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A symbiotic development strategy for farm areas and townships in Heilongjiang, China

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Abstract: This study focuses on the further well-coordinated development of farms and towns in Heilongjiang, China. In this research paper, we identified coordination problems and their causes through an analysis of the present status of farms and towns. For this purpose, a research framework was constructed using symbiosis theory, and a symbiotic development strategy was proposed to address the integration of the symbiotic unit, the optimization of the symbiotic interface, the selection of the symbiotic mode and the construction of the symbiotic environment.

1. INTRODUCTION

Farming, a peculiar occurrence under China's pole-economic system, is the result of state institution-led reclamation and cultivation of wasteland in regions without agriculture or villages. Most initial farmers are active and ex-servicemen and urban workers; educated young people and prison labour were absorbed over a certain period of time, and a social-economic organization relatively independent from local government was eventually formulated. Guanghai Farm, the first state farm, was incorporated by the Central Committee of the Communist Party of China in Yan'an in 1939 (Ma, G., 2011). There are now 1,785 farms in 31 provinces across China. These farms are referred to as the national team for agriculture operations. They interconnect with local governments in terms of space and area, but most of their management borderlines are not well-defined. Even their property rights are not clearly defined. The coordination problem restricts their developmental footsteps at different levels. It is therefore urgent and significant to study and practice well-coordinated development of farms and towns.

The Central Committee of the Communist Party and the State Council of China in November 2015 for the furtherance of reclamation and cultivation reform and development clearly stated that farms should be guided to cooperate with local government in different ways. Farms must be considered while plans are prepared by local governments in accordance

with laws, and synchronous implementation must be organized. Once again, in the 13th five-year plan programme issued by Heilongjiang Province Government for National Economy and Social Development, it was stated that the farm system reform should be furthered by promoting development of industries complementary to one another, with joint construction and sharing of infrastructure to achieve well-coordinated development of farms and towns.

Therefore, a symbiotic development strategy was proposed using the symbiosis theory in this paper for joint development of farms and towns in Heilongjiang.

2. LITERATURE REVIEW

2.1 Coordinated development of farms and towns

The first batch of socialist farms in the world was established after the October Revolution in Russia. The Soviet Union had 4,384 farms in 1920, and by the beginning of the 1980s, this number of farms had developed to more than 20 thousand ([Lerman, 2008](#)). At the end of the 1980s, the number of farms had plummeted. In the 1950s, farms were established and gradually developed into an important part of the agriculture in North Korea, Yugoslavia, Romania and some other socialist countries. However, there are few studies related to farms and towns. There is some research of land use, labour and agricultural management on farms. For example, [Alasia et al. \(2009\)](#) analysed the influence of the farm on non-farm worker arrangements and urbanization, and the relationship of the farm labour market and town labour market in Canada. ([Smithers, Joseph, & Armstrong, 2005](#)) noted that in North America, there are also conflicts and neglect between farms and towns, with proposals to improve community ties between farms and towns. These two papers seem to be only discussion regarding farms and towns outside China.

In China, many research efforts have been conducted on the well-coordinated development of farms and towns since the initiation of the state farm system reform at the end of the 20th century. For example, [Ai and Lu \(2001\)](#) introduced resource sharing ideology and strategy; [Wang \(2006\)](#) put forward policy selection for the joint development of farms and towns based on gradient elapse. [Ru, Du, and Luo \(2008\)](#) suggested joint training of talents; [Shen and Huang \(2008\)](#) noted problems and solutions. [Mao \(2010\)](#) suggested the model of a joint industrial park. ([Han & Wu, 2012](#)) proposed a system orientation reform. [Liu, X. and Wang \(2013\)](#) noted defects and remedies. As mentioned above, the industrial economy, system reform, population flow, urbanization and administration management have been touched on, but there are few studies of coordination at the grassroots level and a lack of theoretical framework, in particular.

