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## A Cost-Benefit Analysis (Based on Recycling Economy) of Effective Utilization of Livestock Manure

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### ABSTRACT

With the rapid development of animal husbandry, agricultural production structure has been improved and rural economics been promoted. But the castoff produced in agricultural production, especially livestock dung, has caused environmental pollution. Dung de facto contains almost all of the essential nutrients for plant growth, however. Based on recycling economy, a study on the effect of manure on human life shall reap a sea of economic and ecological benefits because it emphasizes the importance of recycling and management of manure and meanwhile introduces how to reclaim the manure. Only by doing this can the resources be fully utilized and the environment less polluted in the meantime.

### KEYWORDS

Resources recycling; Cost-benefit; Manure; Utilization; Livestock.



## INTRODUCTION

Issues concerning agriculture, countryside and farmers hinder more than help China's economic development to a certain degree. It is crystal clear that the status quo of economic development in countryside does not accustom itself to the development planning of low carbon economy. In China, there exist a huge number of villages. Thus, the agricultural economy, as the primary industry, exerts a far-reaching influence upon economy of China. Obviously, of great importance is the development of low carbon economy to rural area. At present, the development of low-carbon economy in rural area begins with renewable energy, such as crops straw, livestock manure, water conservancy and solar energy. Especially, crops straw and livestock manure are the most widely utilized and the technology for them is relatively advanced. It therefore follows that once crops straw and livestock manure, both as renewable energies, can be extensively and vigorously put into use, they shall make greater contribution to the low carbon economy.

With the acceleration of scale and intensification of China's animal husbandry, livestock dung emitted by large-scale farms has become one of the most important contemporary environmental pollution. Some of dairy farms did not take dung pollution into account at the very beginning of its building and thus did not formulate corresponding plan to dispose of dung, thereby resulting in arbitrary discharge of livestock dung and extensive pollution around feeding areas. Such environmental pollution seriously affects animal feeding and growth and also poses a threat to health of the human body. A large number of solid castoff generated by the dairy farm has become main pollution sources in many regions especially in the suburbs of large and medium-sized city. Therefore, promoting and encouraging harmless treatment of livestock dung and technology of recycling dung has become the mainstream of domestic large-scale dairy farm. Dung, treated as a biomass resource, is designed to be harmless, less polluted and more useful. Only in this way can it be economically favorable and environmentally friendly. Many methods for dealing with dung abound at home and abroad. What are popular in production are those of less investment, cost-effective operation with high valued reproduces.

### THE ENVIRONMENTAL POLLUTION CAUSED BY DUNG

As a large agricultural country, China has a crying need for the development of animal husbandry to meet the need of economic development. Especially with the China's entry into WTO, the process of economic integration in China has been speeding up. China's agriculture and animal husbandry is facing severe challenges in the competition of the international market. China thus is obliged to accelerate development of animal husbandry.

According to the latest survey of China Dairy Association, each year China dairy industry gives birth to nearly 18 tons of biological waste such as dung, padding, forage residue. But because the waste disposal is lagging behind, a large number of dung are discharged without disposal thereby causing water pollution and soil pollution, which has become the main culprit of the deterioration of ecological environment of agriculture.

Dung is to blame as both one of the important causes of disease and at the same time the root of the spread of infectious disease, posing a direct threat to the rural population's health. This paper mainly introduces three pollutions:

#### **Air pollution caused by dung**

Because of the intensive feeding, the number of cattle in the dairy farms is huge. In addition, barns are always wet. Discharged feces which are catalyzed by microorganisms and extra cellular enzyme shall produce catabolite which emit foul smell after being mixed with dust, mould padding and exhaled carbon dioxide. According to a recent survey, the foul smell produced by dung contains 168 kinds of compounds, most of which are hydrogen sulfide, carbon dioxide, ammonia etc. If these harmful gases are emitted into the atmosphere, they can not only increase concentration of the air pollution, but also decrease the quality of the air. Such foul smell can do harm to the olfactory nerve and trigeminal nerve, and thus produce harm to the respiratory center. At the same time, the foul gas also does harm to health of livestock and poultry. Respiratory diseases and other diseases caused by the foul gas ultimately affect the growth of livestock and poultry, leading to a decline in production. The large amounts of methane and carbon dioxide produced by dung are important greenhouse gas which exercises undesirable impact on climate change which can never be ignored. And if the ammonia contained in feces is volatilized into the atmosphere, then it will become one of the factors causing acid rain.

