IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

Agricultural and rural ecological environment management: renewable resources evaluation, management methods and management measures[1]

To cite this article: Fengling Jia 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **510** 032032

Agricultural and rural ecological environment management: renewable resources evaluation, management methods and management measures[1]

Fengling Jia

Tianjin Institute of Rural Economy and Agricultural Regional Planning, Tianjin 300192, China

happymary2006@126.com

Abstract. Among agricultural and rural pollution sources, rural domestic refuse, domestic sewage, crop straw and livestock manure are recyclable renewable resources, which can alleviate non-point source pollution in agricultural and rural areas, and also produce huge economic, environmental and social benefits. Taking Tianjin as an example, the production and comprehensive benefits of these four types of pollution sources are evaluated by building models. The results showed that in 2016, the production of domestic waste, domestic sewage, crop straw and livestock manure in Tianjin were 1.31 million tons, 38.9 million tons, 3.74 million tons and 1.53 million tons. Through comprehensive utilization, these pollution sources can produce a total economic benefit of about 2.36 billion yuan, which can reduce greenhouse gas emissions by 1.94 million tons. The total amount of N and P emissions from manure to soil can be reduced by 10.8 thousand tons. In order to improve the utilization rate of renewable resources and control non-point source pollution in agricultural and rural areas, this paper proposes to construct BMPs system, control the source and end of pollution sources from engineering and non-engineering measures. Finally, some suggestions are put forward to improve the ecological environment of agriculture and rural areas.

1. Introduction

Agriculture is one of the main sources of greenhouse gases (GHG). In the process of agricultural production, GHG such as CO_2, CH_4 and N_2O are emitted to promote global warming [1]. According to the fourth assessment of IPCC, GHG emissions from agricultural sources account for 14% of GHG emissions from human activities, and the increase of CH4 and N_2O concentrations mainly comes from agricultural activities, accounting for 52% and 84% of CH_4 and N_2O emissions from human activities[2]. The study points out that a 50% reduction in agricultural GHG emissions can prevent 200,000 deaths per year in 59 countries, especially in Europe, Russia, Turkey, the United States, Canada and China [3]. Strengthening the ecological environment management of agriculture and rural areas to reduce GHG emissions have become the focus of attention in the world.

China is a country with a large population and agriculture. In 2017, China's agricultural output value reached 10,933.2 billion yuan, accounting for 13.2% of China's GDP. Since 2000, the annual average growth rate has been 9.1%. With the high output of agriculture, the consumption of energy resources is also increasing: in 2016, agricultural production consumed 85.44 million tons of primary energy standard coal, accounting for 2% of the total energy consumption in the country, and has

[1] Tianjin Science and Technology Development Strategic Research Plan Project (19ZLZDZF00120)

increased by 2.4% annually since 1980[4]. Agriculture with high resource consumption not only promotes the development of agricultural economy, but also brings serious environmental pollution. Research shows that the total GHG released from agricultural sources accounts for more than 17% of the total GHG released in China [5]. Under the dual constraints of resources and environment, how to play the role of renewable resources, reduce primary energy consumption and minimize agricultural non-point source pollution is the key problem to be solved in the treatment of rural ecological environment in China. Based on the comprehensive evaluation of the main pollution sources in Tianjin, this paper puts forward the BMP system for controlling agricultural and rural non-point source pollution, and puts forward the measures and suggestions for the prevention and control of agricultural and rural non-point source pollution, so as to provide decision-making reference for the relevant government departments.

2. Benefit assessment of major pollution sources in agriculture and rural areas of Tianjin

The main wastes in agricultural and rural areas include domestic garbage, domestic sewage, crop straw and livestock manure, which have a great impact on the ecological environment of agricultural and rural areas. If they are recycled, there will be huge comprehensive benefits.

2.1. Measurement and calculation of major pollution sources

Taking agriculture and countryside in Tianjin as the research object, this paper mainly calculates four main pollution sources: domestic waste, domestic sewage, crop straw and livestock manure.

2.1.1. Estimation model of rural domestic waste production. Rural household garbage refers to the garbage produced by peasant households in their family life.

According to China's "Standards for Setting up Environmental Sanitation Facilities in Cities and Towns", the calculation formula for daily production of domestic waste is as follows:

$$Q_1 = f_1 p f_2 q_1 t \qquad (1)$$

In formula 1, $\mathbf{Q_1}$ is waste production(t/d); $\mathbf{f_1}$ is the uneven coefficient of daily discharge weight of garbage($\mathbf{f_1}$=1.1~1.5，here is 1.1); $\mathbf{f_2}$ is the coefficient of variation of residential population($\mathbf{f_2}$=1.02~1.05，here is 1.02); **p** is the number of permanent residents in rural areas(person); $\mathbf{q_1}$ is the daily weight of garbage per capita(According to China's "Method for Calculating and Predicting the Production of Municipal Solid Waste"，here is 1.2kg/person/d); **t** is time(d).

