International Food and Agribusiness Management Review
Volume 26, Issue 2, 2023; DOI: 10.22434/IFAMR2021.0097

Received: 2 August 2021 / Accepted: 7 September 2022

Techlex: a corporate practice to initiate inclusive agri-food value chain development in China

CASE STUDY

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Abstract

A tradeoff lies between inclusiveness and economic efficiency in meeting the Sustainable Development Goals such as poverty reduction, food security, and climate resilience. Vertical coordination between agribusinesses and farmers, in tandem with corporate social responsibility, has been perceived as an approach to surmount such tradeoff from a micro perspective. In a localized context of developing economies, the vertical coordination with farmers is reducible to a path for agribusinesses towards inclusive local value chain development (LVCD) at the grassroots level. However, few models are documented for agribusiness managers to refer to in practice. This study harnesses the Techlex Group and its pig business as a case, zooming in on the vertical coordination of agribusiness and vulnerable smallholders in lagging rural areas of China. Based on an overview of China's pig industry and Techlex's value chain, this study highlights three inclusive models and their alternatives for the LVCD. Though proffered in the Chinese context, those models can enrich the LVCD toolkit and be attuned to fit a different scenario.

Keywords: Techlex, agribusiness, value chain development, contract farming, vertical coordination
JEL code: L26, M14

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1. Introduction

Climate change, trade frictions, the pandemic, and many other universal issues unprecedentedly urge agri-food systems to expedite the pace toward Sustainable Development Goals (SDGs) (IFPRI, 2020). For developing countries beset by rural poverty, agri-food producers largely consist of vulnerable low-income smallholders. In most cases, those small farmers are confined to a dearth of access (e.g. access to productive resources and high-value markets) and capacity (e.g. capacity to respond to uncertainties and sustainable pursuits). They tend to be far less competitive vis-à-vis their large-scale counterparts, notwithstanding rapid structural change and urbanization in developing economies yield new market opportunities for value-added agri-food products (Fan and Rue, 2020). Predominant value chain actors, especially enterprises, have the social responsibility to benefit vulnerable smallholders, thereby propelling the agri-food systems en route to inclusiveness and sustainability (Porter and Kramer, 2006; Xia *et al.*, 2018).

Value chain, in general, refers to all the activities of a commodity from conception to end use and beyond (ILO, 2015; USAID, 2006). Since Porter (1985) introduced it as a systematic view for managing business competitiveness, the idea of value chain development (VCD) or value chain intervention has been increasingly engaged with SDGs and embraced by both academia and practitioners (Donovan *et al.*, 2015). Epistemologically, interest in VCD since the early 1990s has cultivated diverse typologies. A governance perspective codifies VCD into five basic types: market linkages with informal traits; modular value chains led by costumers; relational value chains underpinned by dense social networks; captive value chains controlled by lead firms; and hierarchical value chains featuring vertical integration (Gereffi *et al.*, 2005). Although types vary, the current VCD implicitly accentuates global value chain development (GVCD) and whereby the inclusion of poor nations and small and medium-sized enterprises (ADB *et al.*, 2021; Kaplinsky, 2000). Local value chain development (LVCD) underpins the dominant pathway of smallholders to domestic or localized markets, thus functioning as both a supplementary and a springboard for higher-level value chains. However, when juxtaposed with GVCD, it has been less focused on (Hainzer *et al.*, 2019). Knowledge lacunas on inclusive LVCD detour the strides to SDGs.

Over the recent two decades, worldwide facilitators have proffered an array of participatory approaches to embrace smallholders, especially those in low-income countries of Africa and Asia. Many LVCD-based tools prevail in the agri-food field, such as the participatory market chain approach, the making markets work for the poor approach, and the guideline for pro-poor value chain development (Bernet *et al.*, 2006; DFID and SDC, 2008; UNIDO, 2011). Empirical research has explored the repercussions of concrete mechanisms in developing economies, with objectives of poverty reduction in particular (Dries *et al.*, 2009). Although the performance may be deviated by factors such as market malfunction and weak managerial capabilities, vertical coordination between agribusiness and farmers has been deemed key for corporate social responsibility and inclusive VCD (Hajdu *et al.*, 2021; Hayer *et al.*, 2019; Kopp and Sexton, 2021; Lund-Thomsen and Nadvi, 2010). Rather than leaving local stakeholders to compete in their silo, such vertical coordination develops agri-food value chains as a local response to the inclusive pursuits and the ongoing GVCD trends like domestic agglomeration (ADB *et al.*, 2021; Bresnahan and Levin, 2012; Humphrey and Navas-Alemán, 2010; Rich *et al.*, 2011).

For agribusiness managers and other local agencies in developing economies, however, practical concerns arise as to bringing the epistemologies down to earth. The general question is: what coordinative models are feasible and replicable for inclusive VCD in poor rural areas?

The current case library retains three loopholes when responding to those questions. First, a plethora of cases portray inclusive models along regional or global VCD but largely end up with participation at the country or firm level (Antràs, 2020). Contract farming and other forms of vertical coordination develop as export-oriented high-value agri-food production became a strategy in many developing countries (Minot, 2018; Swinnen and Maertens, 2007). Relevant empirical literature has explored inclusive mechanisms extensively. However, the local level multistakeholder partnership and interactions are often anecdotal. Scrutiny on the

proposed models alerts that the excessive generalization of local dynamics can mislead the governance of agri-food systems and value chains (Nguyen *et al.*, 2015; Oya, 2012; Tinarwo *et al.*, 2018).