2.2 Regional development based on symbiosis theory

Symbiosis theory derives from biology and is widely used in various subject fields because of its theoretical universality. Some scholars have introduced symbiosis theory to regional coordinated development. Outside China, regional research based on symbiosis focusses on industry. [Deutz and Lyons \(2008\)](#) proposed that the symbiotic

development of regional industry can realize the static and dynamic agglomeration of a regional economy. [Jensen \(2016\)](#) showed geographic proximity to be a key characteristic of industrial symbiosis and found that the median distance materials travelled within a symbiotic relationship is 20.4 miles. [Costa and Ferrão \(2010\)](#) suggested that regional industrial symbiosis emerged as a collective, multi-industrial approach to improve economic and environmental performance, and developed a “middle-out approach” symbiotic mechanism. [Luciano et al. \(2016\)](#) recognized that an industrial symbiosis platform in Italy should be proposed, aimed at solving some critical issues encountered during its application on a regional scale in Sicily. ([Marchi, Zanoni, & Zavanella, 2017](#)) extended the industrial symbiosis concept, stating that industrial symbiosis should be considered with industrial facilities, utilities and public service facilities as a holistic system. Although most foreign scholars have focussed on industry for regional symbiosis, regional industry symbiosis combines with geospatial aspects, facilities, utilities, public service facilities and information and communication technology ([Grant et al., 2010](#)) and reveals that regional industrial symbiosis is a comprehensive, dynamic and integrated system. Building a symbiotic platform and a symbiotic mechanism is necessary because it provides research ideas for regional symbiotic development.

During this same period, Chinese scholars have recognized the guiding role of symbiosis theory and have introduced the theory to regional development research, extended the research to a geospatial scope, enriched the research content, and obtained diverse research results. The regional scope of the study is related to the cross region between China and other countries ([Thiravong, Xu, & Jing, 2016](#)), the whole region of China ([Liu, R., 2006](#)), the regional urban agglomeration ([Ma, Y. J. & Zhang, 2008](#)), the metropolitan area, etc. Research content covers tourism, logistics, and other industrial symbiosis ([Liu, G. F. & Chen, 2013](#)) and involves technology and cultural symbiosis as well as spatial structure symbiosis ([Guo & Wang, 2011b](#)). Research achievement involves a symbiosis framework ([Leng, Z. & Yi, 2008](#)), a symbiotic mode, a symbiotic mechanism and a symbiosis system with relative regional space and elements ([Guo & Wang, 2011a](#)). Regional coordinated development based on symbiotic theory opens up the idea of the coordinated development of farms and towns.

3. PRESENT STATUS OF FARMS AND TOWNS

As shown in Figure 1, there are in total 113 farms in 74 counties of Heilongjiang Province. These farms occupy an area of 56200 km². Farms and towns interconnect with each other, resulting in conspicuous coordination problems.

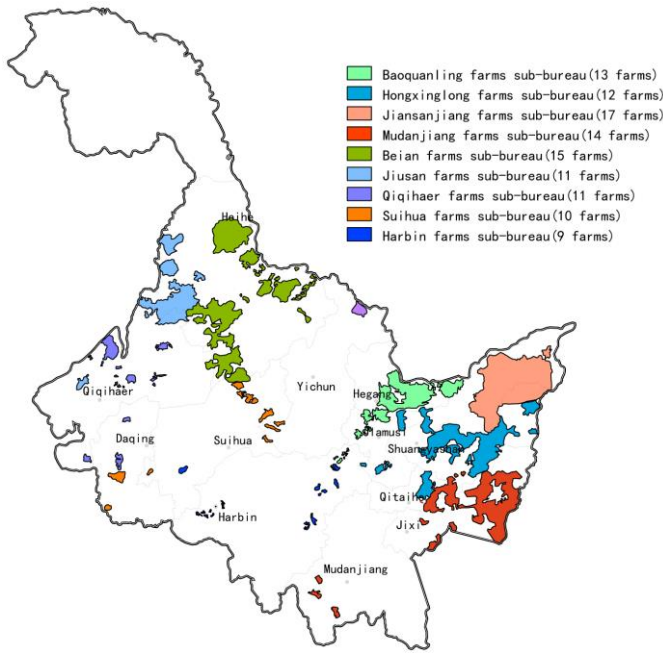


Figure 1. Farm distribution in Heilongjiang Province

3.1 Present structures of farms and towns

3.1.1 Present regional spatial structures of farms and towns

Farms were initially organized for reclamation and cultivation in regions without agriculture. Regions without agriculture vary in size, so they have different structural arrangements. The regions can be classified into 3 major forms: concentrated, undercrossed, or isolated (Lu & Sun, 2016), as shown in Figure 2.