2.1.2. Estimation model of rural domestic sewage production. Rural household water mainly includes kitchen water, laundry water, bathing water and toilet flushing water.

According to the survey, the average daily water consumption per household in Tianjin is about 50L. The calculation formula of rural domestic sewage production is as follows:

$$\mathbf{Q_2 = p q_2 f_3 t} \qquad (2)$$

In formula 2, $\mathbf{Q_2}$ is domestic sewage production（t/d）; **p** is number of permanent residents in rural areas(person); $\mathbf{q_2}$ is water consumption per person per day($\mathbf{q_2}$=50L); $\mathbf{f_3}$ is coefficient of sewage generation($\mathbf{f_3}$=0.8); **t** is time(d).

2.1.3. Estimation model of crop straw production. The main crops in Tianjin are rice, wheat, maize, legumes, potatoes, cotton and vegetables.

According to crop straw-grain ratio coefficient [6], the formula for estimating crop straw yield is as follows:

$$\mathbf{Q_3 = \sum_{i=1}^{n} a_i y_i} \qquad (3)$$

In formula 3, $\mathbf{Q_3}$ is crop straw production（ten thousand t）; $\mathbf{a_i}$ is grass-valley ratio coefficient of crops; $\mathbf{y_i}$ is the yield of type **i** crops（ten thousand t）; **i** represents different crop categories; **n** is a total of **n** crop species.

IOP Conf. Series: Earth and Environmental Science **510** (2020) 032032 doi:10.1088/1755-1315/510/3/032032

2.1.4. Estimation model of livestock and poultry excrement production. Large scale breeding in Tianjin mainly includes pigs, cattle, poultry, etc.

According to the daily faecal excretion, faecal dry matter ratio, faecal collection coefficient and other indicators [7], the calculation formula of faecal production of livestock and poultry is:

$$Q_4 = \sum_{i=1}^{n} f_{1i} f_{2i} f_{3i} f_{4i} N_i \qquad (4)$$

In formula 4, Q_4 is annual production of livestock and poultry manure（ten thousand t）; i is category i livestock and poultry; f_{1i} is No. i daily fecal excretion of livestock and poultry (kg/d); f_{2i} is feeding days of No. i fecal livestock and poultry (d); f_{3i} is dry matter ratio of category i livestock and poultry feces(%); f_{4i} is fecal collection coefficient of category i livestock and poultry; N_i is number of livestock and poultry in category i at the end of the year(ten thousand heads).

2.1.5. Measurement and calculation of main pollution sources .According to formulas 1 to 4, the output of rural domestic waste, domestic sewage, crop straw and livestock manure in Tianjin in 2016 were estimated to be 1.31 million tons, 38.9 million tons, 3.74 million tons and 1.53 million tons respectively.

Among them, the correlation coefficients and yields of the main crop straw and the main livestock and poultry manure are shown in Table 1 and Table 2.

Table 1. Straw Production of Main Crops in Tianjin in 2016 (Unit: 10000 t)

Project	Grass Valley Ratio	Crop Yield	Straw Yield	Converted Energy Coefficient (kg Standard Coal/kg)	Conversion of Standard Coal Energy Quantity
Rice	1	13.36	13.36	0.43	5.74
Wheat	1.37	60.89	83.42	0.5	41.71
Corn	2	118.1	236.20	0.5	118.10
Beans	1.5	1.19	1.79	0.53	0.95
Tubers	1	0.95	0.95	0.43	0.41
Peanut	2	0.56	1.12	0.5	0.56
Sesame	2	0.01	0.02	0.5	0.01
Cotton	3	2.33	6.99	0.53	3.70
Vegetables	0.068	450.36	30.62	0.5	15.31
Total			374		186.50

Table 2. Production of livestock and poultry manure, biogas production capacity and benchmark coal in Tianjin in 2016

Name	Cattle	Pig	Sheep	Poultry	Total
Number of entries at the end of the Year（Ten thousand heads）	20.07	374.79	68.79	7910.6	
Daily Fecal Excretion (kg/d)	24.44	4.25	2.6	0.13	
Number of Feeding Days Throughout the Year (d)	365	365	365	190	
Dry Matter Ratio of Feces（%）	18	20	75	25	
Fecal Collection Coefficient	0.6	0.6	0.6	0.7	
Annual fecal production（ten thousand t）	19.34	69.77	29.38	34.19	152.67
Dry Matter Gas Production Rate（m^3/kg）	0.3	0.2	0.3	0.3	
Biogas Production Capacity（ten thousand m^3)	5802	13954	8814	10257	38827
Standard coal quantity（ten thousand t）（1 m^3 biogas is equivalent to 0.714 kg standard coal）	4.14	9.96	6.29	7.32	27.72

IOP Conf. Series: Earth and Environmental Science **510** (2020) 032032 doi:10.1088/1755-1315/510/3/032032

2.2. Benefit evaluation of resource utilization

The benefit evaluation of resource utilization includes economic benefit evaluation, environmental benefit evaluation and social benefit evaluation.