Second, on the contrary, many LVCD models are likely to lack externality due to their context-specific nature. It is primary to discern the selection and formation of those local-based value chains for a replicable model. In many cases, selected agri-food value chains pivot on staple food (rice in particular), with an increasing focus on fruits and vegetables (Ba *et al.*, 2019; Mishra *et al.*, 2018; Van Hoyweghen *et al.*, 2021). In contrast, cases regarding animal husbandry seem to have a particular interest in the dairy industry (Dong *et al.*, 2020; Ekumankama *et al.*, 2020; Lie *et al.*, 2012), the bulk such as beef and pork have been less documented (Zhang *et al.*, 2019). As for the formation process, either formal or informal (Birthal *et al.*, 2017), the force of donors and the objective of a particular program shape the localization of VCD (Humphrey and Navas-Alemán, 2010; Pietrobelli and Staritz, 2018). Enterprise is a backbone force financing the localization of VCD. However, its role during LVCD of the developing countries has been disputed (Waldron *et al.*, 2010).

Third, from either angle of the dichotomy, the evolution of VCD has rarely been mapped out (Kilelu *et al.*, 2017). The validity of cases could be destabilized by misunderstanding the theory of change, the dim progress of fighting inequality in a broader picture, the lack of comparison, etc. (Devaux *et al.*, 2016, 2018). Staged performance of inclusiveness needs to discuss with long-term rubrics, particularly poverty reduction and environmental sustainability (Bolwig *et al.*, 2010). In addition, most developing economies have not achieved the SDG of no poverty. Such a fact lessens the power of models yield by the South per se. China has eradicated extreme poverty ten years before the 2030 Agenda, which makes its typical cases and models competitive for other South nations to refer to (NCR, 2021).

2. Methods

The motivation for this research derives from the literature review and the practical concerns introduced above. To provide managerial audiences with demanded models, the authors have had in-depth discussions with several industrial consultants and university professors to screen out the study object – Techlex. In 2018, the authors conducted a scoping study of Techlex's value chain in Yunnan, Sichuan, and Guizhou provinces. A general picture of the firm's inclusive VCD has been sketched through participant observation and focused group discussions. According to methods proposed by Yin (2009), a logic model has been extracted from the sophisticated field activities for further data collection.

Since one of the authors poses rich industrial expertise and networks in the agri-food domain, we connected with the chairman, the vice chairman, and the chief executive officer for data necessary for this teaching case. National data from the National Development and Reform Commission of China was used as the benchmark for data comparison. Perceptions on the evolution, staged challenges, and outlooks of the enterprise have been collected through personal communications with the managers and consultants of Techlex. Overall, the dataset of this study consists of first-hand survey data, public statistics, intra-firm reports, and knowledge shared by key informants. As for analysis, this case study has incorporated the actor-oriented approach to map out interactions and value distribution around Techlex's value chain initiative (Long, 1990). At last, we discuss poverty reduction, economic efficiency, and environmental sustainability following a conceptual framework of Bolwig *et al.* (2010).

The following section presents an overview of China's pig industry and the value chain of Techlex. The fourth section will decipher the nexus between national policy initiatives, Techlex's business localities, and the inclusive VCD strategy. The fifth section will delineate the phase-in practical models and their alternatives. Lastly, this paper will end up with introspection of those models and an outlook of Techlex. Supplementary information can be found in Supplementary Material S1.

3. Overview: China's pig industry and Techlex's value chain

3.1 China's pig industry

Hog farming prevails amongst farmers in various cultures, as livestock is key for conventional subsistence agriculture and can simultaneously provide rural households with marketable products. It is an important contributor to food and income especially for small-scale farmers. In the case of China, which remains the largest hog producer and consumer worldwide (Supplementary Figure S1), small-scale farmers have long been the primary force of swineherds.

Since the economic reforms in 1978 and then in 1992, China's pig industry has been invigorated by the burgeoning demand from sustained rapid economic development and fast-transforming food consumption structure. During the recent two decades, the structural transformation of pig supply chain has stretched from conventional pig production to breeds selection, feed, veterinary drugs and vaccines, food processing, logistics, retail, catering, and many other segments. As quality safety and environmental restrictions regarding hog production have also been intensified, in accordance with outbreaks including the African Swine Fever (ASF), China's swineherds have been restructured (OECD and FAO, 2021). On the one hand, the share of backyard pig farming still persists as the bulk but shows a shrinking trend. On the other, the scaling-up and consolidation of hog farms expedite. Large-scale feed-based hog production systems has been installed within the value chain of agribusinesses. The private sector, accounting for more than 98% of enterprises in domestic pig industry, turns out a driving force towards industrial intensification (NDRC, 2020).

3.2 Techlex and its value chains[1]

Seizing the opportunity of national economic reforms, the Techlex Co Ltd was founded in 1992. Originated as a nascent feed processing enterprise, it soon after developed into the Techlex Group (i.e. the Tie Qi Li Shi Group), incorporating feed, livestock, food, and biological engineering. Five business divisions – feed, pig, laying hens, food, and the new business line – are deployed throughout its value chain at moment.

Feed business is a cornerstone for the value chain extension of Techlex. More than 30 branches and subsidiaries contribute to sustaining its feed production capacity of 4 million tons per year. The feed products not merely are earmarked to satisfy the large-scale farms of the Group per se, but also generate a valued brand amongst consumers. Large-scale domestic farms are the major customer base. Albeit feed production has been impeded by the bump up of price volatility regarding inputs and many other factors during ASF and COVID-19, the feed business of Techlex has retained an annual profit growth of about 67% (Techlex, 2021). In addition, the Group has been granted as one of the top ten leading companies of China's feed industry in 2020, whereas its fermented feed (i.e. Jiaoyida) was bestowed upon a pioneer brand for the antibiotics-free kind.

Largely benefited from upstream feed production as well as research and development (R&D) along the value chain, the Group's business engaged with the hog industry becomes vibrant. It integrates breeding (breeders and piglets), fattening, slaughtering, processing, and marketing. In terms of pig breeding, Techlex fully avails of the ownership of several national key breeding farms, which are identified by the Ministry of Agriculture, for either independent or joint R&D of improved pig breeders. The Group has sustained international cooperation with Genesus Inc. for a long period. Two reputed indigenous breeds in Sichuan province have therefore been screened out and improved. Since the Group led the establishment of industrial standards in Sichuan province, its pig business has further scaled up and extended nationwide. With over 30 large-scale pig farms, the Group aims to yield 3 million qualified commercial piglets per year by 2022.