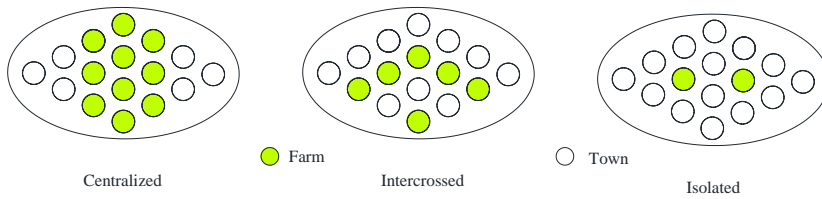


Figure 2. Structural arrangement of farms and towns

The farm unit and town unit are also displayed in different spatial structure modes, separated into two forms: parallel and intersurrounded, as shown in Figure 3. Parallel farms and towns can be separated by rivers and topography and may have regular boundaries. Intersurrounded farms and towns are intersurrounded by each other or interconnected with each other and usually have irregular spatial boundaries.

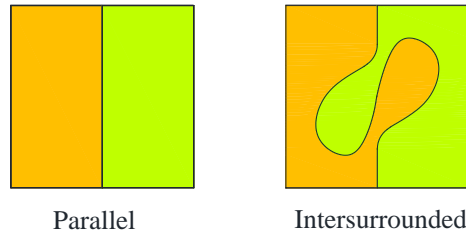


Figure 3. Spatial distribution of a farm unit and a town unit

3.1.2 Present construction areas of farms and towns

Farm living quarters were constructed independently or relying on the original towns. At the beginning of farm reclamation, different distributions are formed that can be classified into separated, interconnected, undercrossed or inclusion, as shown in Figure 4.

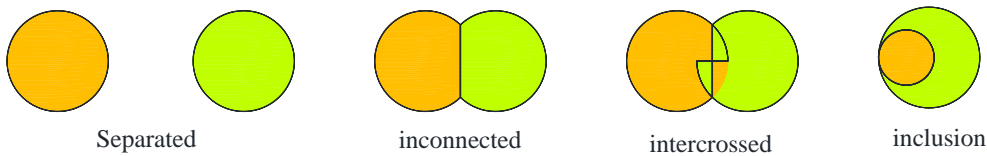


Figure 4. Spatial distribution of farm and town construction areas

3.2 Major existing coordination problems

3.2.1 Towns not in a regional system

Farms and towns interconnect each other in different forms with complicated interfaces. However, the function of farms and towns in an area is oriented on their respective management areas. There are prominent superimposing functions of elements between farms and towns, as shown in Figures 5 and 6.

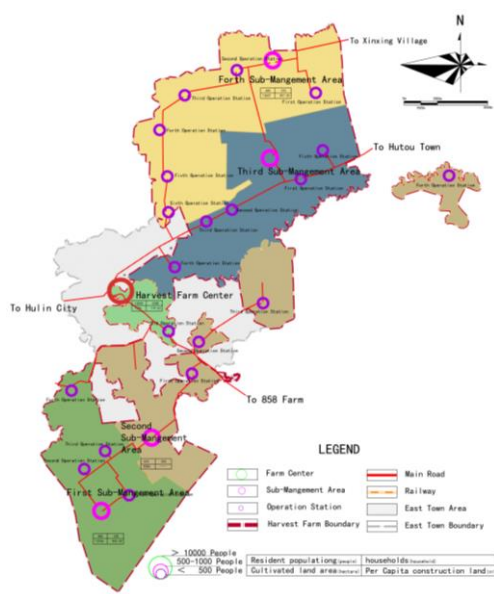


Figure 5. Urban system planning for Harvest farm

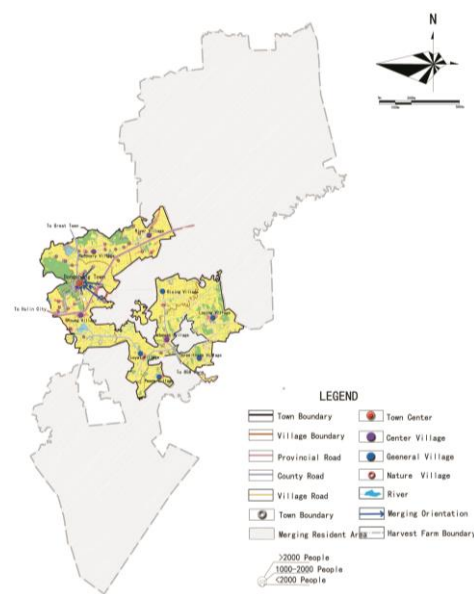


Figure 6. Urban system planning for East town

3.2.2 Inadequate coordination of urban construction

Among the 113 farms in Heilongjiang Province, 17 farms have mixed construction areas. Although the construction area is adjacent and intersurrounded, the farms have their own construction systems, which result in repeated construction, waste of land, high capital cost, administrative cost, and contrasting appearance, as shown in Figure 7.



