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Building sustainable circular agriculture in China: economic viability and entrepreneurship

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Abstract

Purpose – In the context of China, the purpose of this paper is to empirically answer three related questions: Could circular agriculture (CA) attain economic, ecological and social benefits simultaneously? What is key to a successful CA business in emerging economies? And who plays the vital role in building and sustaining a circular business?

Design/methodology/approach – The paper is based on a field study and looks at a farm in China. It uses a triangulation methodology to collect information. Besides longitudinal filed work at the farm, the researchers have also interviewed multiple stakeholders and conducted field research at the local markets.

Findings – With concrete performance data, the study proves that a circular approach can help achieve ecological, economic and social goals together. It shows that economic viability is essential to succeeding in circular operation, sufficient production pathways are required to make such operation sustainable, and entrepreneurship is key to build and grow a circular business.

Research limitations/implications – The findings point to the crucial role of entrepreneurship in promoting the circular model in emerging economies. These findings, however, may not be readily generalizable, given the limitations of the case study approach.

Practical implications – The study highlights a few areas in which government assistance can make a difference, including financial incentives, information provision, technical support and most importantly the creation of a positive environment for entrepreneurial development.

Originality/value – While prior research emphasizes the role of government in promoting circular economy in developing and emerging markets, the study proves that entrepreneurship is key to turning government initiatives into economically viable and sustainable circular operation.

Keywords China, Field study, Entrepreneurship, Circular agriculture, Economic viability

Paper type Research paper

1. Introduction

A circular economy (CE) is considered a fundamental way to achieve sustainable development (Liu and Bai, 2014; Ghisellini *et al.*, 2016; Su *et al.*, 2013), especially for countries whose agricultural sectors are faced with environmental, human health and social problems posed by continuous economic development (Geng *et al.*, 2012; Ghisellini *et al.*, 2016). Responding to this new development, academic literature has emerged concerning circular agriculture (CA) (Bluemling *et al.*, 2013; Chen *et al.*, 2016; Ghisellini *et al.*, 2016; Song *et al.*, 2014). The published studies have touched upon the various aspects of CA such as economic assessment, environmental performance and social preference. However, since CA has caught scholarly attention only recently, the literature is understandably limited. A review of the literature suggests three major limitations. First, there is an overall lack of empirical work compared to conceptual development on the topic (Xue *et al.*, 2010), especially at the micro level that should serve as the very foundation for the field to move forward. Second, most prior research is conducted in industry contexts, and systematic accounts of circular practice in agriculture has been rare. In a tone-setting report commissioned

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by OECD, keeping "components and materials in closed loops and prioritize inner loops" (MacArthur *et al.*, 2015, p. 25) is described as one of the six business actions comprising a CE, but the document barely cites any concrete examples in agriculture. Third, previous research tends to be focused on developed economies, giving little attention to emerging and developing economies (Goyal *et al.*, 2013). The aforementioned limitations have left several important questions unanswered in respect to CA in emerging/developing economies, namely, whether CA could achieve different goals – ecological, economic and social goals; what is an essential element in a successful circular operation; and which actor is most likely to be responsible for building and growing a sustainable circular business.

The current study addresses the above questions with a field study in China. China is the largest emerging market country with a high proportion of agriculture in its national economy, where accelerated depletion of natural resources and environmental degradation are forcing the government to seriously consider taking a circular approach toward its economic development strategy and agriculture (Gangnibo *et al.*, 2010; Wu *et al.*, 2014). The study is based on fieldwork surrounding the circular operation of an economic entity in rural Jiangxi, accounting for activities ranging from deployment of material inputs, exploitation of bioenergy, and discharging of outputs into the social system. Starting with concrete, quantitative performance data, the study explores a model-in-use in China's CA and some of the best practices by a Chinese entrepreneur pioneering in this field.

The remainder of this paper is organized as follows. Section 2 provides a literature review. Section 3 introduces the method and procedure. Sections 4–6 present and discuss findings. Based on the findings, Sections 7 and 8 discuss policy implications, and the study's limitations and future research directions. Section 9 concludes.