Sundaily Village is a lucrative supplementary to Techlex's value chain. Techlex is the first in China to pose a full poultry industrial chain, spanning from breeders, feed, cultivation, and high-value egg production.

[1] Supplementary development trajectories of the Techlex Group can be located in the teaching notes.

Innovatively, the Group has established a traceable nutrition database of the Sundaily Village branded egg products. At present, there are 21 subsidiaries and 19 farms nationwide. The number of laying hens in stock has already exceeded 13 million, whereas at least 500 million families in China consume Sundaily Village branded egg products every year (Techlex, 2021).

Food business subsumes the deep processing of food and the pilot projects for the Valley of Quality Food. For the former, Techlex has established about 20 branches in Sichuan, Guizhou, and many other provinces. With dozens of food brands (Maple Leaf Ranch, etc.), the Group has marketed various of food products (fresh, cooked, casual snacks, etc.) through well-known national companies (Three Squirrels, COFCO, Fresh Hema, etc.) and by exporting to more than 20 countries and regions (US, Canada, Japan, Australia, EU, etc.). For the latter, the Valley of Quality Food goes beyond the conventional industrial park, and transforms the value chain of Techlex into a platform for industrial cluster development. Techlex innovated the projects as the incubator and accelerator of its VCD strategy. In line with the Group's standards, those pilot projects trigger the formation of its comprehensive regional value chains that integrates local enterprises closely related to the platform but short of resources and marketability.

As the youngest business division, the new business line coalesces all the products and supply-chain resources of Techlex, devoting to developing innovative retail models in such a way as to lead the digital development of agribusinesses. At moment, the division works on incubating ecommerce matrix for the interwoven divisions of the Group.

4. Why for Techlex towards inclusive agri-food value chain development?[2]

Wenyong Lei, the chief founder and the chairman of Techlex, has committed to China's agribusiness development for over 29 years. His entrepreneurship matures along with the corporate value chain evolvement. Insofar as the Group has been nationally recognized as a key leading enterprise in agricultural industrialization, it endeavors to become a leader for China's high-value food in a way as to transform into a large-scale social enterprise. The value proposition of Techlex has been converted to a composition of innovation, value, and sharing.

Even upheld by more than 150 branches and subsidiaries nationwide, fulfilling the mission to be a social enterprise is a bumpy ride. For instance, the hog value chain was once refrained from scaling up by a range of bottlenecks, including insufficient land and workers, rising threshold (for instance food-safety and environmental standards), and risks for hog production. To breakthrough, Techlex has leveraged on the nexus amongst those challenges and the market opportunities to cooperate with small and medium-sized enterprises (SMEs) and producers at the bottom of pyramid (BOP) (Prahalad and Hart, 2002). Projects of the Valley of Quality Food and the vertical coordination with smallholders have been considered as the potential thrust.

Projects of the Valley of Quality Food have been piloted in five provinces. Thereinto, Sichuan, Guizhou, Heilongjiang are significant to China's hog production, as shown in Figure 1. Driven by the Valley of Quality Food, comprehensive regional value chains mainly cover the southwestern district of China. From an ex-post perspective, this distribution (Figure 2.) further nudges Techlex towards inclusive VCD, whilst the extension of germane models reciprocally reinforces the comprehensive regional value chain.

The southwestern provinces in China are vastly mountainous areas. Residing far from markets, most rural households in provinces such as Sichuan, Guizhou, Yunnan used to be deprived. To develop rural areas and their population, Targeted poverty alleviation (TPA) was a dominant policy in China from 2013 to 2020, whilst the rural revitalization strategy (RRS) has edged up to the core of the national development policy landscape since 2017. Accordingly, in the lagging regions, more governmental resources and social capitals have been redirected to developing rural industries and benefiting the poor. For internalizing competitive

[2] In addition to narratives in this section, internal and external drivers are itemized in Supplementary Material S1.

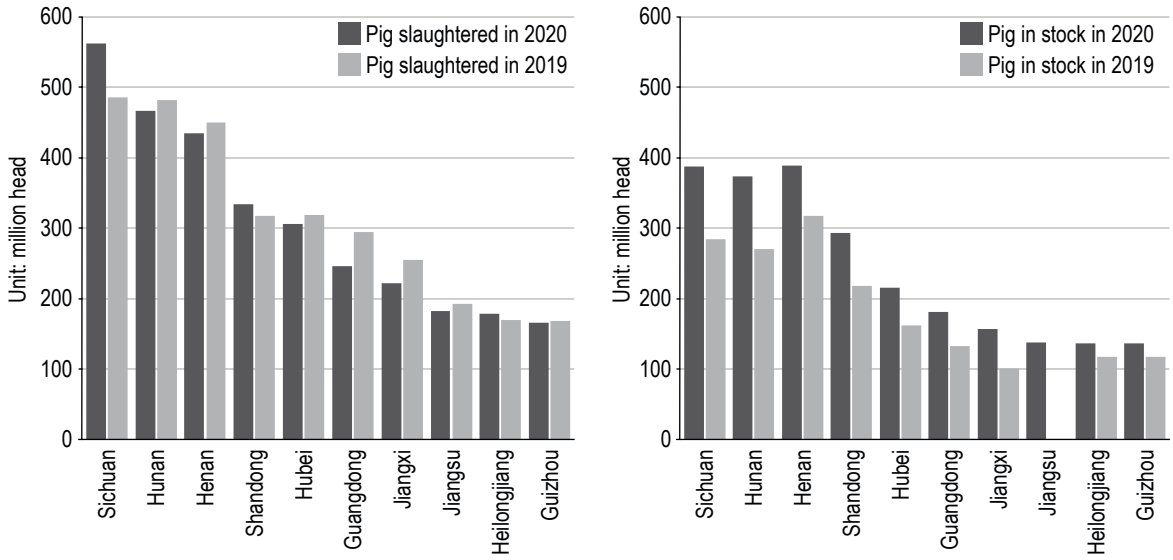

Figure 1. Hog production in the major pig breeding provinces of China. Data for the number of pigs slaughtered in Hubei province is only available from January to November 2020. Data for the number of pigs in stock in Jiangsu province is not available. Author computed based on reports from the provincial Department of Agriculture and Rural Affairs.