2.2.1. Economic benefit evaluation. (1) Economic benefit evaluation model of rural domestic waste. The economic benefits of domestic waste resource utilization are mainly embodied in the organic fertilizer produced after in-situ reduction treatment, as well as the transportation and treatment costs reduced by waste reduction. Therefore, the calculation formula of economic benefits of domestic waste resource utilization is established as follows:

$$E_1 = E_{Replace} + E_{Saving} \quad (5)$$
$$E_{Replace} = Q_{11}(f_1p_1 + f_2p_2 + f_3p_3)$$
$$E_{Saving} = Q_1p_4$$

In formula 5, E_1 is economic savings of rural domestic waste reduction; $E_{Replace}$ is cost-saving of organic manure instead of commercial fertilizer from domestic waste; E_{Saving} is reducing the cost of transportation and disposal of domestic waste; Q_{11} is the reduction of garbage(about 70% of garbage production）; f_1 is quantity of 1 t organic fertilizer replacing ammonia sulfate(1 t common compost is equivalent to 20-25kg ammonium sulfate，here is 22.5kg); p_1 is current Ammonia Sulfate Market Price(about 1000 yuan/t); f_2 is quantity of 1 t organic fertilizer replacing superphosphate(1 t compost is equivalent to 11-16kg superphosphate， here is 13.5kg）; p_2 is current market price of superphosphate(about 700 yuan/t); f_3 is quantity of 1 t organic fertilizer replacing potassium sulfate(1 t ordinary compost is equivalent to 9-14kg of potassium sulfate，here is 11.5kg）; p_3 is current market price of potassium sulfate(about 3000 yuan/t); p_4 is costs of collection, transit, transportation and disposal of domestic waste(about 500 yuan/t).

(2) Economic benefit evaluation model of rural domestic sewage. The rural domestic sewage can replace the underground clean water resources for agricultural production. Therefore, the calculation formula of economic benefit of rural domestic sewage resource utilization is as follows:

$$E_2 = Q_2 * p_5 - Q_2 * p_6 \quad (6)$$

In formula 6, E_2 is net water resources cost saved by rural domestic sewage treatment; Q_2 is rural domestic sewage production; p_5 is price of groundwater resources for rural domestic land (The current price is 4.9 yuan/t.); p_6 is treatment cost of 1 t domestic sewage (The current price is 1 yuan/t, including labor and management costs, equipment depreciation costs, power consumption medicines and equipment maintenance costs.).

(3) Economic benefit evaluation model of crop straw. In this paper, the economic benefits of crop straw as a substitute for primary energy were calculated from biomass gasification and biomass power generation. Biomass gasification is calculated based on the liquefied gas fuel with equivalent effective heat energy as straw gas. In addition to gasification, straw can also be used for power generation. Power plants buy straw from farmers, who produce economic value by selling straw. Assume that 1/3 of the straw is used for centralized gas supply to farmers as energy for daily use, and 1/3 for power generation. The formulas for calculating the economic benefits of straw resource utilization are as follows:

$$E_3 = \frac{1}{3}E_{Gasification} + \frac{1}{3}E_{Electricity} \quad (7)$$
$$E_{Gasification} = [(CV_1 * r_1)/(CV_2 * r_2)] * p_7 * Q_3 * d$$
$$E_{Electricity} = Q_3 * p_8$$

In formula 7, CV_1 is calorific value of biomass combustible gas(20,934kJ/m^3); r_1 is thermal efficiency of biogas stove(60%); CV_2 is low calorific value of liquefied gas(5,0241kJ/kg); r_2 is average thermal efficiency of liquefied gas stove(60%); p_7 is liquefied gas price(7.3 yuan/kg); Q_3 is available straw yield; d is combustible gas production from biomass gasification(300m^3/t); p_8 is the price of straw sold to power plants(The current price is 100 yuan/t.).

(4) Economic benefit evaluation model of livestock and poultry manure. Livestock and poultry

manure produces biogas, biogas residue and biogas slurry through biogas engineering. Assuming that livestock and poultry manure can be collected for biogas engineering, 1/3 of biogas is used for cooking, and 2/3 of biogas is used for power generation. Assuming that biogas residue and biogas slurry are all substitutes for chemical fertilizer, the production of biogas residue is 1/2 of the available dry matter production of livestock and poultry manure, and the production of biogas slurry is 4.5 times that of biogas residue. The formulas for calculating the economic benefits of the utilization of livestock and poultry manure are as follows:

$$E_4 = E_{Fuel} + E_{Power} + E_{Fertilizer} \quad (8)$$

$$E_{Fuel} = \frac{1}{3} * (Q_{Pig} * a_1 + Q_{Others} * a_2) * [(BV_1 * r_3)/(BV_2 * r_4)] * p_9$$

$$E_{Power} = \left[\frac{2}{3} * (Q_{Pig} * a_1 + Q_{Others} * a_2) * b\right] * r_5/r_6 * p_{10}$$

$$E_{Fertilizer} = \frac{1}{2} Q_4 * (f_4 p_1 + f_5 p_2 + f_6 p_3) + 4.5 * \frac{1}{2} * Q_4 * (f_7 p_1 + f_8 p_2 + f_9 p_3)$$