#### **Water resources pollution caused by feces**

A weight of 500-600 kg grown cow shall have 15-25 kg of urinary output, causing a range of 15-20 L water pollution. Arbitrary discharge of feces and wastewater in dairy farm will put a great deal of decayed organic matter into the water, where breeds a large number of toxic algae which shall exhaust dissolved oxygen in the water thereby contaminating the water and resulting in the death of aquatic organism (e.g. fish, shrimp). Harmful substances such as hydrogen sulfide, ammonia and mercaptan generated by the anaerobic decomposition shall blacken the water which smells foul. Eutrophication therefore follows.

Eutrophication is an important symbol or index of water polluted by feces. A lot of fecal sewage which are directly discharged into river and the rural area extensively pollutes the water quality and ecological environment in rural areas. People drinking contaminated water are easy to be infected with allergic reactions, skin rash and induce cancer etc.

#### **Pathogenic pollution caused by dung**

Some sick cows or cows of recessive disease shall defecate feces with a variety of bacteria and parasite eggs, such as Salmonella, Escherichia coli and Marek virus. If not treated properly, they will become a dangerous source of infection,

which shall spread disease. Not only shall they affect the other cow health, but pathogens also affect human health. In addition, without proper preservation measures, mountains of dung tend to breed a large number of pests such as mosquitoes and flies etc., which tend to attract a lot of rats and finches, thereby also having many adverse effects on the normal production in farms.

### ANALYSIS OF RECYCLING OF DUNG

In order to improve conversion efficiency of grass, livestock, fertilizer and grain in agricultural ecosystem, to reduce the waste of resources and environmental pollution, it is necessary and fundamental to open up approaches to apply the excretion in a recycling way and to regard cow excretion as a resource for effective management and full use. Overall recycling use of cow excretion can be divided into the following types:

#### Transforming the manure into fertilizer

Because the manure contains element like N, P, K which are not absorbed, these nutrients can be directly used in agricultural land as fertilizer after some simple processing. With the increasing investment in agricultural technology, there arise many processing methods.

In some organic fertilizer production plant, the main processing methods go as followings: microwave method, puffing method, fast drying method, composting, anaerobic fermentation, oxygen dynamic fermentation method.

At present, more researches are put on the composting method. The method is that the manure of livestock and poultry, crops straw and other solid organic waste are piled up together according to a certain proportion. Then appropriate control of moisture, pH, oxygen and temperature is necessary. After that, it is important to regulate the proportion of carbon and nitrogen in the process of fermentation. This method is applicable to large-scale intensive agriculture production, but as for the domestic agricultural production this method also has some limitations. Because the farmers' houses lie nearby livestock barns, the livestock manure often piled up in the neighboring farmers' houses. In case of bad weather like windy, frosty, rainy and snowy, feces will flow with rainwater or something like that. Without timely cleaning, it will cause serious environmental pollution and a waste of resources. In order to reduce the smelly odor of stink feces and to improve efficiency, modern microbial technology and fermentation process are popular with foreign countries. Compound organic fertilizer is made in this way: first, having a fast fermentation of manure; next comes sterilization of manure; after the deodorization, adding appropriate compound fertilizer. If the manure is applied in farmland, it is beneficial to improvement of soil structure, to control condition of soil compaction, and to improvement of the soil fertility and crop yield. Therefore, it is high time livestock manure resources should be fully exploited and environmental pollution be well controlled.

#### To transform feces into fecal energy

There are basically two kinds of methods: one is the anaerobic fermentation of cow dung. In this way biogas (methane) can accordingly obtained to provide bioenergy for life and production. At the same time, biogas residue and biogas slurry are good organic feeding stuff and organic fertilizer. This will not only curb pollution, but also reap the economic benefits of pollution control. The second method is to put feces directly into the incinerator furnace to burn, providing heat. It is reported that ennie dung power station established in the Suffolk in England, has a capacity of up to 12.5 MW and can consume feces of 125000 t per year, thereby reaping enormous economic benefits. At present, at home and abroad, generally there are two ways to transform the livestock and poultry manure into fuel, namely anaerobic fermentation of both straw and manure with produced biogas and burning them on the spot. Using decomposition of anaerobic bacteria, biogas method is to transform organic substance (fat, protein and carbohydrate) into methane and carbon dioxide<sup>[2]</sup>. This method is widely applied, and its undesirable impact on the surrounding environment is less. In addition, this method also forms a certain recycling economic model, which has been widely used in agricultural production. Burning feces on the spot refers to burning some combustible wastes like feces under a certain temperature until they become gas. This method is generally used for the household garbage.