Figure 2. Distribution of Techlex's comprehensive regional value chains and inclusive models. This padded cartogram is made on a base map (approval number: GS(2019)1673) downloaded from the Ministry of Natural Resources of China. The base map has not been modified and is available at: https://tinyurl.com/yckjtzj7.

industrial chains, local governments were zealous to offer a set of public goods (land, finance, and other aspects) to facilitate the intensification of livestock production. As for the pig industry, vertical coordination of agribusiness and farmers has been promoted by the government as it could elicit industrial development in lagging rural areas and contribute to increasing the income of participants. Such policy inclination neatly dovetails with the developmental need of Techlex and its comprehensive regional value chains in the localities where the Valley of Quality Food has been piloted.

Overall, the nexus of those external impetuses and the internal demand has led Techlex to pursue inclusive VCD. In a localized context of poverty reduction and rural revitalization, the inclusive VCD of social enterprises is expected to benefit poor rural households. Yet, a question for the helmsman of Techlex is about how to realize it?

5. Value chain models for integrating agribusiness and smallholders[3]

5.1 Incubation of Techlex's value chain models

Techlex learned the concept of agri-food supply chain management by participating in the small farmers adapting to global markets (SFAGM) project granted by the Canadian International Development Agency during 2003-2008. As a major project component, SFAGM piloted its interventions in Sichuan province, wherein Techlex is headquartered, to enable better market access for small farmers. Local capacity building was counted significant for exploring channels to cut through an agri-food supply chain from farm to plate. Hence, SFAGM provided technical assistance and training, which engrossed in farmers, agribusinesses, extensions, and local competent authorities, in line with WTO rules and pertinent standards in terms of quality safety and environmental protection. Thereinto, Techlex actively engaged in the activities by contracting small farmers to fatten piglets. The capacity of supply chain management has thus been acquired during providing productive hog breeds, standardized operation procedures, on-farm quality and environment management, hog farming insurance, etc.

The knowledge and know-how in pork supply chain management have subsequently been forged as a value-chain approach to further coordinate with other interested supply chain parties. To put a step forth in participating in TPA and later in RRS, Techlex set out to build a laboratory to incubate inclusive models systematically. Although the laboratory was established later in 2019, Techlex has already probed viable mechanisms for inclusive VCD in form of contract hog farming. The first trial was in Guangyuan city, Sichuan province as early as 2014. In 2017, a barebones inclusive model, which later developed into the 1+N model, was registered as a trademark. It has conceptualized that the enterprise is the driver of the models, whereas they should be monitored by the government, participated by villagers, and supported by civil society. Overall, a set of models traces its origins to the grassroots practice of the Group in provinces including Sichuan, Guizhou, Yunnan, and Heilongjiang, as shown in Figure 2.

While the precise treatment effect of implementing the inclusive models cannot be measured, their inclusiveness, efficiency, and sustainability have been widely perceived and accepted by both the initiator and participants. The following sections will exemplify the county-level hog production models according to the report from Techlex (2021) and its vice chairman Bo Lei (personal communication.). Rather than giving a geographical tour of the subcases, this study articulates the azonal models with a phase-in logic.

[3] Please note that the county-level models have primarily been summarized by the Techlex Group and titled as '1+8(N)' and '1211' (Santai), 'T+high quality pig industry alliance' (Suijiang), 'VT141' (Weixin), '4321' (Yanhe), '1234' (Qinggang), and 'Five in One' (Xide). This case study reframes and synthesizes the regional subcases with a phase-in logic for international audiences to refer to.

5.2 1+N model

The 1+N model is handy for agribusiness managers to start with. The gist is to integrate the agribusiness and individuals, that is, 1+N, through contract hog production based on a family hog farm. The 1+N model is summarized from Techlex's experiences at Santai county, Sichuan province, and Yanhe county, Guizhou province. It can also be reduced to a barebones mode of the 1+N model via integrating Techlex and one poor household through a hog production contract (as registered in 2017).

The hog farm is mainly invested by the local business talent(s), who is defined as the competent rural individual in developing certain businesses. At least eight poor residents are supposed to participate in its establishment and management with dedicated loans. It is compulsory in all subcases that the hog farm must meet pertinent standards (quality safety, environment, etc.) from both Techlex and the government. Techlex is in a role to carry out unified services spanning from designing pigpens to post-production. The local government is in support of platform building for this model, whereon financial institutions offer the earmarked loans to the poor participants.

With the 1+N model, once the contract took effect, contractors can draw the inputs for hog farming (piglets, feed, etc.) on credit from Techlex, while they must pay a deposit of 300 yuan[4] per head (about 46 USD per head) at the same time. In this way, the cash investment for purchasing inputs has been reduced by 75%. Thereafter, the regional task force of Techlex provides substantial training and services to the pig farmers, including pig production and reproduction training, on-site guidance, technical services, disease and parasite prevention and control, etc. Risks for hog production can be lessened with a closed breeding pattern that highlights the value of early weaning as well as all in and all out.