In formula 8, E_4 is economic effect of resource utilization of livestock and poultry feces; E_{Fuel} is the economic benefit of producing biogas as fuel from livestock and poultry manure; E_{Power} is the economic benefit of producing biogas from livestock and poultry manure by generating electricity; $E_{Fertilizer}$ is the economic benefit of replacing commercial fertilizer with biogas sludge from livestock and poultry manure; Q_4 is the production of animal manure; Q_{Pig} is the annual output of pig excrement; Q_{Others} is the annual output of other livestock and poultry excrement except pigs; a_1 is the rate of biogas production from dry matter of pig manure(0.2m^3/kg); a_2 is the rate of biogas production from dry matter of other livestock and poultry manure(0.3m^3/kg); BV_1 is the calorific value of biogas(20,934kJ/m^3); BV_2 is the low calorific value of liquefied gas(50,241kJ/kg); r_3 is the thermal efficiency of biogas stove(60%); r_4 is the average thermal efficiency of liquefied gas stove(60%); p_9 is the price of liquefied gas(1.88 yuan/m^3); b is the power generation of 1 m^3 biogas(1.9 kWh/ m^3); r_5 is the power generation efficiency of natural gas(37%); r_6 is the power generation efficiency of integrated coal gasification combined cycle unit(41%); p_{10} is the average electricity price(0.6 yuan/kWh); f_4 is the nitrogen content in the biogas residue(0.8%~2%, taking the median is 1.4%); f_5 is the phosphorus content in biogas residue(0.4%~1.2%, taking the median is 0.8%); f_6 is the nitrogen content in the biogas residue(0.6%~2%, taking the median is 1.3%); f_7 is the nitrogen content in the biogas slurry(About 40% of the nitrogen content of biogas residue, here is 0.08%); f_8 is the nitrogen content in the biogas slurry(About 23% of the nitrogen content of biogas residue，here is 0.046%); f_9 is the nitrogen content in the biogas slurry(About 37% of the nitrogen content of biogas residue, here is 0.074%).

(5) Estimation of economic benefits of major pollution sources. Based on the calculation of main pollution sources, according to formulas 5 to 8, it is estimated that the cost of reducing rural domestic waste in Tianjin in 2016 will be about 519.43 million yuan. Among them, organic fertilizer instead of chemical fertilizer saved 60.93 million yuan economically, and the transportation and disposal cost saved by reducing waste is 458.5 million yuan; The cost of net water resources saved by treating domestic sewage is 151.83 million yuan; The economic benefit of comprehensive utilization of main crop straw is 1261.63 million yuan. Among them, the economic benefit of straw gasification is 1136.96 million yuan, and that of straw power generation is 124.67 million yuan; the economic benefit of comprehensive utilization of livestock and poultry manure is 423.86 million yuan. Among them, the benefits of replacing primary fuel with biogas are 101.37 million yuan, that of replacing primary energy with biogas power generation is 266.28 million yuan, and that of replacing chemical fertilizer with biogas slurry is 56.21 million yuan. Through the comprehensive utilization of these four types of pollution sources, the total economic benefit will be about 2356.75 million yuan.

2.2.2. Environmental benefit assessment. Considering that the impact of rural domestic waste and sewage on the air, soil and groundwater environment is relatively small, this paper mainly estimates the impact of crop straw and livestock manure on the air environment and agricultural and rural non-point source pollution.

(1) Estimation model of environmental benefits for reducing air pollution. The environmental benefits of crop straw can be evaluated by comparing the atmospheric pollutants discharged from gasification combustion with those discharged from substituting coal combustion (converted into standard coal). Livestock and poultry manure is based on the comparison of pollutants from biogas combustion and those from coal combustion to evaluate its environmental benefits. The formulas for calculating the environmental benefits of reducing air pollution are as follow [8]:

$$EA = \sum_{i=1}^{2}(EB_i - ER_i) \qquad (9)$$

$$EB_i = \sum_{i=1}^{2} BE_i * (SO_{2i} + NO_{xi} + CO_{2i})$$

$$ER_i = \sum_{i=1}^{2} BR_i * (SO_{2i} + NO_{xi} + CO_{2i})$$

In formula 9, EA is the total environmental benefit; EB_i is the pollutant emission of the i kind of biomass benchmark coal after combustion; ER_i is the pollutant discharge of the i kind of biomass resource utilization; SO_{2i} is the SO_2 emission factor of the i class of biomass; NO_{xi} is the NO_X emission factor of the i class of biomass; CO_{2i} is the carbon dioxide emission factor of the i type biomass; BE_i is the discounted energy quantity of the fifth biomass resource(see Table 1 and Table 2); BR_i is the resource utilization of the i kind of biomass. The resource utilization of straw is expressed by straw gasification, and the resource utilization of livestock and poultry manure is expressed by biogas fuel. The emission coefficients of SO_2, NO_X, CO_2 and CH_4 from common straw and livestock manure to the atmosphere are shown in Table 3.