#### To divert dung into forage

Cattle manure contains a large amount of undigested protein, vitamin B, minerals, crude fat and a certain amount of carbohydrate, which is safe and highly efficient if they are properly used as recycling forage. Protein content of fresh feces is 1.7% ~ 2.3%. and feces contains a wide variety of amino acid. Dry feces contain 17 kinds of amino acid, constituting 8.27%. At present, due to the shortage of fodder, especially the protein feed, the development of new protein feeding stuff has become a pressing matter of the moment to meet the supply of feeding stuff for animal husbandry. Because of the higher protein content, complete amino acids and higher production, the feces have become one of the most popular non-conventional feeding resources. Methods for that mainly include ensilage process and drying method. Ensilage process method is simple, convenient, and effective. Mix the fresh cattle feces with other feeding stuff and crops straw first; next do an anaerobic fermentation of them. And then mix them with other raw materials. Such feeding stuff can be directly used to feed breeding pig, thereby saving 30% of feeding funds. Such feeding stuff boasts better palatability and easier digestion for piglets. This method is simple and cost saving. Drying method is to rapidly dehydrate feces under high temperature. Such processed feces are easier to be transported and stored.

At present, feeding the fish and shrimp with feces has been widely applied in production. Some researches show that nutrition in the manure of livestock and poultry are the best for ruminant animal. Shown in the TABLE 1.

**TABLE 1 : Nutritional Components of livestock manure (dry matter)**

Nutritional Components	Feces of hens	Feces of poultry	Feces of beef cattle	Feces of dairy cattle	Pig manure
Crude protein (%)	28.0	31.3	20.3	12.7	23.5
Digestible protein (%)	14.4	23.3	4.7	3.2	-
Coarse fiber (%)	12.7	16.8	31.4	37.5	14.8
Crude fat (%)	2.0	3.3	-	2.5	8.0
Nitrogen free extract (%)	28.7	29.5	-	29.4	38.3
Crude ash (%)	28.0	15.0	11.5	16.1	15.3
Total energy (KJ/kg)	14782.1		19782.0	-	19120.9
Amount of digestible nutrient (%)					48.0

Of course, feces also have some potentially harmful substances, including undigested chemicals, accumulation of which will produce some harmful microorganisms. Drug residue contained in feces left by sick livestock and poultry are not conducive to the ecological environment. Although once American departments of food hygiene management assumed that feces are not healthy, the latest research shows that, after a good treatment of livestock manure they can be safely fed to livestock. Research shows that recycling feces as forage can reap the most economic benefits among all the recycling utilization of feces of livestock and poultry. Technology for processing feces of livestock and poultry: the high and low temperature fermentation, drying method, the direct use of feces, ensilage process and separation method.

### THE MEASUREMENT AND CALCULATION OF FECAL

Another kind of rural renewable energy is human feces and livestock feces, which can be used for the development of biogas. Firstly, calculate the fecal resources available, then calculate the amount of biogas production, the specific calculation formulas go as follows:

Fecal exploitation amount = excretion amount + collection coefficient + utilization coefficient

Amount of Livestock feces excretion per year = feces excretion parameter+ number of livestock + days

Produced biogas volume of manure = total amount of manure per year + dry matter content of feces + gas parameters

Produced biogas volume of Cattle manure = total amount of livestock manure per year + dry matter content+ gas production parameters TABLE 2 parameters for model,

### RESOURCES

**TABLE 2 : Parameters for feces gas production**

Gas speed Days for fermenting Names of raw materials	Gas production rate of raw materials (%)					Amount of gas produced (m <sup>3</sup> /kg)	Dry matter (%)
	10	20	30	40	50		
Pig feces	74.2	86.3	97.6	98.0	100	0.42	20
Horse feces	63.7	80.2	89.1	94.5	100	0.34	20
Feces	34.4	74.6	86.2	92.7	100	0.30	20
Goat feces	48.2	71.8	85.9	91.8	100	0.45	75
Hen feces	46.2	69.2	84.6	91.0	100	0.40	80

### THERE ARE 5 LIMITATIONS FOR RECYCLING LIVESTOCK MANURE

#### Backward technology

Currently, the development of livestock feces treatment technology in China seriously restricts its recycling exploitation. There is a technical gap between China and developed countries in terms of the advanced technology.