Figure 7. Comparison of construction areas between Shanhe farm and Keluo town

3.2.3 Sharp contrast in industrial structure and inadequate interaction

As shown in Figure 8, farms and towns are both engaged in agriculture, but most of the farms have secondary and tertiary industries better than the towns, and the difference in the industrial structure is obvious. In addition, farms and towns have agricultural production cooperation in cultivation, planting and harvesting. However, the cooperation in the second and third industries between farms and towns is not enough. There is more competition than cooperation, less complementarity and no good interaction at all.

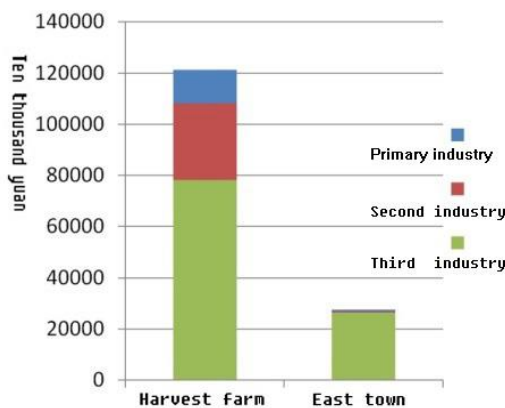


Figure 8. Comparison of industrial structure between Harvest farm and East town
Data source: Statistical yearbook of Hulin City of 2015

3.2.4 Inadequate facility consistency and low degree of sharing

Between farms and towns, a sharp contrast can often easily be seen in the road section form and road surface quality. Irrigation canals often bypass each other. The water supply, drainage, heating, fire protection, sanitation and other infrastructure components are all constructed separately in interconnected construction areas of farms and towns, and these services are incompatible with each other. Mutual use of potential is not considered at all.

As far as healthcare is concerned, farms and towns all have their own hospitals, but medical resources cannot be effectively used in a joint manner. Farms and towns have their own primary and middle schools, but farms have their own kindergarten and have good teaching facilities. Towns have inadequate child education facilities. Most farms are built with indoor cultural centres, libraries, etc. Most towns need cultural facilities, as shown in Figure 9. Generally, farms are obviously better than towns in terms of the supply of civic facilities and social facilities, but the facilities are not well connected and shared.



Harvest farm cultural square



Harvest farm hospital



East town outdoor activity area



East town clinic

Figure 9. Comparison photographs of the facilities of Harvest farm and East town

3.3 Causes

3.3.1 Age-old malpractice

Farms are state-owned enterprises, but they also provide social services. The farms have independent social functions, are self-contained in production and have different life styles. Thus, the farms were kept relatively independent from towns. In addition, at the initial stage and for a long period of time, the administration boundary was not clearly defined between farms and towns. Contradiction and competition often occurred in boundary delimitation and natural resources.

3.3.2 Weak regional sense and conspicuously selfish departments

The traditional regional management mode was a relatively closed vertical management system in China. Each region management organization paid more attention to the perfection of its own interior boundary than external boundaries. Self-contained management concepts limited the interregional flow of essential elements and delayed the symbiotic process among regional units. In addition, the main symbiotic bodies were concerned more about the size of the self-earning than a symbiotic partner, cost-benefit distribution, etc. All these factors have their effect on the enthusiasm and initiative of the main symbiotic bodies.