Table 3. Biomass Emission Coefficient

Source	Mode	SO_2/kg · t^{-1}	NO_X/kg · t^{-1}	CO_2/kg · t^{-1}	CH_4/kg · t^{-1}
Crop Straw	converted standard coal	28.5	7.04	2554.31	127.67
	gasification	5.74×10^{-2}	1.95	0	
Livestock Manure	converted standard coal	28.5	7.04	2554.31	127.67
	methane	5.74×10^{-2}	1.95	0	

(2) Estimation model of environmental benefits for reducing agricultural and rural non-point source pollution. Using livestock manure to produce biogas and biogas manure can reduce N and P emissions from manure to soil and water, and control agricultural non-point source pollution from the source. Therefore, the environmental benefits of agricultural non-point source pollution can be evaluated by the content of N and P in livestock and poultry manure. The calculation formulas are as follows:

$$TE = EN + EP = \sum_{i=1}^{n} LS_i * LN_i + \sum_{i=1}^{n} LS_i * LP_i \qquad (10)$$

In formula 10, TE is the total amount of N and P; EN is the amount of total N; EP is the amount of total P; LN_i is the content of N in the excrement of the i kind of livestock and poultry; LP_i is the content of P in the excrement of the i kind of livestock and poultry; LS_i is the excrement resource of the i kind of livestock and poultry(See Table 4).

(3) Comprehensive evaluation of environmental benefits of major pollution sources. According to formula 9, assuming that 1/3 of straw is used for gasification and direct combustion, and 1/3 of biogas is used for rural living energy, it is estimated that the utilization of straw and livestock manure in 2016 in Tianjin can reduce the greenhouse gas emissions by 1.937 million tons. Among them, SO_2 emission reduction is about 20.3 thousand tons, NO_X emission reduction is about 1.6 thousand tons, CO_2 emission reduction is about 1823.9 thousand tons and CH_4 emission reduction is about 91.2 thousand tons.

According to formula 10, it is estimated that in 2016, the total amount of N and P discharged into the soil from the main livestock and poultry manure in Tianjin will be reduced by 10.8 thousand tons through resource utilization. Among them, the total N emission is reduced by 5.6 thousand tons and the total P emission is reduced by 5.2 thousand tons.

Table 4. Estimation of total N and P in livestock and poultry manure in Tianjin in 2016 (unit: 10,000 t)

Serial number	Livestock and poultry species	N content /kg · t^{-1}	P content /kg · t^{-1}	Livestock and poultry excrement resources	Total N	Total P	Total N and P
1	pig	2.4	5	69.77	0.17	0.35	0.52
2	cattle	4.4	2	19.34	0.09	0.04	0.12
3	sheep	9	3	29.38	0.26	0.09	0.35
4	poultry	1.26	1.31	34.19	0.04	0.04	0.09
Total				152.67	0.56	0.52	1.08

2.2.3. Social benefits. The comprehensive utilization of agricultural and rural pollution sources not only has better economic and environmental benefits, but also has better social benefits.

(1) Ensuring energy security. Biomass energy is renewable energy, and its development and utilization can improve the energy structure and reduce the dependence on fossil energy.

(2) Promoting agricultural transition and upgrading. The development and utilization of biomass energy will promote the transformation from traditional agriculture to modern agriculture, help cultivate new development direction of agriculture, and promote the healthy development of modern ecological agriculture.

(3) Promoting farmers' employment and income increase. Farmers sell agricultural wastes as commodities, which can bring benefits to farmers. In addition, the development of biomass energy industrialization will give birth to many new industries, which is conducive to the employment and Entrepreneurship of farmers and reduce the pressure of social employment, which plays an important role in maintaining social stability.

3. Thoughts on the management of agriculture and rural ecological environment

3.1. Overall thinking

Guided by the construction of beautiful and livable countryside, focusing on the control of non-point source pollution in agricultural countryside and the beautification and upgrading of rural human settlements environment, and in accordance with the best management measures (BMPs), the BMPs system is constructed. The source control and end control of agricultural and rural pollution are carried out from engineering measures(EM) and non-engineering measures(NEM), so as to eliminate or reduce pollution from the source and further consolidate and enhance the effectiveness of non-point source pollution control from the terminal to ensure the good ecological environment of agricultural and rural areas, make up for the shortcomings of environmental governance in rural revitalization, and lead the green and sustainable development of agricultural and rural areas with ecological livability.

