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Developmental Status Quo and Trends of Low-carbon Agriculture

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Abstract In order to reduce carbon emission in agricultural production, this paper has discussed the developmental trends of low-carbon agriculture in terms of developing precision agriculture, improving the efficiency of fertilizer utilization, scientific use of pesticides, water-saving irrigation, ecological control of pests and diseases, as well as energy conservation and emission reduction by agricultural machinery and other agricultural practices.

Key words Low-carbon agriculture, Precision agriculture, Greenhouse gases, Ecological control, Energy conservation and emission reduction

The global climate change has become an important issue of concern to all mankind. In February 2007, IPCC published the fourth assessment report on global climate change, which indicated that the surface temperature is increased by 0.13 ℃ every decade from 1956 –2005. The amount of increase is twice as high as in the past 100 years[1]. The increase in global surface temperature has affected food security and threatened the production, life and survival of human beings. It also has a serious impact on the natural ecosystems and socioeconomic system. Developing low-carbon agriculture is an important strategic measure to eliminate the climate warming and energy crisis, and is an inevitable choice to transform the agricultural production growth pattern.

With the scale enlarging and improvement of mechanization level, the economic linkage between the agricultural production and reducing greenhouse gas emissions is even closer in the agricultural production system. The agricultural inputs are divided into the inputs produced in the agricultural activity itself and the inputs produced in the industrial production. The relations between the inputs of agricultural biogenic elements and greenhouse gas emission are increasingly close. Electric power, petroleum and other energy resources are also needed for the manufacturing and using of agricultural machinery. Energy consumption is essential for the processing and distribution of agricultural products. Energy consumption is also needed for the processing and utilization of agricultural wastes. The whole process before, during and after agricultural production is associated with the energy consumption and greenhouse gas emissions. Therefore, the developing of low-carbon agriculture model is also one of the long-term development strategies for the development of low-carbon economy throughout the country.

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1 Current situation of greenhouse gas emission in agricultural production

Greenhouse gases mainly include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3) and chlorofluorocarbon (CFC) *etc*. Among the greenhouse gases, CO_2 has the maximum quantity (excluding the water vapor), accounting for about 0.04% of the total atmospheric capacity[2]. As the energy consumption and greenhouse gas emissions of modern agricultural production are considerably larger, the modern agriculture is also called "oil agriculture". It is estimated that the total greenhouse gas emissions in soil preparation, sowing, irrigation, drying as well as fertilizers and pesticides each year have reached $1.50-2.00\times10^8$ t of carbon dioxide equivalent (CO_2 e). And 100 –130 kg CO_2 e/hm^2 of it is distributed to the farmland around the globe[3]. The greenhouse gas emission caused by fossil fuel consumption and agricultural input is one of the emission factors that get the earliest attention[4–6]. Relevant researches in China and America indicate that the greenhouse gas emission of farmland after applying the nitrogen fertilizer could offset 184% –552% of the carbon fixation efficiency of soil[7,8].

1.1 CO_2 emission in agricultural production With the improvement of scale and mechanization degree, the whole process before, during and after agricultural production is more closely associated with the energy consumption. And the emission of greenhouse gases including CO_2 has been increased. Both the inputs produced in the agricultural activity itself (such as the seeds and organic fertilizer *etc*.) and the inputs produced in the industrial production (such as the chemical fertilizer and other agricultural materials) will lead to greenhouse gas emission. For example, nitrogen fertilizer will consume a large amount of fossil energy and result in carbon emission during the production process. According to the synthesis ammonia reaction, synthesizing 1 mol of ammonia will emit 0.375 mol CO_2, even when it is in the ideal state of synthesis – efficiency of 100%[5,9]. Studies show that carbon emission produced by each ton of nitrogen fertilizer in America is 0.814 1 t CO_2 e[10], and the greenhouse gas emissions produced by each ton of chemical fertilizer throughout the production, packing, storage and transportation processes may reach 0.9 – 1.9 t CO_2 e[11]. As the main energy source used for nitrogen fertilizer production is anthracite, no less than 1.74 t CO_2 e will be emitted when producing one ton of nitrogen fertilizer[8].

