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Agricultural Ecosystem in China: A Case-based Practitioner's Perspective

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Abstract

Although sustainable agriculture and food systems have appeared to start generating increasing scholarly and policy-maker interest since the 1950s (Pretty, 2008), the very idea creating some level of sustainability in agriculture can be traced back to ancient writings in China (Li, 2001). Despite scholarly and policy efforts, the growing population which in turn results in increasing demands for food and other agricultural products while minimising potentially negative impacts on earth and the environment has remained as a major challenge for this century (Godfray et al., 2010; Sanaullah et al. 2020). With the growing literature on agricultural ecosystems and sustainability in farming, and despite practitioners being an important of the community, there has been insufficient discussion on the practitioners' views grounded in experiences. Accordingly, this paper provides an account of case-based practitioner's experiences in China.

Keywords

China, Agricultural ecosystem, Practitioner, Sustainability

Introduction

Although sustainable agriculture and food systems have appeared to start increasing scholarly and policy-maker interest since the 1950s (Pretty, 2008), the very idea of creating some level of sustainability in agriculture can be traced back to ancient writings in China (Li, 2001). In general, and for a long time, agricultural sustainability has been an inspiring concept to both practitioners and researchers who aspire to provide communities with security of food and energy, clean and accessible water and productive soils by considering how farming may affect the broader ecosystem (e.g., Brundtland, 1987; Wu, 2013, Wang et al., 2020). In China in particular, agricultural productivity has been increasingly and negatively affected by climate change for the past decades especially because of changing water resources (Piao et al., 2010),

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while Chinese scholars have examined a wide range of issues relating to the sustainability and environmental effects of farming and, more broadly, agriculture in China (e.g., Dou et al., 2019; Wang et al., 2019, Zhan et al., 2019). Although there have been long debates regarding the definition of sustainability, sustainable agriculture or agricultural ecosystems (for example, since Balfour, 1943), four primary principles summarised by Pretty (2008, p. 451, direct quotation) may include: (i) integrate biological and ecological processes such as nutrient cycling, nitrogen fixation, soil regeneration, allelopathy, competition, predation and parasitism into food production processes, (ii) minimize the use of those non-renewable inputs that cause harm to the environment or to the health of farmers and consumers, (iii) make productive use of the knowledge and skills of farmers, thus improving their self-reliance and substituting human capital for costly external inputs, and (iv) make productive use of people's collective capacities to work together to solve common agricultural and natural resource problems, such as for pest, watershed, irrigation, forest and credit management.

Despite scholarly and policy efforts, the growing population which in turn results in increasing demands for food and other agricultural products while minimising potentially negative impacts on earth and environment has remained as a major challenging for this century (Godfray et al., 2010; Sanaullah et al. 2020). In coping with this challenge, many techniques, concepts, and systems have been devised, such as diversified farming (Rosa-Schleich et al., 2019), different agricultural management systems (Sanaullah et al. 2020), soil diversity (Thakur et al., 2020), advancing agriculture management apps (Inwood et al., 2019), along with a variety of emerging methodologies for estimating climate effects, for example, carbon sequestration in agricultural soil (Nayak et al., 2019). With the growing literature on agricultural ecosystem and sustainability in farming, and despite the fact that practitioners are an important part of the community, there has been insufficient discussion on the practitioners' views grounded in experiences. Accordingly, this paper provides an account of case-based practitioner's experiences in China.

A Chinese Practitioner's Account

China has been facing serious energy and environmental problems in both urban and rural areas. In particular, China produces nearly 4 billion tons of livestock manure every year, while 180 million tons of hay are not effectively used. At present, the amount of chemical fertiliser used in China exceeds 60 million tons, and the gap of sewage treatment is 3.7344 million tons. According to the Renewable Energy Market Report (2018), bio-natural gas will account for 8% - 10% of the domestic natural gas consumption market by 2030, which will reach the size of 150 billion yuan. In 2011, the market scale of China's organic fertilizer industry was about 50.47 billion yuan, which increased to 90.99 billion yuan in 2018, with a compound growth rate (CGR) of 9%. With the implementation of organic fertilizer subsidies by Chinese government, the growth rate of the market will be further accelerated which is expected to exceed 200 billion yuan by 2023 (Renewable Energy Market Report, 2018).

The Biomass Energy's 13th Five-Year Plan (2016) (《生物质能"十三五"规划》) had predicted that by 2020 the annual utilisation of bio natural gas would reach 8 billion cubic meters, generating biogas power of 500000 kilowatts, while increasing investment in bio natural gas would reach 120 billion yuan. Furthermore, Environmental Protection Tax (环保税) that had been under consideration for 10 years was finally approved in December 2016, effective since the 1st of January 2018. The tax rate is currently varying between five to 1,000 yuan per ton according to the tax calculation method of environmental protection tax issued in June 2017. In June 2017, the central government's Opinions on Accelerating the Recycling of Livestock and Poultry Wastes (《关于加快推进畜禽养殖废弃物资源化利用的意见》, hereafter referred to as Opinions) proposed to start pilot projects of resource utilisation of livestock and poultry manure which would be funded from pubic/central government funds. The Opinions suggests to initiate and implement integrated projects of planting and breeding circulation, while promoting the resource utilisation of livestock and poultry manure in the whole county. It also encourages local governments to use centrally allocated funds to give out local subsidies for livestock and poultry manure recycling equipment, and for using organic fertilisers instead of chemical fertilisers.