3.2. Construction of BMPs system

The construction of BMPs system includes engineering and non-engineering measures, and combines engineering and non-engineering measures to control pollution sources in basic unit. According to different treatment units, different BMP combinations are selected. Through cost-benefit analysis, the optimal BMP combinations are selected to construct a BMPs system suitable for non-point source pollution control of the treatment unit[9, 10, 11, 12]. BMPs system for non-point source pollution control is shown in Fig. 1.

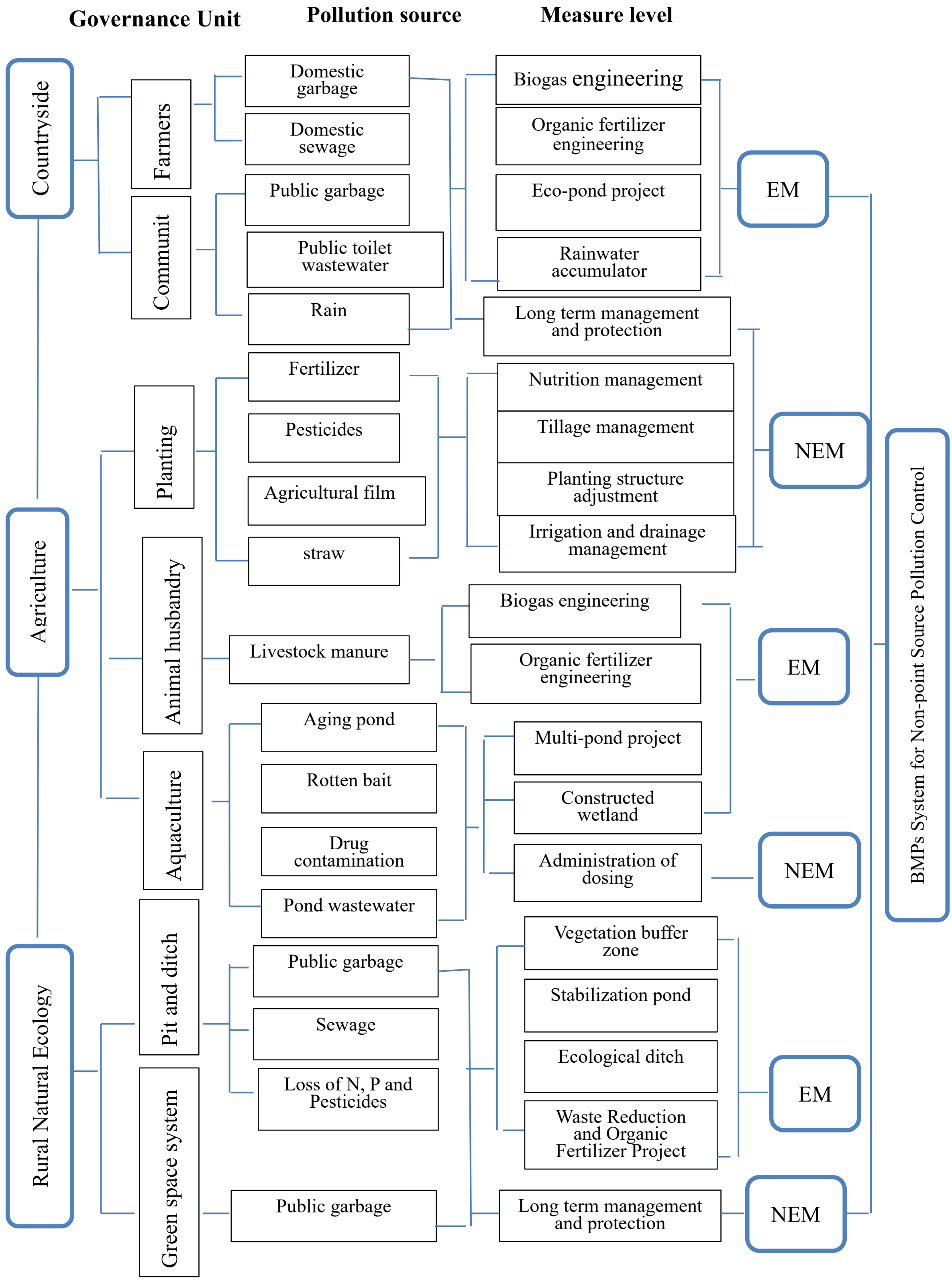

Figure 1. BMPs System for Non-point Source Pollution Control

According to Fig. 1, non-engineering BMPs mainly take source control as the basic strategy, and take appropriate measures to reduce non-point source pollution in pollution management and agricultural cultivation through relevant administrative regulations and the participation of the masses. Non-engineering BMPs mainly include nutrient management at the agricultural level, farming management, crop structure adjustment, irrigation and drainage management, drug administration in aquaculture industry, and long-term environmental protection measures at the rural level.