Along the standardized production process, the contracted hog farm should deliver two batches per annum. Techlex in turn ensures the farm with remuneration for each year. When the hogs reach a certain market weight, both Techlex and the contractors jointly weigh the hogs and complete the payoff (total sales weight × contract price). In addition to wages, the yearly dividend for the poor is normally 5,000 yuan (about 769 USD) per capita, which is pursuant to their equity capital on loan. Notably, those loans will be repaid by the business talent instead of the poor.

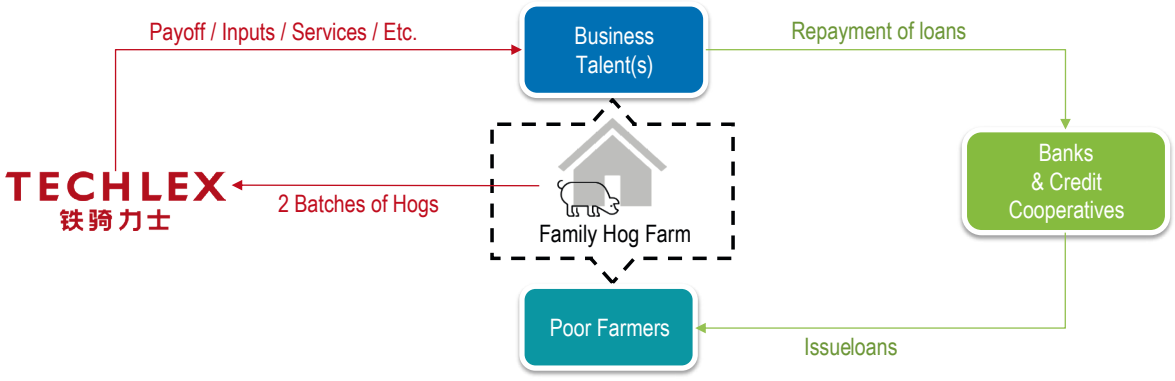

Figure 3. 1+N model.

[4] Yuan is the Chinese base unit of currency. Please note that all amounts in this paper are in 2018 constant price and provided by Techlex unless otherwise specified.

In general, the responsibilities of key stakeholders in the 1+N model are:

- Techlex: design of the pigpens; supply of piglets, feed, drugs and vaccines, etc.; standardized process management; purchase of hogs with contract price; marketing via the Group's outlets.
- Local business talent(s): construction of pigpen and security deposit; concrete management; labor supply; and repayment of loans.
- Poor farmers: construction of pigpen with loans; and labor supply.

5.3 2+N model

Techlex's 2+N model is akin to the 1+N kind but further includes the village collective on the basis of strategic cooperation between Techlex and the local government. Notwithstanding its definition falls in the lacuna, the village collective is a cooperative-like economic entity endorsed by the constitution of China. Its assets benefit all dwellers in the village community, thus making it a nonnegligible actor for agribusinesses towards inclusive VCD in the local context. The gist of this model is to embrace individuals and their collective by mobilizing both the regional value chain of Techlex and idle resources from the local government.

In the praxis at Qinggang county, Heilongjiang province, Techlex and the local government are the two financing sources of the 2+N model. Facilities of large-scale bases regarding hog breeding and fattening are invested by the government, and accredited to the village collective for management. Reciprocally, the Group signs a long-term agreement (normally 15 years) with the local authority, declaring that the Group pays 5% of the total government investment as an annual rent designated for the village collective. As local job opportunities have been created in the bases, villagers are able to access the hog production value chain of Techlex through the village collective. A protective recruitment criterion is employed for embracing the vulnerable group as the participation of business talent(s) seems more lucrative. The large-scale base is expected to have a production capacity of 200,000 heads per annum, which is necessary to prop up the Valley of Quality Food in a neighboring location.

Since Techlex has comprehensive regional value chains, its 2+N model for inclusive VCD can be employed as a reproducible script around the locality where there is a Valley of Quality Food. For instance, it has been replicated at the village level in Weixin county, Yunnan province. A 'one village one farm' mode becomes an extension of the generalized 2+N model.

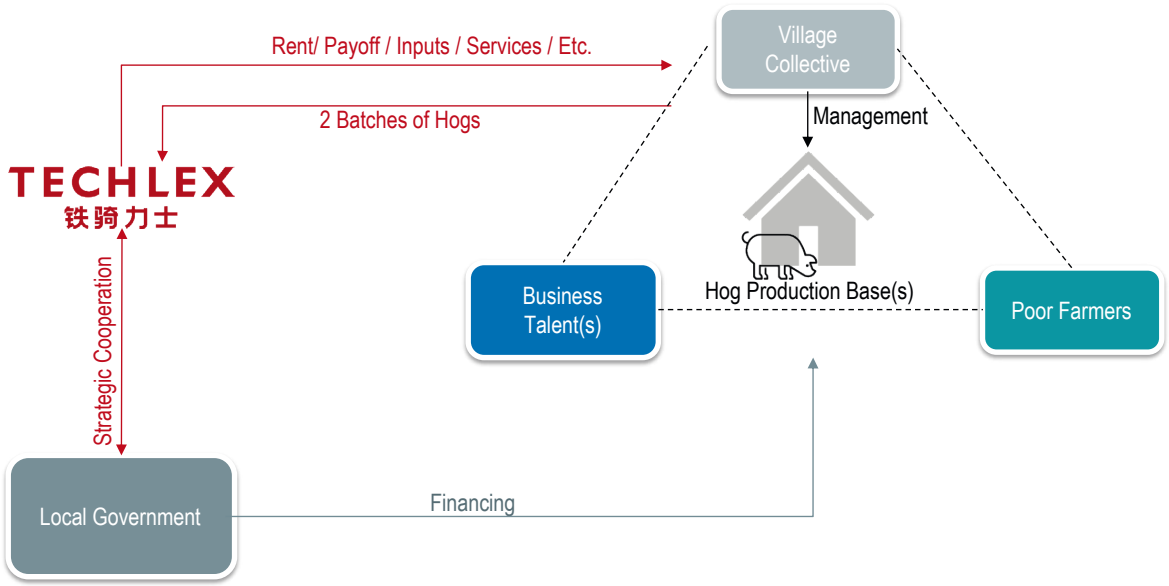

Figure 4. 2+N model.