Finally, the processing of wastes from agricultural production will also emit a large amount of CO_2. At present, the agricultural straw output in our country is about 6×10^8 t per year[12]. And the straw of rice, maize and wheat accounts for about 76% of the total amount. Generally, straw burning is applied to process the straw, which produces large amount of smoke, CO_2 and other polluting substances[13]. Under appropriate conditions, the natural fermentation of straw will also decompose and produce a large amount of CO_2[14].

1.2 CH_4 emission in agricultural production The contribution of CH_4 in the global climate warming effect accounts for 15%, second only to CO_2. Currently, CH_4 is increased at a rate of 0.6% each year, and the total content of CH_4 in the atmosphere has reached 4 700 Tg (1 Tg = 10^{12} kg). The emission source of CH_4 in the atmosphere can also be divided into the natural and anthropogenic sources. In the natural source, the wet land emits 100 – 200 Tg of CH_4 per year to the atmosphere, the land and water surface emit 1 – 25Tg, and the oceans emit 5 – 20 Tg. The anthropogenic source emits 289 – 640Tg of CH_4 to the atmosphere per year, mainly including fossil fuel production, coal mining, natural gas transportation, biological energy combustion, landfill, cud chewer and rice field *etc*. Among them, the CH_4 emission from irrigation of rice fields accounts for 11% of total CH_4 emissions[15], and is an important emission source of CH_4[16]. At present, the rice field acreage around the world is about 140 million hm^2, and more than 90% of the rice field is distributed in Asia. In 2007, the rice planting area accounted for about 18.66% of the total rice area around the world[17]. It is scientifically estimated that the CH_4 emission of the rice field in our country per year is about 7.67 – 8.05 Tg[18], accounting for about 19.6% of the total methane emissions from the rice field around the world.

1.3 N_2O emission in agricultural production N_2O is the third largest greenhouse gas, increasing by 0.2% – 0.3% per year[20]. As compared to CH_4, the decomposition velocity of N_2O in the atmosphere is slower. N_2O may exist for about 140 years in the atmosphere, and the greenhouse effect caused by N_2O is 150 – 200 times of that of equivalent CO_2[21]. Besides, N_2O may also lead to O_3 decomposition and a series of environmental problems[22]. It is estimated that 90% of N_2O in the atmosphere comes from the biological source of earth surface. The soil is the most important N_2O emission source of the world, especially the farmland soil and tropical soil. The contribution rate of soil reaches up to 70% – 90%[23]. The application of nitrogen fertilizer constitutes a major cause for the increase of N_2O emissions in farmland[24]. Especially when too much nitrogen fertilizer is applied[25.26], N_2O emissions in farmland will be increased rapidly.

According to De Nitrification De Composition (DNDC) modeling, Li Changsheng *et al*[27] believe that N_2O is the primary greenhouse gas emitted by the farmland in China. Besides, studies show that the direct N_2O emissions in soil will be 78% and 155% of the current level respectively when the application amount of chemical nitrogen fertilizer in farmland is halved or doubled. In Canada, the contribution of chemical nitrogen fertilizer accounts for 10 – 15% of the total N_2O emissions[28]. Therefore, the application of nitrogen fertilizer will increase N_2O emission to a large extent. Follet[7] believes that net mitigation potential of chemical nitrogen fertilizer application is negative, and the application of nitrogen fertilizer can not make a contribution to the mitigation of global warming. Excessive nitrogen fertilizer can not hold more organic carbon, but only increase N_2O emission of soil and the greenhouse gas emissions in nitrogen fertilizer production.

2 Developmental trend of low-carbon agriculture

2.1 Perform precision fertilization to improve the efficiency of fertilizer utilization Chemical fertilizer is the fastest and most effective measure to increase production. The application amount of chemical fertilizer in our country has been increased at a rate of 4% since the 1980s. Currently, China has become the largest fertilizer producer and consumer of the world. The application amount of chemical fertilizer in our country each year approaches 1/3 of the total application amount of the world. The total application amount of chemical nitrogen fertilizer all over the country each year is about 12 070 000 – 42 760 000 tons[8,30-31]. Generally, the application amount of pure nitrogen in production is 180 – 250 kg/hm^2, and the application amount in individual regions reaches up to 400 – 600 kg/hm^2. Excessive nitrogen fertilizer will reduce the utilization efficiency of nitrogen fertilizer, increase the crop production rate, and cause a serious waste of resources. The loss of nitrogen fertilizer will cause serious environmental pollution, ground water pollution and eutrophication of rivers and lakes. Besides, the greenhouse gas emitted through denitrification will accelerate global warming. The data show that the utilization efficiency of chemical fertilizer in our country is relatively low. Under the influence of volatilization, leaching and runoff loss, the utilization rate of nitrogen fertilizer on rice, maize and wheat is 28% – 41%[32] in China, and the utilization efficiency of nitrogen fertilizer on rice is 33% ± 11%[33]. The utilization rate of phosphate fertilizer in current season is even lower at about 10% – 25%[34]. The utilization rate of potash fertilizer in current season is only about 50%, though it is greater than that of the nitrogen and phosphate fertilizer[32,35].