2. Literature review and research questions

2.1 Circular economy

CE refers to a closed-loop of material flows in the economy such that the economy and environment constitute a circular relationship (Pearce and Turner, 1990; Boulding, 1966). Seen as a new business model, CE aims to reconcile the relationship among economic development, environment protection and resource saving (Geng *et al.*, 2012; Hansen, 1996; Wu *et al.*, 2014; Ma *et al.*, 2014), which is accomplished through three main actions summarized in the so-called 3R's principle – reduction, reuse and recycle (Geng *et al.*, 2012; Su *et al.*, 2013). Beginning with a narrow focus on waste recycling, CE has gradually shifted to broad efficiency-oriented operations through an increase in the effectiveness of resource allocation, resource utilization and productivity, in a variety of areas, including agriculture (Su *et al.*, 2013). In the past two decades, modern agriculture in many countries around the world has been challenged by both resource depletion and environmental crisis (Norse, 2012). In search for feasible solutions, CE has increasingly been recognized for a potential role in addressing both challenges (Geng *et al.*, 2009; Su *et al.*, 2013). For example, while agricultural residues pose a serious threat to the environment without corresponding disposal mechanisms, a circular approach enables significant economic dividends from the abundant agro-residue resources as raw material for production. Increasingly, the CE model is viewed as an inevitable option for sustainable agricultural development (Geng *et al.*, 2009; Li *et al.*, 2010; Su *et al.*, 2013).

2.2 Role of entrepreneurship

Earlier literature emphasizes the role of governments and institutions in the transition toward sustainable development (Jolly *et al.*, 2016; Schaltegger and Wagner, 2011). Increasingly, however, there is a realization that human factors play a significant role in CE implementation (Jabbour *et al.*, 2015; Jabbour and Jabbour, 2016). As far as CE is an innovation process (Cuerva *et al.*, 2014), entrepreneurship should be an important part in it with entrepreneurs being the innovator who carries out new combinations (Schumpeter, 1934). For entrepreneurship scholars, entrepreneurial action is an important vehicle for combating environmental degradation (e.g. Patzelt and Shepherd, 2011). For example, Cohen and Winn (2007) posit that market imperfections contribute to environmental pollution, which, however, serves as a source of significant entrepreneurial opportunities. According to Schaltegger and Wagner (2011), "sustainable entrepreneurs" engage in essentially the same process of opportunity discovery and exploitation as conventional entrepreneurs, that is, a process that addresses the unmet demand for environmentally sound products and services "that are successful in the marketplace of mainstream customers" (p. 223). Many scholars use the term "ecopreneurship" to more specifically label environmentally oriented entrepreneurs. While economic profits are the ultimate goal, ecopreneurs would include environmental objectives as an integrated part of the business. For these entrepreneurs, the organizational challenge is to better integrate environmental performance into the economic business logic (Hockerts and Wüstenhagen, 2010).

Unlike in mature, developed economies, the existing literature maintains a greater emphasis on government and institutions when it comes to the drivers of sustainable development in emerging economies, which are often characterized by homogeneous institutions and restricted policy discourse, resulting in government domination in transition toward sustainability (Jolly *et al.*, 2016). Even when looking at some of emerging bottom-up processes, researchers tend to focus on institutional actors, such as government officials, regional governments and research institutions whose purposes are to advocate and facilitate changes in policy and institutional arrangements, rather than to build and grow businesses that are both ecologically and economically viable (Jolly, 2017). According to a recent study by Dhahri and Omri (2018), entrepreneurship in their sample of 20 developing countries positively contributes to the economic and social development but have negative impact on the environment aspect of sustainable development. However, the limited research has not offered convincing evidence on the lack of impact of entrepreneurship in sustainability transitions. First, since entrepreneurs, with limits set by the state, have been the main driver toward market-oriented transformation in emerging economies such as China (Nee, 1992), it is plausible that such entrepreneurial spirit and energy can be directed at sustainable transitions with financial incentives. Second, the imperfection of institutional environments in emerging markets, which Khanna and colleagues (2005) famously described as institutional voids, may paradoxically offer greater flexibility and opportunities for entrepreneurs to experiment and take action (Jolly *et al.*, 2016). A recent study shows that entrepreneurship makes bigger contributions to environmental improvement in lower-income countries than in high-income countries. Unfortunately, there is an overall lack of attention to the role of entrepreneurship in promoting sustainable business in emerging markets (Hall *et al.*, 2010).