Stakeholders and their basic responsibilities amid the 2+N model are:

- Techlex: pay the rent; design of the bases; supply of piglets, feed, drugs and vaccines, etc.; standardized process management; purchase of hogs with contract price; marketing via the Group's outlets.
- Government: financing; construction and general management of the hog breeding and fattening bases; coordination with the village collective.
- Village collective: concrete production management and grassroots coordination.
- Local business talent(s): labor supply; joint investment (possibly).
- Poor farmers: labor supply.

5.4 Nested model

In the nested model, stakeholders encompassed in both the 1+N and the 2+N form are mobilized. The gist of this model is the systematic coordination of stakeholders at binary value chain stages, namely hog breeding and hog fattening. The vulnerable group is involved in the value chain through either hog breeding in a partial 2+N mode or hog fattening in the 1+N mode.

The nested model has been conducted at Xide county, Sichuan province. According to provincial policies on poverty reduction, the county government has consolidated relevant resources to set up an investment corporation for agricultural development. The investment corporation is state-owned and runs both the government funds and the credit from financial institutions. A hog breeding base is funded by the investment corporation on behalf of the government and serves as the major supplier of piglets to meet the demand from local family hog farms. Techlex defrays the rent of hog breeding base to the local government resembling in a typical 2+N model. The coordination of Techlex and individuals in terms of hog fattening relies upon the hog farm, as introduced in the typical 1+N model. In addition, the village collective engages as an alternative contributor for the village talent(s) to fund the hog farm.

An extended mode has been implemented in Suijiang county, Yunnan province. As the initiator, Techlex has probed to incorporate other interested parties along with the local pig industry. Complementary resources from local agri-food cooperatives, veterinary drug enterprises, and slaughterhouses have been pooled in the

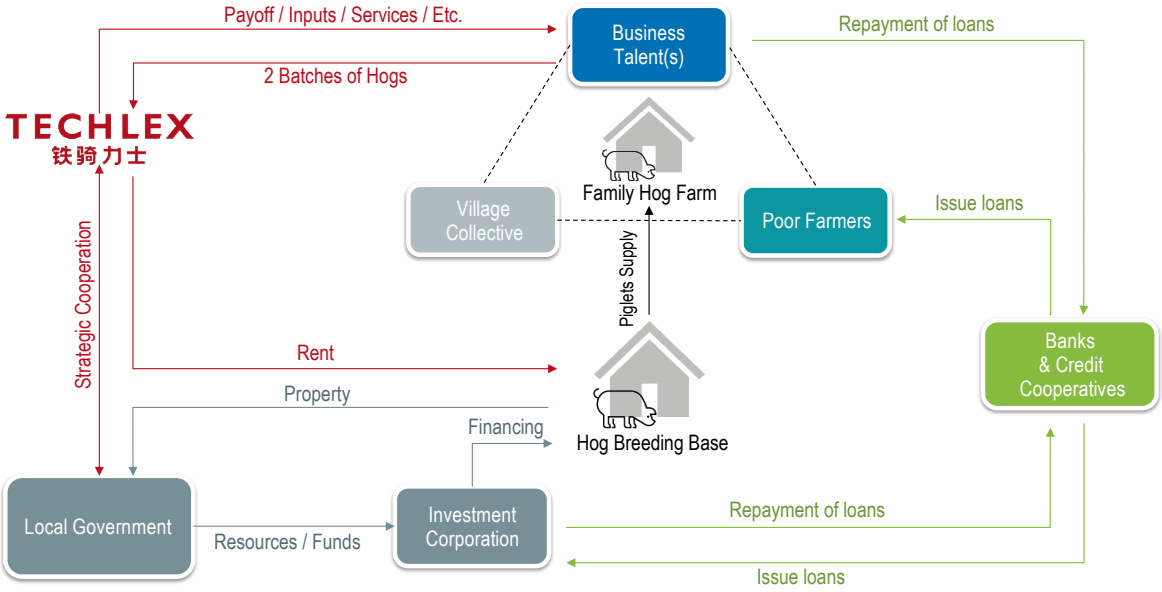

Figure 5. Nested model.

model. Relying on the alliance, the responsibility of input supply can be largely transformed to the local alliance, which is likely to reduce the costs of the inclusive models. In this sense, the extended nested model not merely contributes to taking in farmers, but also the petty agribusiness at the local level.

In the nested model and its extended mode, stakeholders and their basic responsibilities are:

- Techlex: coordination; pay the rent; design of the bases; supply of piglets, feed, drugs and vaccines, etc.; standardized process management; purchase of hogs with contract price; marketing via the Group's outlets.
- Government: financing; construction and general management of the hog breeding and fattening bases; coordination with the village collective.
- Investment corporation for agricultural development: resource management; financing bases on behalf of the government; repayment of loans that the local government credit.
- Banks and credit cooperatives: credit to the poor and the government.
- Local business talent(s): construction of pigpen and security deposit; concrete management; labor supply; and repayment of loans.
- Poor farmers: construction of pigpen with loans; labor supply.
- Village collective: joint investment (possibly); grassroots coordination.
- Alliance and its participants: input supply.

6. Discussion

6.1 Inclusiveness and efficiency

Inclusiveness is the overwhelming merit of the three models. For households in lagging rural areas of China, hog farming was one of the conventional sources of livelihoods and food, yet tended to be stunted by scant technology and marketability. As for the most deprived, hog production might not even be a choice within reach. The models and the alternatives have been initiated by Techlex as approaches to benefit smallholders accordingly. In all subcases, Techlex has leveraged its strengths in technology, management, capital, and brand. Capacities of other value-chain stakeholders have also been activated to better surmount local developmental deficiencies. In particular, the cooperation with intermediaries (i.e. the local government, village collective, etc.) arouses their aptitudes in utilizing and redirecting inventory resources to inclusively benefit poor farmers.