3.3.3 Planning inconsistency

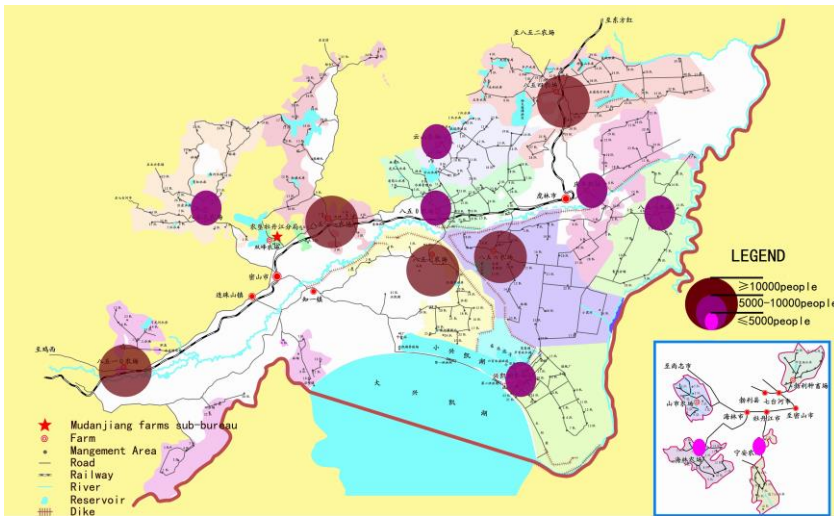


Figure 10. Urban system planning for Mudanjiang Farms sub-bureau

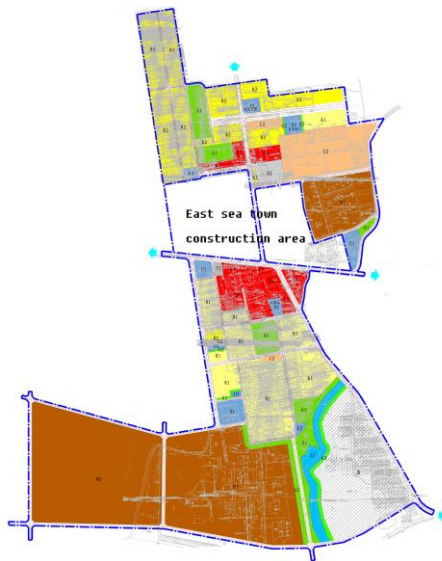


Figure 11. Construction area planning for 8510 farms

Integral planning has never been done between principal bodies of farms and towns. Town planning sometimes includes farms, but joint planning was normally disregarded from farms when planning was implemented. When a farm prepares its planning, the effect on the town and interconnection with the town are not considered, as shown in Figures 10 and 11. Mutual independent planning caused the coordinated development opportunity to be missed at the initial construction of farms and towns.

3.3.4 Parallel management institutions and a long symbiotic chain

The farm is under the management of the reclamation bureau, and the town is under local government. The superstructure management is also parallel. According to the Heilongjiang provincial people's organizational reform scheme, the farm did not have the qualifications for an administrative main body. All the administrative management of the farm must be approved by the Heilongjiang farm management bureau. Moreover, the town rarely has an execution right for administration ([Liu, K., 2010](#)). All the coordinated development activities need approval from the superior management institution. Parallel management systems have prolonged the management chain of farms and towns, lowered the management efficiency and had its effect on the enthusiasm towards coordinated development of farms and towns.

4. SYMBIOSIS THEORY AND SYMBIOTIC DEVELOPMENT OF FARMS AND TOWNS

4.1 Symbiosis theory and its application and significance in farms and town development

4.1.1 Applicability analysis of symbiosis theory in farm and town development

Symbiosis was first introduced by Anton de Bary in 1870 for application in the field of biology ([Ahmadjian & Paracer, 1986](#)). Symbiosis studies the process of different species of organisms living together for material exchange and energy transfer. The biological community or biological system, formed by symbiotic units, will evolve in the direction of symbiosis or will generate new systems. Farms are state-owned, but towns are managed by local governments. Farms are mainly engaged in agricultural operations, but they also have their social management functions, and they have to construct their own urban areas. Farms and towns are independent from each other, and heterogeneity is therefore obvious. However, farms and towns interconnect closely with each other, and they have to exchange economic and social information. Their coexistence complies with the biological symbiosis principle. Therefore, it is logical to use symbiosis theory to study their coordinated development ([Leng, H. & Li, 2016](#)).

4.1.2 Symbiotic development significance of farms and towns

The symbiotic development of farms and towns is a positive evolution process between regional units and is a process of eliminating contradictions and forming a new regional system. The symbiotic development of farms

and towns will contribute to the avoidance of regional industrial overlap and disorderly competition, will be beneficial to realize the optimization of a regional industrial structure and will form a healthy industrial structure system with upstream and downstream complementation. This development will contribute to the integration of regional infrastructure and social facilities, realize facility sharing and save investment cost. The symbiotic development of farms and towns will contribute to the integration of urban construction areas, avoid contradictions, save investment cost and resource consumption, and form a beautiful and unified town style. The development will contribute to residents being able to obtain social services nearby, improve living quality and people's livelihood, and will contribute to overall development of resources, avoiding the waste of resources. Moreover, symbiotic development of farms and towns will contribute to modern large-scale agricultural development, and the realization of mainly functional area planning. Additionally, symbiotic development of farms and towns will contribute to the advancement of the state farm reform process, forming overall advantages to gain more opportunities for regional competition and global competition.