2.3 Circular agriculture in China

China is facing severe resource and environmental issues in its agricultural sectors due to rapid development (He *et al.*, 2013; Su *et al.*, 2013). Applying the circular principle to agriculture in China, scholars contend that the core of CA is promoting the circular utilization of agricultural resources. It could not only alleviate energy shortage in rural areas but also effectively reduce the environmental risk associated with agricultural waste (Li *et al.*, 2010; Koçak and Şarkgüneşi, 2017; Vergé *et al.*, 2016). Notably, while scholarly attention to CA in the English publications is relatively a recent phenomenon (Chen *et al.*, 2012, 2016; Song *et al.*, 2014; Zhou *et al.*, 2010), records of CA practice in China can be found at much earlier dates. Evidence shows that, as early as in the 1950s, there was a government-guided effort toward utilization of renewable resources through experimentation such as the well-known biogas project (Bond and Templeton, 2011; Ni and Nyns, 1996). Over the years, the nation-wide experimentation has led to a variety of regional models based on the ecological agriculture thinking that agriculture production and resource management should be managed with a holistic approach within a complex, co-evolutionary ecological-economic-social system (Bond and Templeton, 2011; Chen *et al.*, 2016; Raven and Gregersen, 2007; Zhou *et al.*, 2010), apparently a precursor to the contemporary notion of CA. Indeed, there has been a large body of literature on biogas projects in China up to date, and the recent heightened scholarly interest in CA is nothing but a reflection of the worsening reality facing China. Since resource depletion and environment deterioration have become a threat to the entire national economy, many scholars now hope that CA can help Chinese agriculture leapfrog into a more sustainable economic structure (Chen *et al.*, 2006, 2009; Gangnibo *et al.*, 2010; Su *et al.*, 2013).

However, despite the accumulated knowledge about CA in China, existing research has left several key questions largely unanswered. First, it remains unclear to what extent the adopted circular practice has achieved economic, ecological, and social benefits simultaneously. While much of the prior research has investigated the environmental impacts of biogas projects, there is a lack of understanding of their economic effects (Li *et al.*, 2010). Second, without empirical evidence from field studies, we know nothing about the best practice in achieving successful circular results. Third, there is also little understanding of the role of entrepreneurship in driving viable circular business. Prior literature emphasizes the importance of government policy as the driving force behind the development of CE in China and the awareness of local government officials as the key to successful implementation of policy initiatives (Ren, 2007). However, some scholars have already realized the need for the government to take a more market-driven approach in facilitating sustainable transition, hinting at the role of entrepreneurship (Xue *et al.*, 2010).

To fill the gaps in existing literature, the current study addresses three interrelated questions in the context of emerging markets: Could CA achieve the ecological, economic and societal objectives simultaneously? If so, what is key to such operation? And who plays the vital role in building and sustaining a circular business?

3. Method and procedure

The research is centered on a farm (hereafter “the Farm”) in China’s Jiangxi Province. The Farm, located in Pingxiang City of the Jiangxi Province in China, is a pig breeding enterprise established in 2004. It covers about 900 acres with a total investment of approximately US $20m. Originally, it followed a traditional model of linear production which was faced with several challenges. For example, a large portion of natural resources, including land and water, was underused. Biogas from animal waste was not fully utilized with the unused portion being left to the open air to become a source of pollution. There was an attempt to put the biogas slurry and residues into productive use, but the practice led to unhealthy foodstuff, for example, fish that could be poisonous. Similar experiments were made with tea plantation and Chinese herb medicine, but all failed. While these by-products did not contribute significantly and positively to the bottom line, the Farm continued to concentrate on producing conventional pig brands that rely on manufactured synthetic feeds. Given the low margins on the pigs, the Farm was not run profitably. In 2012–2013, it lost $500,000. And it was around this time that the government stiffened the requirements for the pig farms to reduce negative impacts on environment, especially from the pig urine and manure. In responding to these challenges, things started to change around 2015 when the Farm decided to replace the traditional production approach with a new circular one. The transition has received noteworthy assistance from the government, which provided grants for environmental initiatives, and a major university in the Province, which offered technical support and consultations. During the past two years or so, the Farm has increasingly shifted to organic pig and at the same time added other organic products including bamboo shoots and fish. More importantly, it has abandoned the one-way flow of linear economy, i.e. the "resources → products → waste" pattern, but re-built its entire operation in a circular manner as shown in Figure 1. Centering on biogas fertilizer, the circular operation consists of several pathways – "pig-biogas-feed-pig," "pig-biogas-feed-fish" and "pig-biogas-fruit." By 2016, the Farm's pig production turned profitable. The profitability of the entire operation at the Farm increased dramatically due not only to the improved pig production and the added incomes from other organic products (i.e. bamboo shoots and fish, but also to fuel cost reduction and savings on chemical fertilizers). Additionally, the Farm obtained significant amounts of revenues from electricity sales.