Two months later, the National Development and Reform Commission (发改委) and the Ministry of Agriculture jointly issued a plan to promote the recycling of livestock and poultry manure throughout China. In 2020, the comprehensive environmental management of 200 Chinese counties will be completed, with a total investment of nearly 100 billion yuan, further proceeding with 'whole-county promotion' (整县推进) of environmental management in more detail. In August 2018, the Comprehensive Department of the National Energy Administration (国家能源局综合司） issued the Notice on Reporting the Demonstration and Reserve Project of Bio-natural Gas Industrialisation (《关於请上报生物天然气产业化示范储备项目的通知》), which proposes to establish pertinent policy supports and management systems, increase subsidies, build a number of commercial projects, and form an initial new business model of biological natural gas circular economy. Finally, in December last year, the Guiding Opinions on Promoting the Industrialisation of Bio-natural Gas (《关于促进生物天然气产业化发展的指导意见》) suggest that, by 2025, China will reach a certain scale and form of a new, green, low-carbon, clean, and renewable gas industry with an annual output of more than 10 billion cubic meters. By 2030, biogas market will be developing steadily. The scales indicated in this latest 'guiding opinions' are unprecedented in China, while the annual output of bio-natural gas will exceed 20 billion cubic meters, accounting for a considerable proportion of domestic natural gas production and consumption. Therefore, there is a clear trend at a policy level that China encourages the acceleration of the industrialisation and commercialisation of bio-natural gas, which will require an established organic fertiliser production and consumption system and centrally guided large-scale state-owned enterprises (SOE) to invest in the construction of bio-natural gas industrialisation projects.

Current Difficulties and Issues Encountered by Environmental Project Companies

From a practitioner's viewpoint, the main difficulties encountered in the industry are multifold. Mainly and briefly, these may include the following. First, environmentally friendly agricultural ecosystem projects usually lack overall planning, where the cultivation and planting are separated. Second, it is difficult to collect, store and transport organic waste materials, while the collection, storage and transportation system is still very unprepared to accommodate practical needs. Next, the organic wastewater is difficult to treat without adequate technical support, while the promoted 'restoring agricultural field' model (还田模式) lacks explicit standards or legal guidelines. Finally, the quality of organic fertilizer cannot be guaranteed and is difficult to assess, with the promotion of the marketising livestock manure based organic fertiliser being more difficult than that of plant based organic fertiliser. Furthermore, for the two utilisation modes of energy and fertiliser, the source of raw materials of organic wastes is one of the key factors, which also concerns collection and transportation. The collection of raw materials must ensure long-term and stable supplies of usable waste and haywithin a certain distance range. Especially for livestock and poultry breeding companies, it is necessary to sign long-term contracts with the government or concerned parties for exclusive rights of collection. Finally, the production, stability and transportation radius of animal manure is related to scale, efficiency and the company's financial resources.

In addition, sales volume and competitiveness of end products are another key factor. For energy utilisation, biogas and electricity are the final products, but the construction of biogas digesters is mainly distributed in the vast rural areas in China. The investment and cost of laying biogas pipe network is very high, which farmers are understandably unwilling to pay for use. As a result, most of the biogas digesters are small in scale, and are usually unable to meet threshold level for joining the existing grid networks. The high cost of power generation and untimely subsidies which are usually promised quickly but released slowly make companies lose motivation to engage more proactively. For fertiliser utilisation, there needs to be enough farmland for consumption. However, at present, the market of organic fertiliser is not big enough, especially since the quality of such organic fertiliser cannot be quarantined as a common phenomenon in the industry resulting in unwilling farmers who generally prefer to use chemical fertilisers that are cheaper and more convenient.

Solutions – A Case Study of Huaying Agricultural Ecological, Waste-recycling Industrial Park Project

Huaying Agricultural Ecological, Waste-recycling Industrial Park project（华英农业生态循环产业园农业废弃物循环利用项目) is located in Xinyi city, Jiangsu province in China, with a total investment of about 86.510 million yuan. It is a centralised processing point of waste which was promoted by the county of Xinyi city and has now been put into operation.