2.1.1 Precise real-time and field nitrogen fertilizer management. It will take a long time to perform sample collection, treatment and analyzing test in the traditional soil testing and formulated fertilization, which requires a lot of labor and material resources with long cycle and low efficiency[36]. In fact, the field crops including rice will show some obvious characters under the nutrient stress. According to the relative data of chlorophyll monitored in field conditions and the leaf color from nitrogen diagnosis determined on the basis of the relationship with the nitrogen content of plant, the nitrogen content of crops and its utilization will be inferred and used to guide fertilization. The greatest strength of this method is that the fertilization time and nitrogen application rate will satisfy the demand of crops. The real-time and field nitrogen fertilizer management will coordinate the relationship between the rice yield and quality in a better way. But it is important to determine the appropriate preset threshold of the chlorophyll meter according to different rice varieties and traits. Under this experimental condition, the real-time and field nitrogen fertilizer management mode recommends to take a threshold of 38 – 39 on chlorophyll meter for the two-line hybrid rice variety "Liangyoupeijiu" and a threshold of 35 – 37 on chlorophyll meter for the "Shanyou 63" variety[37]. The threshold of 35 on chlorophyll meter applies to most of the tropical indica rice varieties[38].

2.1.2 Application of slow/controlled release fertilizers. One important reason for chemical fertilizer's low use efficiency is that the nutrient releasing time and strength of fertilizer do not match the crop needs. The slow/controlled release fertilizers can effectively delay or control nutrient releasing through improving the fertilizer efficiency releasing mechanism of the fertilizer itself. This ensures that the nutrient releasing time and its strength go well with the nutrient absorption law of crops, and is conducive to coordinating the nutrient requirements of plant, reduce fertilizer loss and improve the fertilizer utilization rate[39].

2.1.3 Precise management on comprehensive nutrient of farmland. The precise management technology of farmland nutrient is an important part of Precision Agriculture. The Precision Agriculture is a complete set of modern farm operation technology and management systems carried out at fixed position, fixed time and fixed quantify supported by the information technology according to the spatial variation. The basic meaning is to regulate crop inputs according to the soil properties of crops, verifying the internal soil properties and productive spatial variation of farmland on one hand, and determining the production target of crops on the other hand. Perform "system diagnosis, formula optimization and scientific management" at fixed position and improve soil productivity to achieve equal income or higher income at the minimum or most economic input, which is helpful to improve the environment, utilize all kinds of agricultural resources efficiently and obtain the economic profit and environmental benefit[40]. The Precision Agriculture is composed of ten systems including the global positioning system, farmland information collection system, farmland remote sensing monitoring system, farmland geographic information system, agricultural expert system, intelligent farm machinery system, environmental monitoring system, system integration, network management system and training system[41].

Precision fertilization is one of the most popular techniques applied in the agricultural decision analysis. First, collect the data on soil nutrient (N, P, K, pH, organism, and trace elements) and crop growth condition and determine the difference on spatial attributes of farmland applying GIS. Then make decisions on fertilization according to the analysis system on variable rate fertilization decision in combination with the crop growth model and nutrient demand law. Finally, realize precision fertilization through the differential global positioning system and the variable rate fertilization control technology.

2.2 Straw returning to field The crop straw contains a lot of nutrient elements including nitrogen, phosphorus and potassium and a lot of trace elements including ferrum, manganese and zinc. After returning straw to the field, the physical, chemical and biological characters of the soil will be improved, playing an important role in reducing soil bulk density, loosing the soil and improving the permeability[43]. Besides, the cellulose, lignin and plentiful carbonaceous substances in crop straw are the main source to form soil organic matters. Applying the mixture of straw and chemical fertilizer is helpful to change the humic acid component in soil and improve soil humus quality of the soil. Moreover, straw returning in long term can also improve soil fertility, increase the organic content in soil and rationalize the soil nutrient structure, relieving the ratio imbalance of nitrogen, phosphorus and potassium in most of the land in China[44].