We adopted a triangulation methodology in the present study. The authors are members of a project team from the business school of the university mentioned earlier. Since early 2015, the team has visited the Farm monthly. Spending two to five days each time, the team was able to talk to people – everyone from the owner, his family members, and all the full-time and part-time employees working on the Farm. These "talks" are interviews that could be either structured (e.g. when collecting performance information with the owner) or unstructured (e.g. for understanding a historical event). Besides these interviews, we were able to directly observe how people conduct their work on the Farm and even the interactions between the Farm's owner with external stakeholders. For example, we had the chance to sit in meetings where the owners briefed local government officials on their performance. To get a comprehensive and balanced picture of the Farm's operation, we also interviewed some of the key stakeholders, including other local farmers, representatives from industry organizations (e.g. the Association of Pig Farmers), and officials of the county government agencies (e.g. the Bureau of Agriculture). We even collected some primary data at local markets to verify the price and profit information from the Farm. We received generous support from the Farm's owner during the entire research process, who not only offered us full access to their employees and archive data on the Farm's operation, but helped review and verify our notes from the field study.

The presentation of our findings starts with detailed data on the environmental, economic and social performance at the Farm. We will include quotations from the Farm's owner as well as other people we have interviewed, which were recorded in our field notes. Considering the space constraints, the calculations of key parameters are not included in the paper but available upon request.

4. Performance of circular production

Our findings confirm that circular operations at the Farm successfully reached its performance goals with respect to three sets of criteria. Environmental performance is evaluated primarily in regard to biogas production and biogas fertilizer exploitation. As for economic performance, this paper considers each of the operation's pathways and compares them in terms of contributions to the entire operation. Finally, social effects are examined in terms of organic product offerings, improved sanitation conditions and spill-over effects in the neighboring community.

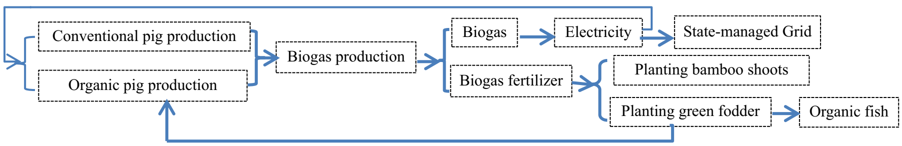

Figure 1.
Circular production at the Farm

4.1 *Environmental performance*

One of the main purposes of CA production is to recycle energy and to reuse agricultural resources. Biogas production, as an important pathway of circular operation, has significant economic advantages in the form of energy savings. It yields three products – biogas, biogas slurry and biogas residues. Biogas is a comparatively clean, high-methane fuel for living and production. Biogas slurry and biogas residues need to be disposed of, otherwise they will cause pollution and seriously affect soil quality. As products of anaerobic fermentation, biogas slurry and residues contain all the non-degradable or insoluble organic and inorganic substances present in the original feedstock and can be used as organic fertilizer substituting for chemical fertilizer in agricultural production. At the Farm, the circular treatment of biogas fertilizer started in 2015, until then they were either left in farmland as waste or shipped elsewhere as solid organic fertilizer. While the circular utilization of biogas resource grew only 1.9228 percent from 2015 to 2016, its development is projected to reach an annual growth rate of 30 percent between 2019 and 2020. By 2025, the proportion of circulation of biogas could be close to 100 percent.

In Figure 2, "Circular disposal" is used to indicate the percentage of circulation and "Conventional disposal" to indicate the percentage of biogas fertilizer resource being left as wastes or shipped elsewhere. As shown, the year 2019 is the turning point when circular disposal starts to exceed conventional disposal. Since shipping solid fertilizer will incur transportation costs, circular utilization of biogas resources should further reduce the costs of agricultural operation at the Farm. In other words, the discussion of environmental performance cannot be separated from economic performance of CA.

4.2 *Economic performance*

Table I presents product yields for each of the circular production pathways examined in this paper. Profits are reported in Table II and portrayed graphically in Figure 3.

