CHAPTER I
INTRODUCTION

Livestock manure can be either a valuable resource or an environmental pollutant. Generally, manure refers to animal feces and urine production, and contains organic matter and nutrients (Tao *et al.*, 2008). Currently in most of manure management, livestock manure is collected in holding ponds or stored outdoors and generates unpleasant odor from partial decomposition of organic matter by anaerobic bacteria (John *et al.*, 2003). The gases emitted from manure include methane (CH_4), carbon dioxide (CO_2), nitrous oxide (N_2O), hydrogen sulfide (H_2S), ammonia (NH_3) and volatile organic compounds (VOCs) (Hishinuma *et al.*, 2008). Among them CH_4, N_2O, and CO_2 are considered the sources of greenhouse gas (GHG) (Solomon, *et al.*, 2007). In the United States, total GHG emissions in 2011 amounted to 6,702 million metric tons (MMT) of carbon dioxide equivalent and 8% of this amount was from agricultural emission (US.EPA, 2001). Fresh manure emitted methane and nitrous oxide, two major sources of greenhouse gas (Karen *et al.*, 2010). According to the greenhouse gas standards developed by the Intergovernmental Panel on Climate Change (IPCC), methane and nitrous oxide has 28 times and 265 times more global warming potential (GWP) than carbon dioxide has over a 100 year time span (IPCC, 2013).

Many states in US have many dairy farms and many of them do not ban direct manure spreading on fields. When applied to land, nutrients, pathogens, and other contaminants in the manure seep into the soil and infiltrate drinking water sources threatening the public health and the environment. The dairy manure management systems these days consist of untreated holding ponds typically followed by land application and anaerobic digestion with co-generation of methane for energy production (OSU, 2006; Denis, 2001). Untreated holding ponds can be used for storing liquid manure. The large exposed surface area permits large quantities of odorous gases to be released into the air (Natural Resource, 2013). An anaerobic digestion is the controlled microbial decomposition of organic matter in the absence of oxygen (Volbeda, 2009). A specific bacteria break down manure into a

variety of gases, including methane and carbon dioxide (UW-Extension, 2001). These manure management systems result in a wide range of greenhouse gas emissions. Development of an efficient manure process would be helpful to improve manure management costs and to reduce gas emissions. The proposed process design combines advantages of highly energy-efficient superheated steam drying (SSD) technology and the heat generated from a reaction between cow manure moisture and fly ash. Therefore it may be economically and environmentally beneficial to convert agricultural animal wastes to biofuel instead of land application. An efficient manure process may be also to reduce the water and soil pollution due to the run-off water from direct field application of animal manures.

In any case, collecting of manure should demonstrate its positive impacts on environment in order to be validated as an effective process. In this study, Life Cycle Assessment (LCA) method has been adopted to evaluate and analyze the environmental impacts of product, process, services, or systems in various management schemes. Moreover, it can be used to define and quantify GHG emissions of manure management systems. Its basic procedures have been standardized in the ISO14040 (ISO, 1997) and ISO 14044 (ISO, 2006). LCA consists of four steps: (i) goal and scope definition, (ii) inventory analysis, (iii) impact assessment, and (iv) interpretation (Miettinen, 1997). One dairy farm in Swanton, Ohio, was used as a model system.

The purpose of this study was to investigate and compare the environmental impacts of the proposed biosolids process with fly ash mixture for energy production to existing manure management methods in USA.