2.3 Scientific use of pesticides Pesticide application is a key point for the quality and safety of agricultural products and quality safety. Proper use of pesticides is an important measure to ensure agricultural output and improve the quality of agricultural products. According to statistics, there are 1 648 kinds of agricultural pests in our country. Several kinds of serious disease, pest, weed and rat attacks will break out and spread out each year, resulting in crop loss and crop failure in large area and serious quality decline. Grain loss caused by diseases and pests, weed attack and rats account for about half of the total grain output of the world. The application of pesticides may reduce the grain loss by almost 1/3. Rice is a major food crop of our country, and the rice grain yield accounts for about 40% of the grain output, playing an important role in ensuring national food security. Even with positive control, those diseases and injurious insects still bring about $0.4 \times 10^7 - 0.5 \times 10^7$ t of rice loss per year[45]. In order to control disease, pest, weed and rat damages, plentiful pesticides have been applied in the agricultural production. Meanwhile, as most of the farmers have inadequate understanding on the effect of pesticides and their environmental impact and do not know how to use pesticides appropriately; propaganda and supervision of pesticide supervision department is poor, excessive pesticide application, misuse of highly toxic and high-persistent pesticides and pesticide abuse are fairly common in the agricultural production of our country. Excessive application amount of chemical pesticides, the intensifying of environmental pollution, poisoning of people and livestock and chemical injury of crops, drug resistance of pests, exceeding pesticide residue on agricultural products and quality reduction have serious impact on the physical and psychological health of domestic consumers and reduce the international competitiveness of our agricultural products[46].

In view of this severe situation, making scientific prediction and suiting the remedy to the case are of great urgency. In recent years, many provinces and cities have established the disease and insect intelligence forecasting center to actively track and investigate the diseases and pests, publish the pest and disease damage condition observing and control methods and guide the farmers of use pesticides scientifically. Certain achievement has been obtained in this way.

2.4 Water-saving irrigation China is the world's largest rice producer, and rice is one of the major food crops in our country. The perennial plant area is 30.67 million hm^2 with the yield of around 19 billion kg, which accounts for 22.7% of the rice sowing area and 37% of the gross output all over the world. Furthermore, rice is one of the largest water consumers among the crops. The water consumption of rice accounts for more than 65% of the agricultural water consumption. Though more than 90% of the rice area throughout the country is distributed in the southern region that is rich in water resources, seasonal drought occurs frequently as the water resource is not uniformly distributed between years, regions and seasons in a year[47].

Our country is deficient in water resources seriously. Though the total amount of water resources reaches 2 800 billion m^3 which ranks the sixth in the world, the average per capita water availability is only 2 300 m^3, accounting 1/4 of the world average[48]. Besides, the water resource is unevenly distributed in different regions, the land and water resources do not match with the territorial resources. The land area of Yangtze River Basin and regions to its south only accounts for 36.5% of the whole country, but its water resources quantity accounts for 81% of the whole country; the land area of Huaihe River Basin and regions to its north accounts for 63.5% of the whole country, but the water resources quantity only accounts for 19% of the total amount of water resources all over the country. Moreover, the annual and inter-annual distribution of water resources is unbalance with frequent droughts and floods. At present, the agricultural water in our country accounts for 64.6% of the total water consumption. Without over-pumping of groundwater, the total water deficit at present is about 30 – 40 billion m^3 according to the normal requirements. Generally, the farmland drought area per year is 60 – 200 billion hm^2[49]. Besides, the utilization rate of agricultural water in China is relatively low, and water wastage is very serious when the traditional irrigation method is applied. Therefore, the development of water-saving efficient agriculture has become an urgent problem to be solved. In recent years, efficient techniques of precision irrigation including sprinkling irrigation and micro-irrigation with the features of low pressure, energy saving and multipurpose utilization have been promoted, normalized water saving irrigation projects have been built and efficient water management has been strengthened, certain achievements have been made in the water-saving irrigation of rice all over the country in this way. Moreover, various areas of China have promoted the water-saving irrigation measures including thin wet irrigation, thin dew, thin wet drying, intermittent irrigation, controlled irrigation, semiarid cultivation and thin film dry farming[47]. Also, some efficient water-saving methods have been obtained.