Pig production continues to be vital to the Farm. As shown in Figure 3, the profit from organic pig is projected to be the highest. While the profits from the other three products remain low, their operations are vital parts of the entire circular loop. For example, electricity generating from biogas is needed for operating the pig production. Importantly, if the biogas is not fully converted into electricity, it will be left in the air to pollute. The biogas fertilizer could also become a source of pollution if only used in producing green fodder. At the Farm, the problem is solved by applying the rest of it to the plantation of bamboo shoots, another profit-generating and air-purification activity. The choice of white bamboo for the

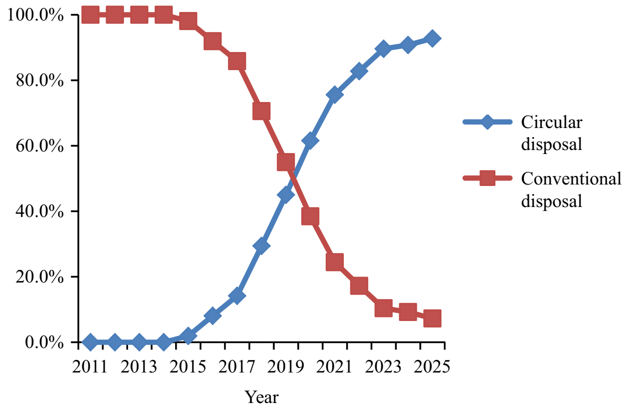

Figure 2.
Circular disposal vs conventional disposal

Table I.
Yields of circular production

Period	Year	Yield of green pig (H)	Yield of organic pig (H)	Yield of organic fish (acre)	Yield of bamboo shoots (acre)
The 12th Five-Year Plan (actual data)	2011	7,500	0	0	0
	2012	8,000	0	0	0
	2013	8,200	0	0	0
	2014	7,000	0	0	0
	2015	7,500	68	0	5
The 13th Five-Year Plan	2016	7,400	500	16	16
	2017	7,000	950	0	33
	2018	6,400	1,550	0	74
	2019	6,000	1,950	20	115
	2020	5,600	2,650	25	165
The 14th Five-Year Plan	2021	5,000	3,200	41	198
	2022	4,600	3,600	53	214
	2023	4,300	3,900	61	231
	2024	4,100	4,300	64	239
	2025	4,000	4,500	66	247

Table II.
Product profits (thousand US$)

Items	2015	2016	2017	2018	2020	2022	2024	2025
Green pig								
Profit from green pig	115.5	113.96	107.8	98.56	86.24	70.84	63.14	61.6
Profit percentage of green pig (%)	70.42	49.64	37.36	26.73	16.39	10.8	8.39	7.89
Organic pig								
Profit from organic pig	9.42	69.25	131.58	214.68	367.03	498.6	595.55	623.25
Profit percentage of organic pig (%)	5.74	30.17	45.61	58.23	69.77	76	79.12	79.8
Organic fish								
Profit from organic fish	0	3.8	3.8	3.8	5.7	12.16	14.82	15.2
Profit percentage of fish (%)	0	1.66	1.32	1.03	1.08	1.85	1.97	1.95
Bamboo shoots								
Profit from bamboo shoots	0.76	2.53	5.06	11.39	25.3	32.89	36.69	37.95
Profit percentage of bamboo shoots (%)	0.46	1.1	1.75	3.09	4.81	5.01	4.87	4.86
Electricity								
Profit from Electricity	38.34	40.02	40.27	40.27	41.79	41.54	42.55	43.06
Profit percentage of electricity (%)	23.37	17.43	13.96	10.92	7.94	6.33	5.65	5.51
Total profit	164.01	229.56	288.51	368.69	526.06	656.03	752.75	781.06

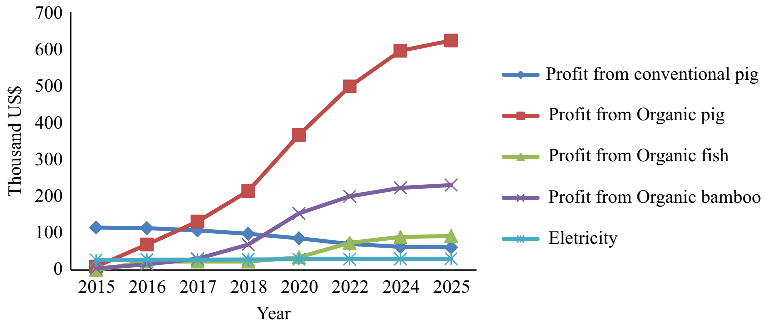

Figure 3.
Profits from organic products

Farm, according to the owner, is based on two considerations: the bamboo consumes the biogas fertilizer and the bamboo shoots are expensive in the marketplace.