4.2 Established of symbiotic framework for farms and towns

A symbiotic system consists of the symbiotic unit, symbiotic mode, symbiotic environment and symbiotic interface (Li & Wei, 2011). The rational construction of these four elements has its direct effect on the effectiveness of the symbiotic system built. To further the symbiotic development of farm and town, the internal structure of each element and the interrelation among these elements must be carefully studied so that a rationale framework system can be built up for the construction of a symbiotic system with positive effectiveness.

4.2.1 The symbiotic unit

The symbiotic unit is the primary unit of energy production and exchange, the primary condition for formation of a symbiotic body. Farms and local government are both systems of units embedded at different levels from the upside down, as shown in Figure 12.

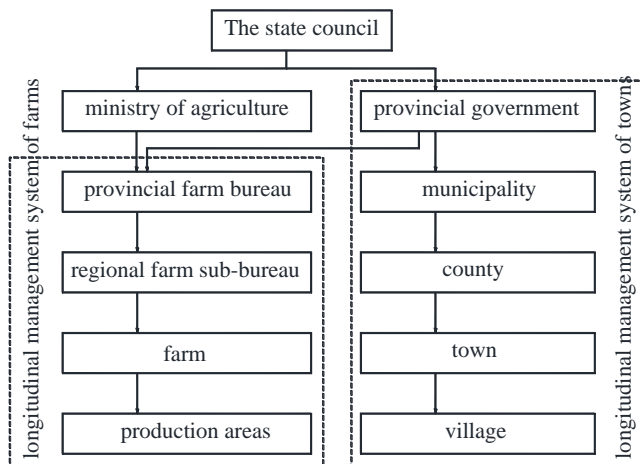


Figure 12. Structure of the symbiotic unit

4.2.2 The symbiotic interface

The symbiotic interface is a medium, channel or carrier for the transmission of material, information and energy among symbiotic units. The symbiotic interface is the basis for the formation of symbiotic relationships and the integral development of a symbiotic unit system. The interface covers urbanization, population flow, industrial development and operation, urban construction and operation, infrastructure construction, social and public administration, etc. Through the interconnection of the symbiotic interfaces, farms and towns carry factors as to what kind of exchange technology, capital information, energy traffic flow, etc., is possible.

4.2.3 The symbiotic mode

The symbiotic mode is also referred to as the symbiotic relationship, indicating the means of interaction among symbiotic units. The symbiotic mode includes organizational and behavioural symbiotic modes. The organizational symbiotic mode is defined as the frequency and scale at which units realize their structural relationship is on point, is broken, or is a continuous integration. The behavioural symbiotic mode means that a relationship is formed, and it can be a parasitic, a partial interest, a non-symmetric multi-benefit or an asymmetric multi-benefit relationship.

4.2.4 The symbiotic environment

The symbiotic environment is the external environment that has an effect on the interaction of symbiotic units. The symbiotic environment includes nature, politics, laws and regulations, policy systems, markets, human and social administration, etc. According to the level of policy output, the symbiotic environment can be divided into the macroenvironment at the state level, the middle environment at the provincial level and the microenvironment created by counties, towns, reclamation bureaus, and farms.

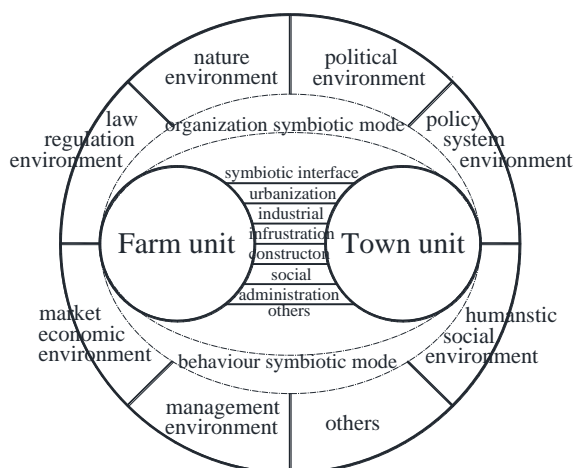


Figure 13. Symbiotic system model for a farm and a town

The development of farms and towns is under the influence of the symbiotic environment. Through energy-information transfer and

transformation, in a certain symbiotic mode, a symbiotic system is formed for farms and towns in a particular area, as shown in Figure 13.

