed cations in soils (Feng et al., 2005). However, all of the three extraction procedures above are single extraction. Among the variety of sequential extraction procedures, the first step of the BCR extraction procedure according to the procedure recommended by The Standards, Measurements and Testing programme of the European Union (SM&T) is selected and applied in this study to estimate the bioavailability of heavy metals. The use of a leaching approach based on sequential extractions may help to elucidate the relative contribution of mixed pollution sources (i.e., particulate and/or soluble sources) and may aid in the predictions of trace element mobility by identifying and characterizing different bonding fractions of heavy metals in soil (Manz et al., 1999).

All the above methods are useful under defined conditions. However, no method has been recognized as a universal approach for prediction of bioavailability. The common features of those extraction procedures are focused on metal fractions associated with certain soil geochemical phases. There have been significant efforts applied in order to establish a more widely usable method for prediction of metal bioavailability in soil. The influence of metal distribution among different soil colloidal fractions on bioavailability has been investigated. Therefore, the aim of this study is focused to compare the EDTA, DTPA, $CaCl_2$ and the first-step of BCR extraction procedures in determining the bioavailability of Cd and Zn in sugarcane grown in Cd contaminated area in Mae Sod District, Tak Province.

Emphasis of the comparison was put on the performance of suitability of those methods for different types of soils.

1.2 Objectives

The main objective of this study is to investigate and correlation of the bioavailable form of Cd and Zn leached from contaminated land in Mae Sot District with different extractants. The objective also includes some sub-objectives as follow

- To determine concentrations of Cd and Zn in soil in forms of total and fractions by different extraction procedures.
- To determine concentrations of Cd and Zn in sugarcane grown in the Cd contaminated area.
- To correlate the concentration of Cd and Zn in soil and sugarcane

1.3 Hypotheses

Bioavailability of Cd and Zn relates to soil properties and their total concentrations, forms and fractions of the metal present in the soils, age of sugarcane and the extraction methods.

1.4 Scopes of the Study

1.4.1 Study area

Soil and sugarcane (LK 92-11) samples were collected from Mae Sod District, Tak Province where the area is contaminated by cadmium.

1.4.2 Soil Analysis:

- Soil properties: pH, oxidation-reduction potential and organic matter content of soil samples were determined.
- Total Cd and Zn: Total concentrations of Cd and Zn in soil samples were determined, according to EPA standard method (EPA-Method 3052, 1996).

- Extraction procedure: In this study the efficiency of extraction among different extraction procedures is of the major concern. The extraction procedures covered the use of the single extraction using EDTA, DTPA and CaCl_2 as extractants and the first-step of BCR sequential extraction procedure.

1.4.3 Sugarcane Analysis:

Five parts of sugarcane including underground stems, roots, bagasses, leaves and juice were prepared and determined separately for cadmium and zinc according to EPA standard method (EPA-Method 3052, 1996). For juice, it as determined according to tri-acid digestion.

1.4.4 Study Site:

Seventy eight polluted soil and sugarcane samples were collected from Mae Sot district, Tak province. Cadmium contaminated areas were separated into zoning in accordance with their total cadmium concentration by using Geographic Information Systems; GIS (NRC-EHWM, 2005) as:

1.4.4.1 Mae Ku (< 3 mg Cd/kg) in Mae Ku Noi village, Mae Ku sub-district.

1.4.4.2 Mae Tao 1 (3-20 mg Cd/kg) in Mae Tao Pae village, Mae Tao sub-district.

1.4.4.3 Mae Tao 2 (> 20 mg Cd/kg) in Mae Tao Pae village, Mae Tao sub-district.

The summarization for scope of the study is presented in Figure 1.1.

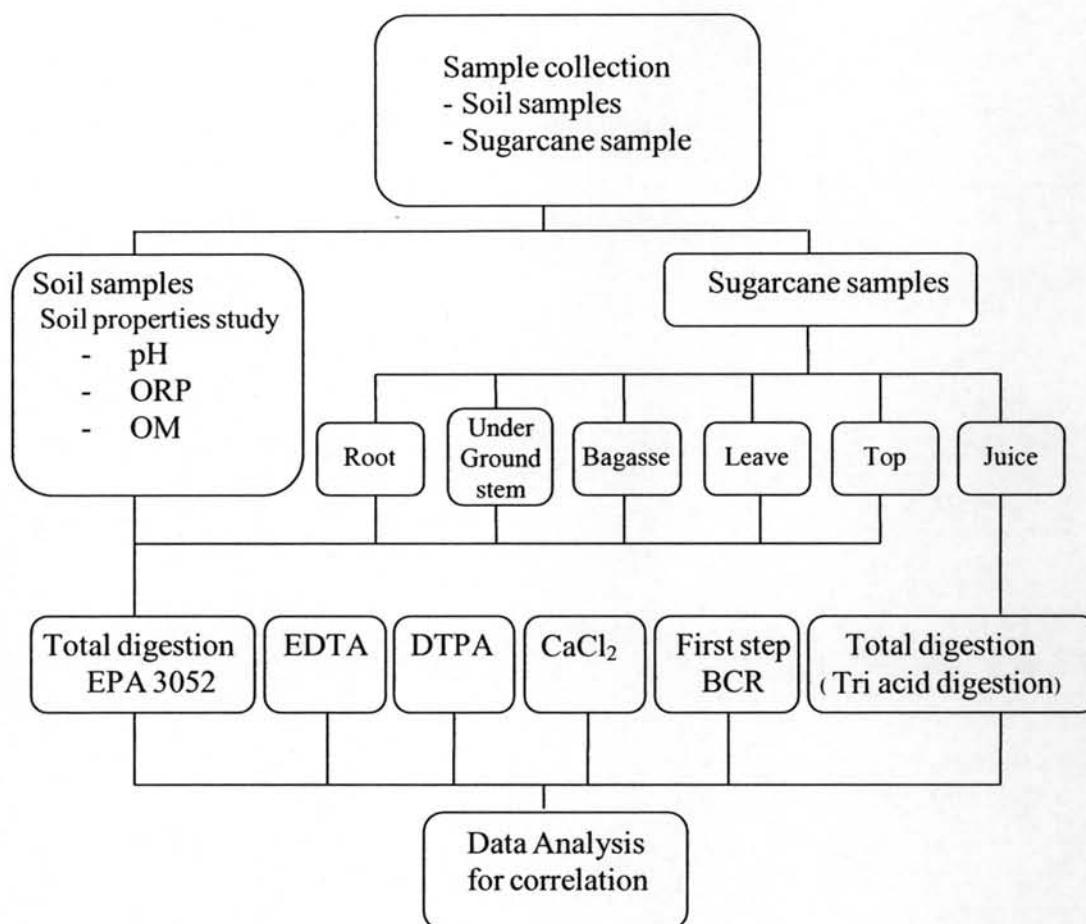


Figure 1.1 Schematic diagram of scope of the study

1.5 The benefits of the study

At the end of study, the use of four single extraction procedures that included, CaCl_2 , EDTA, DTPA and the first step BCR could be applied to investigate the bioavailable forms of cadmium and zinc from the contaminated soils in the area. With further study, this technique could be applied to the other contaminated sites. The correlation between heavy metal concentrations with these four single extraction procedures can be investigated in order to select the best extractant that can be used for this contaminated sugarcane cultivation area at Mae Sod District, Tak province. In addition, the selected extractant could provide the useful information, as well as the

rapid determination of the heavy metals (cadmium and zinc) uptake to sugarcane, and in turn, the prediction of heavy metal toxicity.