2.5 Ecological defense of disease and pest injury 61 kinds of diseases including rice blast, bacterial blight, sheath blight and virus disease *etc*., and 78 kinds of injurious insects including rice borer, rice plant hopper, rice leaf folder and leafhopper *etc*. result in great threats to the quality and output of rice. According to statistics, the occurrence area of 2000 – 2003 exceeded 85,000,000 hm^2, and the occurrence area of rice plant hopper, rice leaf folder, chilo suppressalis and tryporyza incertulas accounts for 72.5% of the total occurrence area of rice pests all over the country. In the four years, the average occurrence area of rice plant hopper accounts for 18% of the total occurrence area, the rice leaf folder accounts for 17%, chilo suppressalis accounts for 17%, tryporyza incertulas accounts for 9%, rice blast accounts for 6%, banded sclerotial blight accounts for 16%, bacterial blight accounts for 1% and other pests account for 16%[50]. Though chemical pesticide has the advantages of high efficiency, rapid response, easy of implementation, low cost and quantitative application, the long-term use of chemical poisons may produce pesticide residue, cause pesticide residue due to incorrect use of pesticides, lead to pesticide gathering in the organism, kill natural enemies of pests and have seriously impact on ecological environment. Moreover, the long-term use of single pesticide may cause the organism to be drug resistant to certain kind of pesticides[51,52], posing serious problems for the pest control operation. As a result, implementing biological control in combination with comprehensive physical and chemical control in order to reduce the application of chemical pesticides is extremely urgent. Currently, the major ways for ecological control of plant diseases and insect pests are as follows:

2.5.1 Reasonable cropping system. The damage of diseases and insect pests can be reduced through crop rotation, ridge planting, rational fertilization, irrigation, deep tillage and other measures, and the tolerance of crops can be improved through scientific nutrient and water management to decrease the occurrence of the plant diseases and insect pests. Continuous and alternate cropping of soybean may bring about epidemic diseases (including soybean root rot and heterodera glycines *etc*.), insect pests (including pod borer, soil insect and soybean root miner *etc*.), and malnutrition problems including nutrient loss, seriously affecting the soybean quality[54]. Those problems can be solved through replanting corn and other suitable crops. In rice planting, the aggravated disease and pest injury problems caused by long-term planting of uniform variety can be solved through variety collocation and alternation. Reducing the application of nitrogenous fertilizer appropriately may reduce the risk of pest and disease damage.

2.5.2 Research and development of biological control technology. Performing "pest control with pest" utilizing the parasitism of trichogramma, nasonia and other organisms. Research shows that choosing appropriate bee releasing method in field through ecological releasing of trichogramma according to the severity of rice stem borer damage may control the stem borer effectively and reduce the dosage and number of usage of the pesticides[55].

2.5.3 Development and application of biopesticide. Biopesticide include the microbial pesticides made from living microorganisms with reproductive capacity or their metabolic products including the fungus agent[56-58], bacteria agent[59] and virus agent *etc.*, such as the bacillus subtilis, bacillus cereus, pseudomonas fluorescence, bacillus licheniformis, bacillus sphaericus, paenibacillus polymyxa and other bacterial pesticides, fungus pesticides[60-62] including beauveria bassiana and beauveria brongniartii agents, viral pesticides including cytoplasmic polyhedrosis virus and nuclear polyhedrosis virus, validamycin[63] for the control of rice sheath blight as well as the agricultural antibiotics represented by broad-spectrum efficient insecticide and acaricide including abamectin[52] *etc.* Those pesticide formulations with specific effect are synthesized through simulation utilizing the living organisms or their metabolites, having significant effect on pest control and prevention[64,65].

2.6 Energy conservation and emission reduction of agricultural machinery and agronomy Energy consumption will be increased during the producing and operating progress of agricultural machinery and the greenhouse gas emission is on the increase. Greenhouse gases produced during energy consumption of agricultural equipments account for more than 10% of the agricultural greenhouse gases. Therefore, improving the work efficiency and reducing carbon emissions will make a big difference during the combining use of agricultural machinery and agronomy[66].