The profits for the family contractor in the barebones 1+N model can be used as a basic example. The market weight of a hog is usually 110 kg, whilst the contract hog price is 16 yuan/kg. The fattening costs are as listed in Table 1. It is noteworthy that although the costs are higher than the national average partway due to quality control, the performance of Techlex's models in benefits turns out much better, as introduces in the following section. Overall, in the barebones 1+N model, the per-head net profits approximate 150 yuan (=110×16–1,610), which is about 23.1 USD. If the contracted family hog farm delivers 700 to a 1000 heads per production annum, in line with standardized producing criteria, the benefits of that family farm can reach 100,000 to 150,000 yuan (about 15,400 to 23,100 USD) accordingly. With market weight and contract price akin to the basic example, profits for the participants in other models vary merely with shares, the farm scale, and other random factors. As a result of the four-year praxis, 158 villages and over 15,000 individuals have been directly benefited till 2021 (Lei, 2021).

Another quality of the models is that the inclusiveness and the efficiency are mutually benefited to a large extent. On the one hand, for agribusinesses, double marginalization elicited by discrepancies along the agri-food supply chain can keep VCD in limbo (Luco and Marshall, 2020). In those subcases where the strategic cooperation has been endorsed, the local government makes a special effort on streamlining the vertical supply chain coordination (between Techlex and SMEs, farmers, etc.) and providing public goods (facilities, grants, business environment, etc.). With a stable symbiosis with other stakeholders, transaction costs and other latent burdens for Techlex can thus be mitigated to a large extent. On the other hand, as the

Table 1. Fattening costs for the family in the barebones 1+N model.[1]

Item	National average (yuan/head)	Cost (yuan/head)	Cost (USD/head)
Piglets	425.9	462	71.1
Feed	894	1,087	167
Disease control	15.8	30	4.6
Water and electricity	9	6	0.9
Others (without labor)	29.6	25	3.8
Total cost	1,374.3	1,610	248
Net profit	-235.5	150	23.1

[1] Techlex data through field research and the intra-firm audit in 2018. National data is adapted from NDRC (2019). Authors use the national data from NDRC (2019) as a reference. Data may vary at the county level.

contract hog production runs under standardized process management, the models in effect underpin a high-quality food production base for improving the brand premium for Techlex. The success of the models also lubricates the transmission of brand premium.

6.2 Resilience and environmental sustainability

From a long-range way of thinking, uncertainties and pollutions are two vital aspects that managers cannot give a detour in animal husbandry, particularly hog production. An intra-firm audit in 2018 collected rudimentary data on the relative vantage of Techlex's models over the average performance of hog production in China. Analogously, Table 2. gives an example of the economic and environmental competitiveness in the barebones 1+N model.

Managerial competencies and the comprehensive value chain of Techlex are requisite for the models to perpetuate resilience and pursue environmental sustainability. The resilience is largely manifested during the unforeseen outbreaks in 2020. The encounter between ASF, COVID-19 and the last mile in accomplishing TPA projects redoubled uncertainties for stakeholders in the pig industry. Agribusinesses that endeavor to realize inclusive pig VCD were facing a sobering picture. However, Techlex has even steadily scaled up its contracted hog production projects. The loss rate has been restrained within 3% for either the large-scale bases or the contracted family farms, owing to the unified equipment of precision feeding equipment and major disease prevention and control technology. Value-added food processing and end-market branding are key to link the farmers to the market during the plagues through the models. In short, Techlex's capacity in stabilizing production and fulfilling social responsibility is built on its competitive value chain, which spans from biotechnology R&D to the deep processing and marketing of animal products.

As for environmental sustainability, which is one of the overwhelming goals in China's RRS for the coming decades. Recently, China has further pledged to peak carbon dioxide emissions before 2030 and become carbon neutrality by 2060. Stakeholders embedded in the domestic agri-food system are in dire need to internalize environmental sustainability into their development strategy. As animal waste is a major contributor to rural non-point pollution, the disposal of pig manure is critical for agribusinesses amidst animal husbandry (Bai *et al.*, 2017; Cheng and Pan, 2021). As presented in Table 2, Techlex has already focused on reducing emissions. It is now on the way to promote environmental sustainability with a threefold approach. The first is through programs implementing precision animal nutrition (i.e. low protein diet, less use of additives). Secondly, the smart agrotechnology-based feeding system is employed to limit feed and water waste. Thirdly, integrative disposal of manure is utilized to recycle pig manure pursuant to regional and seasonal heterogeneity.

For instance, with an idea to foster ecological agriculture, Techlex and other local stakeholders of Xide county jointly renovated the disposal of manure based on the nested model. As hog production has become a

Table 2. On-farm performance of the barebones 1+N model.[1,2]

Items	Unit	Baseline condition (nonparticipant)	Improvement (participant)
Inputs			
Feed (grain)	kg/head	243.4*	-15%
Water	yuan/head	2.5*	-35%
Energy	yuan/head	6.5*	-30%
Land	yuan/head	0.14*	-50%
Labor	days/head	5.9*	-50%
Outputs			
Piglet survival rate	%	85	12%
Feed conversion ratio	–	2.85:1	-11%
MSY[3] in production	heads	15	57%
Emissions			
Waste	tons	–	-21%
Nitrogen	kg	–	-17%
Phosphorus	kg	–	-25%

[1] Techlex data through field research and the intra-firm audit in 2018.

[2] *As the concrete microdata are partly unavailable, the authors use national data from NDRC (2019) as a supplementary. The baseline condition may vary at the county level.