5. SYMBIOTIC DEVELOPMENT STRATEGY FOR FARMS AND TOWNS

The regional development of farms and towns is an inevitable choice for both. The symbiotic development favours the elimination of separation and obstacles, eliminates management conflict, favours industrial competition of similar industrial structures and the formation of an integral industrial chain system, favours resource sharing to improve utilization of resources, favours mutual interconnection and mutual use of infrastructure, saves construction investment costs, and improves the standard of living of local residents. In addition, the symbiotic development favours the flowing and sharing of manpower, technology, information funds, etc., and forms an innovative environment, outputs innovative technology, lowers production costs, and improves production efficiency ([Yang, 2004](#)); it also favours the elimination of social contradictions to have the sense of regional belonging and cultural identification as well as social harmony. The symbiotic development of farms and towns can be achieved by doing the following.

5.1 Integration of symbiotic elements for farms and towns

A complete urban system is the basis for regional integration. Regional management barriers should be removed to achieve an integral regional system of farms and towns. For the city where the farm is, urban system planning should be established, with the function of farms reoriented and coordinated with other towns. Integral planning should also be worked out between closely interconnected farms and towns to achieve the integration of symbiotic units.

5.2 Optimization and expansion of symbiotic interface

The flow efficiency of the symbiotic interface elements has a direct effect on the symbiotic efficiency of farms and towns. A wide and effective flow can be achieved by breaking and expanding the symbiotic interface of farms and towns. The symbiotic interface between a farm and a town is a complex multifaceted system. Different interfaces have both mutual effects and restrictions. The symbiotic interface development of farms and towns can be achieved by doing the following.

5.2.1 Joint planning and construction of a construction area interface

The interconnected construction areas of farms and towns would be taken as a single urban construction area. The two construction systems should be combined into one construction system by defining the land utilization function and the relationship of each construction area. An integral planning should be done through joint development and construction.

5.2.2 Joint construction of infrastructure interfaces

The integration of the infrastructure interface is a supporting system for the symbiotic development of farms and towns. The regional coordinated development and construction should start with integration of infrastructure through cul de sac and irrigation canal connections to form an integral road and water conservation system. In addition, the interconnected, intercrossed and inclusive construction areas of farms and towns need a proper interconnection of roads and the construction of a unified civic system including water supply, discharge, heating, sanitation, etc.

5.2.3 Integration of industrial interfaces

Effective industrial fusion and industrial economic integration support the symbiotic development of farms and towns. Industrial fusion should be used as the means to expand and deepen the cooperation field. Based on the present cooperation for cultivating, planting and harvesting to further expand the scope of the agricultural technical service, the joint construction of agriculture science and technology parks, animal husbandry parks, regular agricultural technology exchange and competition should occur. Second, for the industrial application, the soybean and corn refining industry should be taken as a joint node, and the existing industrial enterprises should be combined. Joint nodes should be combined for to construct an industry park, to realize a comprehensive interaction among farms and towns, and to form a rational industrial division and a complete industrial chain. Third, the industry, existing transportation and logistics should be combined, and farm and town staff should be encouraged to provide third industrial service within the whole region of farms and towns. Eventually, an integrated industrial system of farms and towns would be formed, as shown in Figure 14.