Biogas is the direct product of swine manure anaerobic digestion and can be used as a substitute for traditional energy sources for cooking, lighting and heating. Besides these, the Farm also uses biogas to generate electricity which is transmitted to the government managed grid for profit. Based on the fieldwork, the value of biogas power generation parameter at the Farm is set as 1.55 KWH/m^3. In 2025, the projected biogas production will reach 277,799 (1,000 m^3), which should produce 430,588.6 KWH of generated power. With both biogas and electricity generated from biogas, the Farm has become self-sufficient in its energy use. It is thus important to recognize energy saving as a significant part of the economic outcome from the circular operation above and beyond the "profits" shown in Figure 3.

Replacing chemical fertilizer with organic fertilizer from biogas slurry/residues also brings about significant economic gains. The Farm saved approximately $11,626 and $41,143 on fertilizer, in 2015 and 2016, respectively, because of the substitution of chemical fertilizer with bio-fertilizer.

4.3 Social effects

It is estimated that the organic products will remarkably increase during the next ten years, as shown in Table I. These products, especially organic pork, will help meet with the increasing demand for high quality organic agriculture products in China. Another positive outcome from the circular operation is the improvement of sanitation conditions at the Farm and its neighborhood. Because of its large size and intense pig operation, the Farm was once a major polluter in the region. Since its adoption of the circular approach, it has now become a model farm with clean water and air. As mentioned earlier, the Farm started seriously considering the circular approach under the governments' pressure for environmental protection. The owner reflected on the process and said, "I wanted to keep the farm going, so I can't continue the way I had in the past. It was a matter of survival. While at the time I felt like pig urine and manure were a burden, but now they are really resources" (Zhu, 2017) Accompanying researchers along the pipeline for biogas slurry, he showed how clean the water became after three phases of fermentation. "Do you smell anything in the air?" He asked while walking by the pig barns, "I used to just respond to the government, but it is me who now wants to make the Farm a clear and enjoyable place. You can tell I am getting there" (Zhu, 2017).

The circular operation has not only yielded sustainable profit at the Farm, but also had a spill-over effect in the neighboring community. It has provided neighboring families with manure for biogas production to meet their own energy needs in cooking, heating and lighting, and as a biogas fertilizer source for bamboo shoots plantation. Other farms in the community have started to enjoy the economic benefits from circular production. At the time the fieldwork was conducted, the owner traveled to a nearby village and tried to convince other farmers to use the biogas fertilizer that cannot be fully utilized in the Farm. For the owner, this is a win-win solution: "I observed that some farmers still use synthetic fertilizer, which is not only costly, but environmental damaging. I told them that they could get the biogas fertilizer from me if they like. It is not only free but will make their products organic" (Zhu, 2017).

5. Ensuring economic viability

What is key to the Farm's successful attainment of the different operational goals – economic, ecological and social at the same time? Our findings point to economic viability, which, in turn, requires a sufficient number of production pathways.

According to local government officials, the biogas projects were initiated several years ago and most of the farmers had tried. However, the Farm was one of the few that have succeeded, and the rest had eventually given up. There were many obstacles, but the one that was most decisive concerns the business' bottom line, that is, whether the project was economically viable. For most farmers who have tried out a biogas production, the returns were simply not worth the trouble. The Farm's owner commented: "Environment protection is a good cause: but to be honest, I started doing these in order to survive. Pig operations create pollution, and the government made it clear that things had to change. So I had two options at the time – either to make a change or probably to get shut down. Now people come to appreciate our air and our water; yes they are clean and I am proud of what I have accomplished, but the reason I can stand here happily showing you all of these is that I have made it profitably. Not everyone is this lucky" (Zhu, 2017). Luck might not tell the whole story, but it is true that the Farm has accomplished what its neighbors have not been able to economically. For example, the Farm not only saves more than $20,000 in utility costs, but is also the Province's first and one of the few farms that has sold electricity to state-run grids. While, in theory, CE is a balancing act that simultaneously takes into consideration both environmental and economic effects, it must be aligned with the financial objective of individual economic entities, that is, companies need sufficient economic motivations toward more efficient use of resources (Ghisellini *et al.*, 2016). In this case, although the adoption of a circular operation was initially a response to the government's environmental concerns, its success ultimately rests on the Farm's ability to attain economic viability through a circular approach.