The project can process 333t/d duck manure, 120t/d pig manure, 45t/d hay, while producing 24500m3/d of biogas, most of which is used to prepare for the production of biomass gas from livestock manure and agricultural waste and the rest is used for plant heating. The leftover from producing biogas is 188.5t/d, which is used to produce bio organic fertiliser which is currently at 67.3t/d with deep processing techniques. The total annual output of bio organic fertiliser is 24239.6t/a (calculated at 360 days a year), all of which are sold as high-quality base fertiliser raw materials of bio organic fertilizer in order to provide necessary nutrients for the growth of local and surrounding farmlands and improve the quality of nearby soil by turn waste into value. The above processes have also promoted developments of agriculture and industry in the local and surrounding areas. The production of biomass gas and ancillary products from livestock and poultry manure and agricultural waste conforms to the scope of nationally encouraged and advocated policies. Overall, the project responds well to the sustainable development strategy of national energy renewable development and economic recycling, and thus is an economically and ecologically beneficial project.

This project was a result of practical innovations at Qingdao Conminent Environmental Energy Engineering CO., LTD., located in Qingdao, Shandong province, China. The company devised plans for the production of biomass gas from livestock manure and agricultural waste. In view of the above discussed difficulties, the company focused on using the company's core technologies. By integrating existing resources, the company was able to derive a project that combines planting and breeding, as well as recycling organic waste resources. In particular, five stages were in place to ensure the planning and implementation of Huaying Agricultural Ecological, Waste-recycling Industrial Park project. The first stage involves the overall planning, which left sufficient time for plan revisions and implementation corrections if/when necessary. In the second stage, technicians used online databases and recourses to devise and establish a collection and storage system in order to achieve the visual management of the whole project. During the next stage, a comprehensive aquaculture wastewater treatment system was planned and established, using techniques and solutions which included CSTR, UASB combining (two-stage/part) AO (二段 AO), HDPE oxidation-pond (黑膜氧化塘) to process organic wastewater. The fourth stage involves comprehensively using intelligence equipment of aerobic organic fertiliser and e-OTFE composting technology (膜去堆肥) technologies to produce organic fertiliser. Finally, sales networks of organic fertiliser were established to complete the recycling system.

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References

Balfour, E. B. 1943 The living soil. London, UK: Faber and Faber.

Dou, Y., Zhen, L., Yu, X., Bakker, M., Carsjens, G. J., & Xue, Z. (2019). Assessing the influences of ecological restoration on perceptions of cultural ecosystem services by residents of agricultural landscapes of western China. *Science of the Total Environment*, *646*, 685-695.

Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M., Toulmin, C., 2010. Food security: the challenge of feeding 9 billion people. Science 327, 812–818. https://doi.org/10.1126/science.1185383.

Inwood, S. E. E., & Dale, V. H. (2019). State of apps targeting management for sustainability of agricultural landscapes. A review. *Agronomy for sustainable development*, *39*(1), 8.

Li, W. 2001 Agro-ecological farming systems in China. Man and the biosphere series, vol. 26. Paris, France: UNESCO.

Nayak, A. K., Rahman, M. M., Naidu, R., Dhal, B., Swain, C. K., Nayak, A. D., ... & Pathak, H. (2019). Current and emerging methodologies for estimating carbon sequestration in agricultural soils: A review. *Science of the Total Environment*, *665*, 890-912.

Piao, S., et al., 2010. The impacts of climate change on water resources and agriculture in China. Nature 467 (7311), 43.

Pretty J (2008) Agricultural sustainability: concepts, principles and evi- dence. Philos Trans R Soc Lond Ser B Biol Sci 363:447–465. https://doi.org/10.1098/rstb.2007.2163

Rosa-Schleich, J., Loos, J., Mußhoff, O., & Tscharntke, T. (2019). Ecological-economic trade-offs of diversified farming systems–a review. *Ecological Economics*, *160*, 251-263.

Sanaullah, M., Usman, M., Wakeel, A., Cheema, S. A., Ashraf, I., & Farooq, M. (2020). Terrestrial ecosystem functioning affected by agricultural management systems: A review. *Soil and Tillage Research*, *196*, 104464.

Thakur, M. P., Phillips, H. R., Brose, U., De Vries, F. T., Lavelle, P., Loreau, M., ... & Wardle, D. A. (2020). Towards an integrative understanding of soil biodiversity. *Biological Reviews*, *95*(2), 350-364.

Wang, Q., Anderson, N. J., Yang, X., & Xu, M. (2020). Interactions between climate change and early agriculture in SW China and their effect on lake ecosystem functioning at centennial timescales over the last 2000 years. *Quaternary Science Reviews*, *233*, 106238.

Wang, Y., Bilsborrow, R. E., Zhang, Q., Li, J., & Song, C. (2019). Effects of payment for ecosystem services and agricultural subsidy programs on rural household land use decisions in China: Synergy or trade-off?. *Land use policy*, *81*, 785-801.

Wu J (2013) Landscape sustainability science: ecosystem services and human well-being in changing landscapes. Landsc Ecol 28:999– 1023. https://doi.org/10.1007/s10980-013-9894-9

Zhan, J., Zhang, F., Chu, X., Liu, W., & Zhang, Y. (2019). Ecosystem services assessment based on energy accounting in Chongming Island, Eastern China. *Ecological Indicators*, *105*, 464-473.