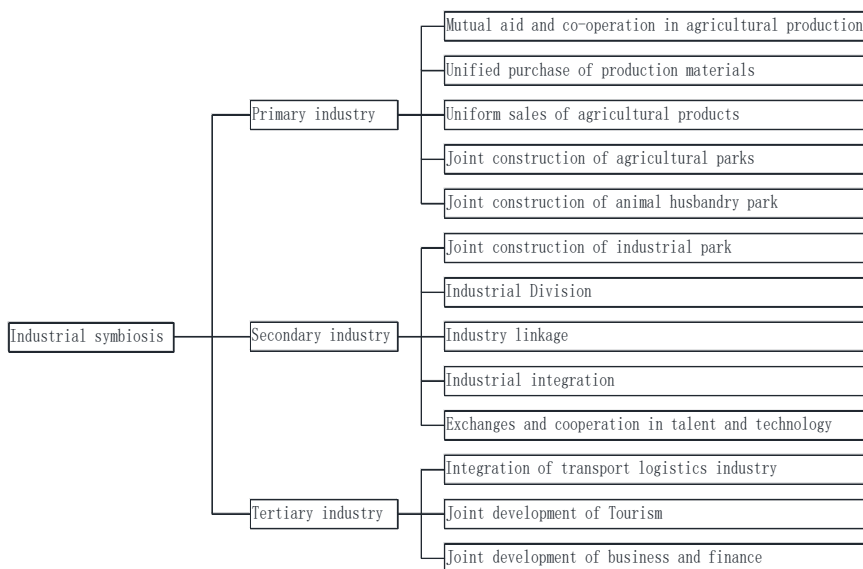


Figure 14. Industrial symbiotic framework for farms and towns

5.2.4 Integration of social interfaces

Social fusion is symbolic of the symbiotic level of farms and towns and can be used to accelerate the symbiotic development pathway of farms and towns. Social fusion strategies should be formulated with the interaction of skilled workers to facilitate the sharing of medical care, sharing of integration of education, culture exchange, etc. As shown in Figure 15, an interactive mechanism of talent resources should be established to practice administrator and artisan exchange. To take advantage of better education facilities and teaching staff, education resources in particular should be integrated to enhance child education cooperation. Healthcare institutions in farms and towns should be integrated for joint construction of medical institutions and the sharing of medical resources. Open park squares, libraries and culture centres, and other social facility resources for residents to conduct sports and culture activities between the farm community and the town community, etc., should achieve complete social fusion.



Figure 15. Social symbiotic framework for farms and towns

5.3 Selection and upgrading of the symbiotic mode

It is very important to select a proper symbiotic mode to improve symbiotic efficiency. The structural form of farms and towns are different, the resource endowment and construction foundations are different, and the existing interconnections are different. Therefore, there are several areas of behaviour symbiotic modes, with the organizational symbiotic mode mainly manifested as intermittent. In regions with large differences among farms and towns, the farm or town with the better developmental condition should be taken as the primary resource body, taking parasitic or partial behaviour as a symbiotic mode to realize the effective utilization of resources and to avoid duplicated construction and waste of money and resources. Farms and towns with their own advantages should be considered as the symmetric mutual benefit and non-symmetric mutual benefit behaviour within the symbiotic mode. In addition, the relationship of the symbiotic interfaces should be continually reinforced for farms and towns in order to upgrade the organizational symbiotic mode, and the relationship of farms and towns should be changed from intermittent to continuous, and finally to integral.

5.4 Construction of a positive symbiotic environment

The positive symbiotic environment is the basis for the symbiosis of farms and towns. The macro- and meso-symbiotic environment framework can be established by quoting the relevant documents mentioned in the introduction. Many cities interconnected with farms have published corresponding development policies to support the coordination of farms and towns. Farm management bureaus and farms also have corresponding policies. The symbiotic environment exploratory framework has been established by state, province, city, farm management bureau and farms, but the symbiotic environment system has not been perfected yet. A specific implementation policy is still missing and the fabrication of a superior policy has not been effectively implemented.

To construct a symbiotic environment system for farms and towns, a symbiotic environmental platform must be built first, cooperative coordination should be instituted, and a symbiotic development system should be established. Symbiotic development funds must be created, and symbiotic development planning must be done, as shown in Figure 16. A symbiotic platform needs policy support from the state and the province. The symbiotic platform can be jointly established by different levels of the symbiotic unit. A coordinating institution should be staffed with people selected from farm and town at the ratio of one to one. These selected people would be responsible for specific affairs, empowered with appropriate rights to shorten the symbiotic chain. They should practice a rotating chairman system and run a once-a-year meeting system. A symbiotic interest balance and compensation mechanism for farms and towns should be created to balance the symbiotic cost and interest. With support from local government and farm management systems, a symbiotic development fund should be established through cooperation with financial institutions and used for the symbiotic organization operation, symbiotic planning preparation, and symbiotic activity expansion. A goal assessment index, responsibility system and award-punishment system should be set up for the symbiotic development. The building of a positive symbiotic environment would promote the coordinated development of farms and towns as policy supports rights and interests guarantee financial support.

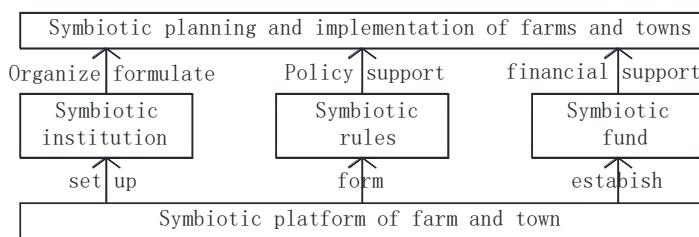


Figure 16. Schematic diagram of symbiotic environment framework for farms and towns

6. CLOSING REMARKS

There are different scales of farms: some are as big as a county, some are as big as a town. There are also different modes of farms: some are

concentrated, some are scattered. The symbiotic unit systems of farms and towns vary, the symbiotic interfaces are complicated, the symbiotic model is also changing, and the symbiotic environment system is not yet perfect. More in-depth theoretical discussion needs to be done to achieve the most reasonable symbiotic development model and the most adaptive symbiotic mechanism.

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