The artificial seedling raising and cultivation is labor-intensive and have a large demand for human resource with low working performance. As the agricultural labor is flocking to other industries-especially at present, the demand for agricultural mechanization has become increasingly urgent. Currently, rice mechanization consists mainly of two major systems including mechanical direct seeding represented by Europe and America and mechanical transplanting of rice represented by Japan. In recent years, our country has carried out research on the direct rice seeding technology actively. The artificial direct seeding technology in early the stage has been developed to the mechanical direct seeding at present. Production tests show that the group structure of rice sowed by hill planter is more reasonable as compared to the artificial broadcast sowing, artificial throwing-seedling and artificial transplantation. Seeding with hill planter may reduce lodging of direct-sowing rice, realize planting with water-saving irrigation, promote root growth[69] and improve the utilization efficiency of fertilizer with different degrees of improvement on the output[70,71].

Over-cultivation will accelerate carbon emission in soil. For this, reducing cultivation will not only decrease the carbon emission in soil, but can also reduce the energy demand during mechanized production. The implementation of conservation tillage is an effective measure for the development of low carbon agriculture. Conservation tillage can reduce the operating process steps, relieve the degree of farmland compaction and reduce carbon emission caused by agricultural machinery input with good water saving effect. Therefore, we suggest that: transform plowing to deep scarification; transform the conventional tillage to conservation tillage; promote tillage-free stubble direct seeding in suitable places; implement the fixed channel operation; and transform the distributed grain drier to centralized drying center.

Using advanced mechanization technology and improving the utilization efficiency of resources. It is required to introduce the advanced manufacturing technology, improve the manufacturing quality of agricultural machinery, apply new materials, improve the overall performance of agricultural machinery and extend the service life of agricultural machinery. Besides, it should strengthen training for agricultural machinery operators, improve the qualification of the operating personnel, and improve the skills of the operating personnel on equipment operation and maintenance through curricula education, professional training, presentation, network media and other forms, especially on engine maintenance, maintenance and repair of agricultural machinery and the development of energy-saving awareness[72].

3 Conclusion

Low carbon agriculture is an inevitable trend of modern agricultural development in response to global climate changes of today's society. The traditional crop industry is based on intensive cultivation, combination of farming and grazing, making full use of organic fertilizer to improve soil fertility, artificial cultivation, artificial weeding, artificial pest control as well as planting and harvesting in due time according to local conditions. The agriculture is environmental-friendly at this time. But with the transformation from the traditional agriculture to the "oil agriculture" with high-input and high-output, the ecological environment has suffered enormous damage and greenhouse gas emission has been aggravated due to the increasing use of chemical fertilizers and pesticides, although the agricultural yield, mechanization degree, modern production facility level and labor productivity have been greatly improved and product categories are richened and diversified increasingly. The earth that we rely on for survival has become overwhelmed. In the face of the serious ecological hazard produced by "oil agriculture", low-carbon agriculture emerges at a historic moment with no time to delay.

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ecological civilization self-discipline mechanism. The propagation of ecological behavior is citizens' opinion of enjoying green economy, beautiful environment and spacious room.

2.4 Changing companies behavior and creating ecological company It is suggested to establish ecological companies that save raw materials, energy and water. Ecological companies would enhance prevention of industrial pollution and discharge pollution according to states' demand. Companies with outdated technology and burning pollution must be shut down. Ecological companies can get economic benefit in energy-saving and environment pollution and fulfill companies' responsibility of sustainable ecological environment.

2.5 Developing ecological agricultural and creating ecological garden The construction of ecological environment in Poyang Lake should develop high-efficient ecological agriculture, promote low-carbon technology, develop recycle economy, eliminate outdated equipment and quicken the high-technological industry development. Given local reality, different soil, climate, environment and ecological systems shall be considered. It is suggested to carry out rural ecological construction vigorously and to build harmonious garden.

3 Conclusions

The construction of ecological Poyang Lake involves various aspects. The ecological construction needs efforts from all sides. The involvement of citizens, governments and companies indicates ecological recovery, environment treatment and reform of spiritual, material and political civilization. Based on ecological rules and the contradiction between human being and nature, it is urgent to reform current behavior and lifestyle, to reinforce education and propagation of environment protection, and to plan scientifically. The aim is to make Poyang Lake an ecological economic zone where ecological civilization unites with economic development and people gets along with nature.

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