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Cadmium in animal production and its potential hazard on Beijing and Fuxin farmlands

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ABSTRACT

A random sample of pairs of animal feeds and manures were collected from 215 animal barns in Beijing and Fuxin regions of China. The concentrations of Cd in manures and feeds ranged from non-detectable to 129.8 mg/kg dry weight and non-detectable to 31 mg/kg dry weight, respectively. The concentrations of Cd in pig, dairy cow and chicken manures were positively correlated to those in their feeds. About 30% of the manure samples contained Cd concentrations higher than the upper limit for use in farmlands, and pig and chicken manures might be the primary contributors of Cd to farmlands. The farmlands in Beijing and around the Fuxin Downtown areas would exceed the soil quality criteria within several decades according to current manure Cd loading rates. Undoubtedly, more scientific animal production and manure management practices to minimize soil pollution risks are necessary for the two regions.

1. Introduction

Domestic feed safety issues and international green trade barriers for agricultural products, combined with public awareness of the impact of environmental pollution on crops and general environmental issues, has provoked major considerations on soil and water contamination in China. Soil is a pool for most solid wastes such as the animal manure, the municipal sewage sludge and agricultural wastes, resulting in soil pollution by heavy metals, etc. [1]. It is estimated that more than 12 million tons of toxic metal-polluted crops have been produced, causing an annual economic loss of over 20 billion Chinese Renminbi (RMB) because of trade limitations and the food safety consideration [2].

As we know, cadmium (Cd), a nonessential trace transition metal, is a carcinogen and a possible mutagen [3]. The impact of Cd on human and animal health is now increasingly recognized [4–6]. Cadmium pollution of farmlands has been investigated since the end of the 1970s in China. It is estimated that more than 13,000 ha of farmland are contaminated by Cd in the 11 provinces of China, and more than 50 million kg/year of Cd-rich rice are produced in these farmlands [7]. In addition, Cd is often detected in vegetables and some animal haslets were observed to contain Cd levels above the national food hygiene standards in China [8–10].

It is common practice to add mineral additives to animal feeds to meet the demands of the animal body for essential micro-nutrients and to stimulate their growth. Copper, zinc, and phosphate are usually added in animal production [11]. Feed supplements are permitted for use in animal production at reasonable levels in China [12]. However, due to abuse of mineral additives, high residues of Cu, As, and Zn in animal manure have been reported, this has caused scientists and the general public to worry about food safety and the potential risks on farmlands where animal manures are used [13,14]. Moreover, the toxic metal of cadmium (Cd) has attracted our attention, because several out of the ordinary values were reported by some studies. The pig manure samples collected in Jilin province were detected with mean value of 59.66 mg/kg Cd and in the big range of 0.25–120.13 mg/kg [14]. Furthermore, a large scale investigation in 14 Chinese provinces concluded that 66.0%, 51.7%, 38.1% and 20.0% of the commercial organic fertilizers made from chicken manure, pig manure, cattle manure and sheep manure contained Cd exceeding the limitation, the highest values were 23.1, 42.7, 51.5 and 4.7 mg/kg, respectively [15].

Because of its environmental hazards and biological toxicity, the studies about the environmental behaviors of Cd and the influence factors have been carried out for longtime. For example, the utilization of poultry litter in metal-contaminated soils could accelerate the movement of Cd in soil profiles, it might be closely related to the soluble or colloidal organics derived from animal excreta which are able to mobilize metals, enhance the risk of heavy metals leaching and possibly deteriorate groundwater quality even increase

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the plant absorption [16–18]. The high annual rainfall will transfer Cd from the cultivated layer into deeper layer in a silt loam soil [19]. Certainly, many simple or complicated models were developed to predict the potential environmental impact on soil based on the toxic metals imports and exports [6,20]. However, the previous regional study proved that not much is known about feed and manure management in China, for example, on Chinese dairy farms [21,22], although Chinese farmers are accustomed to using animal manure as a soil nutrient source for more than thousands years, but people never compared its risks to its benefits because it has always been done this way. Hence, it is necessary to understand the situation of Cd in animal feeds and its residue in manures, and its potential risk on farmlands in order to ensure the reasonable use of animal manure in agriculture.

A large scale investigation was conducted in animal farms in the regions of Beijing and Fuxin in order to identify the range of Cd concentrations in animal feeds and feces, to investigate the source of manure Cd, and to estimate the potential pollution risk of Cd from animal manure application in the two cities.