Engineering BMPs take pollution control in surface runoff process as the main way to remove pollutants by prolonging runoff residence time, slowing down flow velocity, reducing infiltration into underground, physical precipitation filtration and biological purification. Engineering BMPs mainly include stabilization pond, ecological ditch, rainstorm storage pond, vegetation buffer zone, constructed wetland, multi-pond project, biogas project, organic waste fertilizer engineering and other facilities.

4.Measures and suggestions

4.1. Establishment of facilities construction management mechanism

(1) Improving the operation mechanism of rural domestic waste and sewage. The government should improve the mechanism of garbage classification, collection and transportation management, and realize seamless connection from garbage classification to harmless treatment. The mechanism of harmless treatment of rural domestic sewage should be improved, from sewage collection and terminal treatment to discharge up to standard, in line with the requirements of harmless treatment of sewage, to ensure that the sewage can be collected and discharged up to standard [13].

(2) Improving the infrastructure construction mechanism. According to the principle of "what is missing and what is to be supplied", the infrastructure construction mechanism should be established, and the infrastructure construction of rural domestic refuse treatment facilities, sewage treatment facilities, drinking water sources facilities, livestock and poultry breeding communities, aquaculture ponds and farmland road networks should be further standardized. Construction should be carried out strictly in accordance with the design standards.

(3) Improving infrastructure management mechanism. According to the classification of infrastructure, different infrastructure management mechanisms, such as village roads, street lights, garbage treatment facilities, sewage treatment facilities, greening and aquaculture communities, will be improved, long-term management and protection measures will be formulated, and regular inspection and maintenance will be carried out to ensure the long-term operation of facilities.

4.2. Perfecting the supervisory mechanism of legislative enforcement

(1) Perfecting Village Environmental legislation. The management and protection of rural public facilities should be included in the legal framework of rural ecological environmental protection, the environmental protection behavior of villages should be standardized, and the normal and orderly operation of rural public facilities should be guaranteed through legislation.

(2) Improving the legislation of agricultural environment. Laws and regulations on the application of chemical fertilizer and pesticide should be established to regulate the application standards and behaviors of chemical fertilizer and pesticide; laws and regulations on environmental protection such as soil pollution, livestock and poultry breeding pollution and farmland sewage irrigation should be formulated to reduce the pollution of agricultural production on groundwater environment; laws and regulations on the utilization of agricultural waste resources should be established to maximize the utilization of agricultural waste resources.

(3) Strengthen the management of comprehensive law enforcement. Based on the legal system of agricultural and rural ecological environment, the coordination and cooperation mechanism of departments should be established to form a comprehensive supervision mechanism with clear division of labor of relevant departments.

4.3. Improving the management mechanism of management system

(1) Establishing grid management system. According to the principle of territorial management and hierarchical responsibility, according to different environmental governance contents, the government should establish a grid management system with the district as the main responsibility and the town as the responsibility unit, and improve the responsibilities of the grid leader and grid members to comprehensively implement grid management.

(2) Establishing a system of accounting for environmental supervision. Relevant departments should register the environmental problems found by superior supervisors, media exposure, mass complaints and self-inspection, establish the rectification period, and publish the rectification results through the media.

4.4. Perfecting the guarantee mechanism of funds input

(1) Increasing financial investment. Special funds and working funds for agricultural and rural ecological environment treatment projects should be set up. The special funds are mainly used for environmental protection infrastructure construction, operation and maintenance, environmental protection publicity and environmental monitoring. The working funds are mainly used for daily work subsidies for environmental protection personnel [14].

(2) Implementing the charging system for domestic waste and sewage treatment. According to the principle of "Whoever pollutes pays", a mechanism combining household payment, village collective subsidy and financial subsidy should be gradually established to guide the villagers to change their awareness of environmental protection and undertake the responsibilities and obligations of rural ecological environment governance.

(3) Establishing the mechanism of social capital participation. For the projects that can be managed in a market-oriented way, the government and social capital are encouraged to adopt PPP, BOT and other cooperation ways to push the projects to the market, so as to broaden the investment channels of rural ecological environment governance.

4.5. Improving the compensation mechanism for ecological protection

(1) Improving the management mechanism of ecological protection subsidy. The subsidy project system should be constructed to clarify the scope and standard of different ecological project protection subsidies, and the subsidy supervision and evaluation mechanism should be established to ensure the effect of ecological protection subsidies.

(2) Establishing a subsidization mechanism for reducing fertilizer and pesticide application. The subsidy mechanism should be set up and subsidized according to the application amount of organic fertilizer instead of commercial fertilizer. The subsidy mechanism for pesticide reduction should be established and subsidies should be made according to the application amount of biological measures instead of pesticides.

(3) Establishing a subsidy mechanism for the resource utilization of straw and livestock manure. According to different directions of straw utilization, different subsidy policies are formulated to maximize straw utilization. The subsidy policy for the treatment of livestock and poultry manure should be formulated to provide subsidies for the utilization of livestock and poultry manure to maximize the utilization of livestock and poultry manure [15].