[3] MSY = marketed pig per sow per year.

vibrant pillar of the local economy, residents begin to improve crop productions, which has long relied upon potatoes. Substantial manure is recycled and processed as organic fertilizers to ameliorate soil. The petty potato cropping is now transformed to a combination of growing pepper, fruits, and vegetables. In another example, Techlex has invested 20 million yuan (about 3 million USD) in environmental facilities at its largest sow farming base in southwestern China, namely the Maple Leaf Ranch. Five products are separated from the manure, including methane (as an alternative source of energy consumption), biogas slurry (soil fertilizer). dry manure (used for the amelioration of soil quality), liquid fertilizer (soil fertilizer, irrigation), and irrigation water (for the dry season). Thereinto, the pig manure after bio-safety disposal supplies over 4,200 mu (about 280 ha) cropland with organic fertilizer.

6.3 Outlook of Techlex

Overall, Techlex enriches the toolkit of inclusive VCD with three types of handy models and alternatives. The practice to initiate inclusive LVCD is supported by its managerial competencies and the comprehensive regional value chains mostly deployed in southwestern China. Pilot projects of the Valley of Quality Food serve as a springboard for the Group's VCD. Techlex has made well-reputed efforts in vertical coordination with smallholder farmers, SMEs, and other stakeholders. Reciprocally, it has benefited from the initiatives and its replicating and scaling up throughout China. To perpetuate the payoffs from the models, Techlex takes on chief challenges that small hog farmers are confronted with but not able to respond to. It has been the Group's responsibility to counteract the price fluctuation of raw material and products, unforeseen epidemic losses, massive pressure on cash liquidity, environmental thresholds, and meager technology and knowledge of smallholders, etc.

However, these responsibilities give rise to risks that might in principle be as large as the profits. Moral breach of contracts has always haunted the implementation of the models. Multifarious emerging discrepancies that may exacerbate in the future can also skew the models towards attrition. For instance, as the structural transformation in agriculture deepens, scatter petty family farms constructed by the poor household (as the barebones 1+N model) will likely be swift out due to higher industry thresholds (productivity, eco-environment

requirements, higher demand for liquidity, etc.). Techlex, or the adopter of the inclusive models, will need to find a new equilibrium between inclusiveness and efficiency. In addition, as TPA and its transitional package abate in the future several years, Techlex may need to reconsider the definition of inclusiveness of individuals during LVCD in China. Without the partnership of overzealous local government, Techlex must figure out how to curtail costs (services, environment protection, etc.) when better carrying out the models. After all, the adopter of the inclusive models will always need the philosophy to seek equipoise between philanthropical pursuits (to both human and nonhuman actors) and profit-driven strategies in the long run.

According to Techlex's chairman, Wenyong Lei, a social enterprise should not merely pursue profits, but also embrace the dire need for social development. In his words, social enterprises must build on shared social values. Techlex endeavors to continue creating and sharing values with communities, consumers, employees, as well as the dumb environment for the next steps towards a leading social enterprise. Four pillars underpin the future development strategy of Techlex. First and foremost, the Group will grasp the rhythm of agri-food system transition, with persistence to reinforce the supply of high-quality food with inclusive value-chain models. Second, Techlex attempts to redefine the values of agriculture and its factors, via transforming towards a digital technology-based agri-food enterprise. The 'Cloud Valley Lei' is one of its ongoing innovative projects to promote digitalization in agriculture. Third, the development strategy will attach higher importance to ecological values. Last and emphasized by the chairman, Techlex will reinforce the interactions with the civil society, in such a way as to embed the value chain into wide social networks.

7. Conclusions

Given the importance and lacunas of inclusive VCD, this paper commits to providing interested managerial audiences with a teaching case. The case contributes to the demanded knowledge by exemplifying local multistakeholder partnership, contractual hog value chain, agribusiness initiative, and a scenario of China's poverty reduction. Instead of being a broad-based empirical study, this case employs an agribusiness named Techlex as the study object. Specifically, the firm's hog VCD has been socially recognized as an archetypical pattern to benefit poor farmers and other petty rural economies. It is therefore selected as the vehicle zooming in on how agribusiness initiates and sustains inclusive VCD in lagging rural areas. Overall, we enrich the VCD toolkit with extracted models, in tandem with a solid discussion on their economic efficiency and environmental sustainability, to allow users to attune to a different scenario.

In general, the development of Techlex and its models for inclusive VCD have implications in multiple dimensions. For agribusiness managers, a local-based value chain, in tandem with the participation of low-income farmers, poses a large potential to cultivate value creation for a developing enterprise. Whereas the added value indicated by profit margins could be less inspiring, the inclusive VCD can bring the initiator greater power in the high-value markets. As environmental sustainability becomes increasingly overarching, followers of Techlex's models will need to insert clean technology and energy if applicable. Meanwhile, the initiative of inclusive VCD prerequisites a set of implicit qualities. For example, the initiating enterprise will need tight connections to market or even a relatively comprehensive value chain. As the primary models extend, cooperation with other chain actors will further necessitate a strong managerial capacity for cost control. For policymakers, the first clue is that the examined models are likely to resolve the tradeoff between social equality and economic growth at the local level. Therefore, the inclusive agri-food VCD models initiated by agribusiness shall be underpinned by long-term programs. To mobilize finances and other capitals, projects regarding poverty reduction and regional development can be aligned for synergy. Agri-food enterprises like Techlex might be rather limited in some backwater regions, which further pinpoints the necessity of proper industry development policies.

Supplementary material

Supplementary material can be found online at https://doi.org/10.22434/IFAMR2021.0097

Figure S1. Hog production and pork consumption in China and in the world since 2000.
Supplementary Material S1. Background information Techlex.

Acknowledgements

The authors appreciate the Techlex Group, in particular the vice chairman LEI Bo and the chief executive officer LI Quan for their kind knowledge sharing. We would also like to acknowledge the funding of the Zhejiang University–IFPRI Center for International Development Studies (126000-541902).

Conflict of interest

The authors declare no conflict of interest.

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