It is now apparent that economic viability is vital to a successful circular operation, and the next question becomes what the Farm has done to ensure such viability – perhaps differently from other farmers who have not been so successful. Based on the present study, the key is to contain sufficient numbers of production pathways within the system, and these pathways must yield a high return together. Looking at some of the unsuccessful circular projects in the same region, there is a common problem that the revenue sources tend to be rather limited so as not to make the entire operation profitable. Take the example of biogas fertilizers, which is an immediate product of the biogas production. In many farms, they are only sold in the marketplace, but the sales are not guaranteed, or in one farmer's words – "you can't count on (that) as a revenue source" (Zhu, 2017). At the Farm, however, biogas fertilizers are not only sold in the market but more importantly also used within its own system. As portrayed in Figure 1, they are applied in the production of several organic products, which are sold at a premium in the marketplace. The Farm's owner commented: "The biogas production project is expensive, so I have to look for ways to get higher returns. I realized that consumers start appreciating organic foods, so I shifted to organic bamboo, which not only are more profitable but allow me to use up the organic fertilizer" (Zhu, 2017). In the same token, planting green folder would not be that attractive if it is only for sales externally – the price is low and the market is not guaranteed. However, the Farm chooses to use it in producing two organic products within its own production system – organic pig and fish – which (especially the organic pig) turn out to be very profitable. At the Farm, all the pig production "was turned to green as soon as he (the owner) realized that organic pork is the future, but other farmers were half-hearted and hesitant," a local official observed (Zhu, 2017). Apparently, the adoption of a circular approach is akin to the creation of new venture wherein its founder needs to pursue innovative and rewarding yet risky activities.

6. Vital role of entrepreneur

To answer the question, what differentiates the Farm's owner from his neighbors who are faced with similar pressure to implement an environmentally sustainable operation model but have not been successful in doing so, one local government official simply said, “(He) is an entrepreneur, but others are farmers” (Zhu, 2017). As we have described so far, key to the success of circular operation at the Farm is its economic viability, which, in turn, requires many pathways to complete the loop. Note that the earliest intention with biogas projects in China was supplying gas for rural families to cook and the bioenergy project constituting a single manure → biogas operation is still promoted by various local governments in China. However, such a project is difficult to sustain, especially for those farmers who do not breed animals and must buy manure for operating a digester. In our case, the Farm was able to construct a circular system full of many profit-generating paths but all this has come as a result of its owner’s looking out for environmentally sound and profit-making pathways, instead of passively meeting government mandates. In contrast, other farmers are often halted back by the assumption that environmentally responsible activities are deemed money-losing, thus overlooking the increasing options in the marketplace, e.g. for environmental- and health-conscious consumers. Transition to a sustainability approach is comparable to the process of innovation (Boons and Lüdeke-Freund, 2013), and risk aversion may hinder its adoption (Liu and Bai, 2014). The owner noted, “I have tried everything, and bamboo is the one that has so far survived. To get where I am today, I have lost money. Obviously not many people can afford doing this, but this is who I am” (Zhu, 2017).

The owner’s father built the first pig farm in the village in the early 1980s when their neighbors were hesitant to respond to the government’s reform initiatives and remained committed to their traditional grain operations. At the time, Jiangxi was one of China’s inland provinces that lagged other regions in market-oriented economic transformation. To this entrepreneur, adopting a circular approach was no difference than setting up a private business back then since both actions involved courage to embrace new opportunities while facing the unknown. “There is a difference though,” he said, “back then people were starving and they looked for ways to survive. Now that they live comfortably with what they have, they would rather not do this because they don’t see any benefits. They might do something but only half-heartedly for fear of penalties by the government. I am different; I see a trend coming that consumers, not only the government, want green products. I want to seize that opportunity” (Zhu, 2017). Prior research suggests that market pressure might not necessarily influence a Chinese firm’s environmental behavior (Wang *et al.*, 2007). Clearly, only a strong entrepreneurial orientation could lead someone such as the Farm’s owner to explore market opportunities, which are still vague and thus bear huge risks to act on in sustainability transition.

Research has shown that the institutional contexts in emerging economies, while complex and challenging, could also provide innovative opportunities for entrepreneurs to fill the institutional voids, which is not available in mature, developed economies (Tracey and Phillips, 2011; Jolly *et al.*, 2016). Our fieldwork discovers several occasions where the Farm entered a “gray area” to take advantage of government incentives. The Farm is often considered a business in Jiangxi, but that was only where it was originally registered. After several years of operation, the owner realized that the neighboring Province of Hunan offered greater incentives for CA. He quickly managed to acquire a piece of land that was attached to his property but on the Hunan side of the border. This move enabled him to register the Farm also as a Hunan corporation and started enjoying the benefits being offered by Hunan. “It’s legal,” the entrepreneur responded to the researcher’s question with a smile, “both governments like what I am doing and they take credit for that” (Zhu, 2017).