2. Materials and methods

2.1. Sampling areas

Beijing, the capital of China has more environmental protection and public health measures than any other province. Although concentrated animal farms are forbidden within the Sixth Ring of the city, animal production is still the predominant income for Beijing farmers, and currently accounts for 60% of their annual income. In 2004, more than 1250 million pigs, cattle and sheep and 3248 million poultry were produced according to Beijing official statistics [23].

Table 1
Numbers of animal manure and feed samples.

	Pig	Chicken	Cattle	Sheep
Manure	114	18	71	12
Feed[a]	113	18	71	8

[a] Five feed samples were lost.

Fuxin City, located in Liaoning Province, has more than one hundred years of mining history. Due to high unemployment rates, the local government has encouraged unemployed workers to rear livestock. Pig, dairy cattle and poultry production has increased more than 2–3-fold in the last 5 years. Per capita, animal production in Fuxin is currently the highest among the 14 cities of Liaoning province.

In summary, animal production is an important economic aspect in these two cities. Hence, environmental problems relating to animal production in these cities need to be investigated.

Six of ten counties in Beijing and four of seven districts and counties in Fuxin were selected to collect animal feed and manure samples for this study. The sampling areas are shown in Fig. 1.

2.2. Sampling, pretreatment and analysis

A total of 210 animal feedingstuff samples and 215 manure samples were randomly sampled in 2005 in Beijing and Fuxin. Detailed sample numbers for each type of animal are shown in Table 1.

Owing to privatization of the animal farms and the hygienic consideration, visiting animal farms is exceedingly difficult in the two cities. With the consent of farm owners, the feed and manure were sampled, where possible, accompanying with the short interviews with the farmers, about farm operation, including herd size and composition, livestock facilities, feeding practices and manure

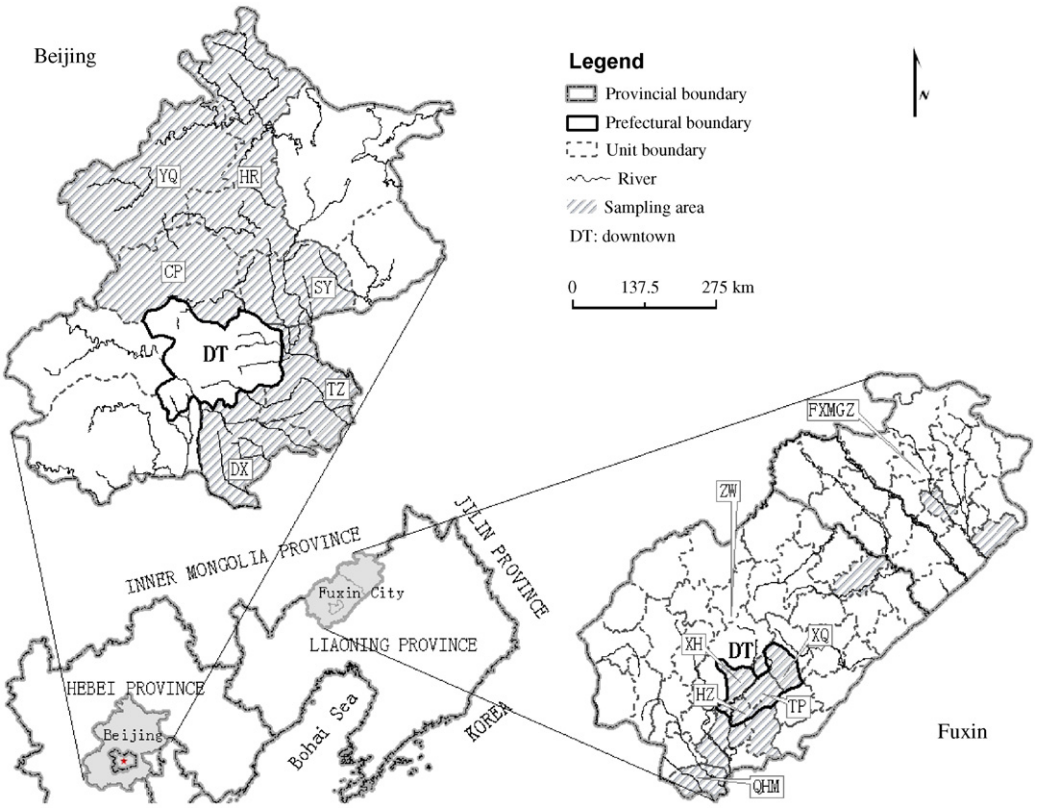

Fig. 1. The study areas and the sampling sites.