There is a huge loss of nitrogen in using technology of biological high-temperature aerobic fermentation, ammonia pollution, less full use of fermentation heat<sup>[5]</sup>. Due to the limitations of technology, feces treatment has not been formed a complete system; utilization of livestock manure is also limited to a certain degree.

### **Environmental pollution caused by small family business**

In the absence of some facilities in the common household, livestock barn and farmers home are adjacent to each other, and they don't have good facilities to deal with livestock manure. Thus feces are dispersed everywhere, especially in the windy and rainy day environmental pollution bulk large. Moreover, there are some harmful gases including some microorganisms sent by manure of livestock and poultry. If not properly handled, there will be cross infection between human beings and livestock.

### **The backward management and the lack of policy support**

The lack of policy support and guidance is an important factor restricting and influencing manure recycling.<sup>[6]</sup> It is imperative to choose site to build a plant strictly in accordance with the standard because if it is built in the area with huge population and lots of livestock, the plant will seriously affect the normal production and operation and hinder more than help the standardized management of manure of livestock and poultry. Government investment is not enough, leading to financial problem for a lot of livestock waste treatment plant, limiting progress of livestock manure resources. Many livestock manure treatment plant lack correct management concept, inadequate supervision. And pollution control capability is weak, thereby resulting in serious environmental pollution.

## **ANALYSIS OF COUNTERMEASURES AGAINST OBSTACLES TO MANURE RECYCLING OF LIVESTOCK AND POULTRY**

### **To improve processing technology of the feces of livestock and poultry**

Technical limitations seriously restrict the recycling of manure of livestock and poultry. The improvement of current technology is conducive to a better and faster development of the recycling of manure of livestock and poultry. First and foremost, it is essential to develop a complete treatment system according to different kinds of resources, that is, different kinds of livestock manure. Only in this way can livestock dung be optimized as most as possible. In the aerobic treatment and anaerobic fermentation, it is necessary to speed up the fermentation time and select different fermentation substances according to different types of livestock and poultry manure.

Different treatment methods shall be adopted for the alpine area and tropical regions.

### **To raise farmers' environmental awareness**

Rural living environment is somewhat unsatisfactory mainly because farmers' environmental awareness is comparatively attenuated. Farmers' long-term bad living habits lead to a gradually deteriorating rural living environment. If cast-off or waste from human life and production cannot be properly handled, they will seriously affect both the rural ecological environment and economic development.

### **To establish a sound management system and to enact strict law**

Only by standardizing management or treatment of livestock and poultry manure, can we have standardized operation. To ensure the normal operation of pollution control facilities in manure disposal field, it is fundamental to strengthen law enforcement. It is necessary to formulate different laws and regulations according to the different geographical environment. After all, effective is a case-by-case management system.

### **To reduce the pollution of the environment from the very beginning of production**

Most of Nitrogen, phosphorus elements in feeding stuff can not be absorbed and thus emitted to the atmosphere. And the concentration of some microelement in feeding stuff shall climb and breed pollutant, thereby polluting the environment. Hence it is imperative to have standardized treatment of livestock manure (e.g. to separate the human beings from livestock) to reduce pollution once for all.

## **RESULT AND DISCUSS**

As a big country of the animal husbandry, it is imperative for China to develop its animal husbandry. But all kinds of livestock discharge a large number of biological wastes every day. Only by upholding concept of scientific development and sustainable development, by recycling waste like dung and reclaiming cast-off shall China walk on the road of socialism with Chinese characteristics.

As far as China's current overall use of the waste like dung is concerned, comprehensive model of recycling biomass waste like dung has been applied and promoted. If the two simple and practicable conversion models mentioned above shall be adopted, the problem of environmental pollution in livestock breeding shall be effectively resolved. In addition, agricultural trash shall be transformed as treasure, which means agricultural trash shall be transformed as commodities for use in many ways. Thus the formation of an industrial chain is a sure thing. In the meantime, by achieving abundant environmental benefits we can also reap enormous economic benefits and social benefits.

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