4.6. Improving the joint supervision mechanism between the government and the people

(1) Establishing the mechanism of supervision by public opinion. Special channel columns should be set up in local government portal websites, TV stations and other media to regularly report local rural ecological environment governance, typical experience models and outstanding environmental problems, and accept the supervision of public opinion.

(2) Establishing a joint supervision mechanism. The plan of agricultural and rural ecological environment governance should be formulated, and the governance measures and management and protection measures should be implemented, so as to implement the normal supervision of the rural environment. Telephone boards for environmental supervision and reporting shall be set up in the

main public places of villages, and the relevant departments should specially accept the rural environmental pollution issues.

(3) Establishing an annual assessment mechanism. The "evaluation index system of agricultural and rural ecological environment" should be issued by relevant government departments to dynamically evaluate the local agricultural and rural ecological environment on an annual basis, and form a long-term mechanism to gradually improve the level of local agricultural and rural environmental governance.

Acknowledgement
Tianjin Science and Technology Development Strategic Research Plan Project (19ZLZDZF00120)

References

[1] Corjan Brink, Ekko van Ierland, Leen Hordijk, Carolien Kroeze. Cost_effective emission abatement in agriculture in the presence of interrelations: cases for the Netherlands and Europe[J]. Ecological Economics, Volume 53, Issue 1, 1 April 2005, Pages 59-74.
[2] Yu Jiangkun, Cai Liyuan, Zhang Ji, Guo Jiao, Hu Ronggui, Qi Desheng. Influencing Factors to Greenhouse Gas Emissions and the Mitigation Measures in Aquaculture [J]. Journal of Domestic Animal Ecology, 2015, 36 (10): 80-85.
[3] Despina Giannadaki, EliasGiannakis, Andrea Pozzer, Jos Lelieveld. Estimating health and economic benefits of reductions in air pollution from agriculture[J]. Science of The Total Environment, Volumes 622–623, 1 May 2018, Pages 1304-1316.
[4] National Statistical Bureau of the People's Republic of China. China Statistical Yearbook - 2018 [M]. Beijing: China Statistical Publishing House, 2018.9.
[5] Dong Hongmin, Li Yue, Tao Xiuping, Peng Xiaopei, Li Na, Zhu Zhiping. China greenhouse gas emissions from agricultural activities and its mitigation strategy [J]. Transactions of the Chinese Society of Agricultural Engineering, 2008 (10): 269-273.
[6] Zhang Yaping, Zuo Yuhui, Bo Yiyao. Resource status and potential development of energy agriculture in Jiangsu Province [J]. Acta Ecologica Sinica, 2008, 28 (8): 3948-3957.
[7] Zhang Tian, Bo Meidong, Geng Wei. Pollution status and biogas-producing potential of livestock and poultry excrements in China [J]. Chinese Journal of Ecology, 2012, 31 (5): 1241-1249.
[8] Zhang Yaping, Sun Keqin, Zuo Yuhui. A Benefit Evaluation and Regional Analysis of Energy Agriculture Development in China [J]. Resources Science, 2009 (12): 2080-2085.
[9] Feng Yongzhong, Xie Xiaojun, Yang Yinlu, Cao Yanchun, Yang Gianhe. Project for controlling non-point source pollution in Ningxia Yellow River irrigation region based on Best Management Practices[J]. Journal of Northwest A & F University(Natural Science Edition), 2011, 39 (07): 171-176.
[10] Tang Hao. Study on BMPs for pollution control of agricultural non-point sources [J]. Yangtze River, 2010, 41 (17): 54-57.
[11] Qiu Weiguo, Wang Chao, Chen Jianzhong, Tang Hao. Discussion on the Best Management Measures for Non-point Source Pollution Control in American Agriculture [A]. China Ocean Engineering Society. Papers of the 12th China Coastal Engineering Symposium [C]. China Ocean Engineering Society: China Ocean Society Ocean Engineering Branch, 2005.5.
[12] Sun Ping, Zhou Yuanwei, Hua Xin, Bo Yiyao, Feng Lin. BMP Framework for Nonpoint Source Pollution Control in the Three Gorges Reservoir Area [J]. Journal of Hydroecology, 2017, 38 (01): 54-60.
[13] Zhang Yu, Zhu Lizhi. Agricultural and Rural Ecological Restoration——Based on the Case of Zhejiang [J]. Environment and Sustainable Development, 2016 (3): 143-147.
[14] Wen Xiaoming. An Effective Way to Protect Rural Ecological Environment in the Process of New Urbanization--Take Longyan City as an Example [J]. Economic Research Guide, 2015, 274 (20): 135-139.
[15] Lin Fang, Zhang Jiayang, Wang Shuli, Zhou Junli, Zhou Yong. The Study on Rural Ecological Environment Protection and Development in Henan[J]. Chinese Agricultural Science Bulletin, 2011, 27 (04): 406-409.