7. Implications for government policy

CA is meant to address environmental and economic challenges simultaneously, but previous research has tended to focus on one of the objectives. While investigating how circular operations help mitigate detrimental environmental effects or resource preservation, scholars are often unable to report the economic benefits with similar levels of clarity. With concrete data on economic performance, the current study proves that environmental, economic and social outcomes can be attained simultaneously, but economic viability is essential for a circular operation to sustain. Importantly, an economically viable circular operation must build upon a sufficiently large number of production pathways which in turn requires entrepreneurial action. These findings bear significant implications for government policy in emerging/developing economies concerning CA.

While this paper's findings confirm that circular operation is attainable in agriculture, they also point to the crucial role of the government in promoting CA which provides environmental benefits as a public good (Chen *et al.*, 2012, 2016; Li *et al.*, 2010; Holm-Nielsen *et al.*, 2009; Song *et al.*, 2014). These findings can inform public policy in emerging economies at similar development trajectory. First, the government may help cover some of the initial costs for biogas projects. As mentioned, the electricity generated from biogas offers sizable incomes to the Farm, which is made possible with a power-generating unit being installed. However, the unit costs money and farmers are often reluctant to bear the costs. This is where government intervention become significant, perhaps in the form of subsidization, for acquiring the unit. Second, the government can offer services to provide information on markets for organic products. Individual farmers could be aware of the importance of maintaining sufficient numbers of production pathways but might struggle to obtain information on market needs and trends. Timely access to market information can also help farmers mitigate risks and effectively adjust their production plans. Third, the government could help farmers with necessary technical support by way of supplying properly trained technicians. Most farmers do not have experience with production of organic products. Currently, the government-sponsored technology service stations in rural China are severely short-handed and can barely meet the needs of farmers contemplating to adopt green technologies. Fourth, the government might consider proper measures to help stabilize prices on organic products as an incentive for farmers whose circular operations are focused on such products. Fifth, the government might even be able to help fill a hole in a viable circular system by addressing some sort of "market failure." As described, the Farm sends a portion of the electricity generated from biogas to state-run grid for profit. This is a vital pathway for its circular operation since, without this venue, the total returns will not sufficiently justify the circular production profit-wise, and the inability to sell biogas-generated electricity externally is the reason many farmers give up on biogas projects.

The most significant finding of the current study is the vital role of entrepreneurship in building and growing a circular business. Existing literature portrays emerging/developing economies as though governments are the key driver of CE as opposed to the developed world where market-driven entrepreneurs lead the sustainable innovation (Schaltegger and Wagner, 2011). However, as demonstrated in the current study, a circular operation cannot sustain unless it is conducted as a business such that entrepreneurs seek innovative solutions for environmental challenges profitably. When capable, profit-seeking entrepreneurs are absent and people (such as those in the Farm's neighborhoods) either passively respond to policy pressures or simply sit on government subsidies, a circular operation will not be economically viable and sustainable. There is already the realization that the government should endeavor to develop a market model to further promote CE while continuing to execute compulsory regulations (Xue *et al.*, 2010). The current study suggests that entrepreneurial development should be at the center of such a market model.

8. Limitations and future research

This study has limitations. Its findings are based on study of a single farm, which should be verified by further evidence, preferably from differently designed studies. A better solution would be taking mixed methodologies in future research (Amui *et al.*, 2017). With a focus on

China, this paper is able to make sense of CA practice in the country's unique institutional environment. However, this focus prevents us from confidently generalizing these findings to other socio-economic contexts. For example, CE is promoted as a top-down national development strategy in China but largely a tool to re-design bottom-up management policies in many Western economies (Ghisellini *et al.*, 2016). Further research can thus take a comparative design, comparing CA practices between developing and developed countries and among developing countries for ascertaining the effects of institutional and national context (Amui *et al.*, 2017).

9. Conclusion

The benefits of CA have been widely accepted, and the challenge today is how to move from rhetoric to implementation (Su *et al.*, 2013). Our study of an individual farm in China proves that circular operation is attainable, but the success requires an emphasis on economic viability, a complete system "stuffed" with profit-generating activities, and an entrepreneur in charge. Although governments in emerging markets will continue to play an important role in implementing CA, it should look up for a market-driven model with entrepreneurs leading the transition from public initiatives to sustainable businesses.

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