Evaluation on the Sustainable Development of Agricultural Industrialization Based on DPSIR Model
——A Case of North Bay Economic Zone in Guangxi Province

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Abstract   According to the connotation of agricultural industrialization, the DPSIR model based on agricultural industrialization is introduced from the five aspects of driving fore, pressure, state, impact and response. Taking the North Bay Economic Zone of Guangxi Province as an example, a total of 23 indices are selected to construct the evaluation index system of sustainable development for agricultural industrialization by using the Analytic Hierarchy Process. And the sustainable development level is comprehensively evaluated by weighted method. The result shows that driving force factor is still in a worse state. Industry, house sites and unreasonable agricultural productive ways have caused obvious pressure on agricultural industrialization. The scores of "state" and "impact" factors indicate that the output scale of agriculture, labor force scale and peasants' income are still in their initial stage. The score of "response" is lower, indicating that the current structural adjustment can not adapt to the development of agricultural industrialization. The developmental environment of the North Bay Economic Zone is studied as well as the opportunities and challenges. On this basis, related countermeasures and proposals are put forward.
Key words   Agricultural industrialization; DPSIR; Sustainable development; North Bay Economic Zone of Guangxi Province; China

Agricultural industry refers to industrial combination with certain vitality and scale benefit, taking agricultural production, processing and distribution as the main contents. Agricultural industrialization, denoted by agricultural industrialization management, has no unified definition yet. It is widely accepted by most of the experts that agricultural industrialization includes six elements, which are products for both international and domestic markets; a modern business management method; specialized division during production; a certain scale of industrial management and development; mainly relying on local natural advantages, product superiority and economic advantages to develop and produce agricultural industrialization; and close combination of agriculture, industry, commerce, production, supply, marketing in production chain[1].

Agricultural industrialization is a modern operation mode of agricultural production for the sustainable use of agricultural resources, relating to people's livelihood, and is conducive to the realization of long-term and short-term objectives of China's rural areas and agricultural development. Therefore, taking the North Bay Economic Zone of Guangxi Province as an example, we analyze the sustainable development of agricultural industrialization based on DPSIR model in order to find a sustainable development way of agricultural industrialization suitable for the North Bay Economic Zone of Guangxi Province.

1   DPSIR model based on agricultural industrialization

In the aspect of sustainable use of regional resources, there are a variety of evaluation methods and conceptual models in international system. In recent years, when studying on resources, environment and sustainable development, most of the domestic and foreign scholars adopt DPSIR model, which is put forward by OECD in the year 1993 and adopted by the European Environment Bureau. In the DPSIR conceptual model, "Driving Force" refers to the underlying causes of environmental change. "Pressure" is the impact of human activity on the environment and natural environment, which is a direct pressure factor on the environment, such as waste emission and infrastructure construction. "State" refers to the status of environment under the pressures mentioned above, such as pollution and land degradation degree. "Impact" is the effect of system status on human health and socio-economic structure. The process of "Response" indicates the countermeasures of humankind in the process of promoting sustainable development, including improving resource use efficiency, reducing pollution, increasing investment and other measures[2-4].

Agricultural industry is a mode of operation based on agricultural resources. Its "Driving Force" includes the natural driving forces and socio-economic driving forces. "Pressure" specifically refers to the competitiveness of industry and housing sites in the resource utilization of agricultural industrialization development. "State" is the resource utilization status, agricultural productivity, management efficiency and the rural people's living standards, and agricultural environment of the whole agricultural system under the effect of pressure and driving force. "Impact" refers the impact of system formed by agricultural industrial structure on human production and life. "Response" is the adjustment of agricultural industrial structure and consumption structure aiming to achieve the sustainable development of agricultural industrialization and the protection of agricultural environment.
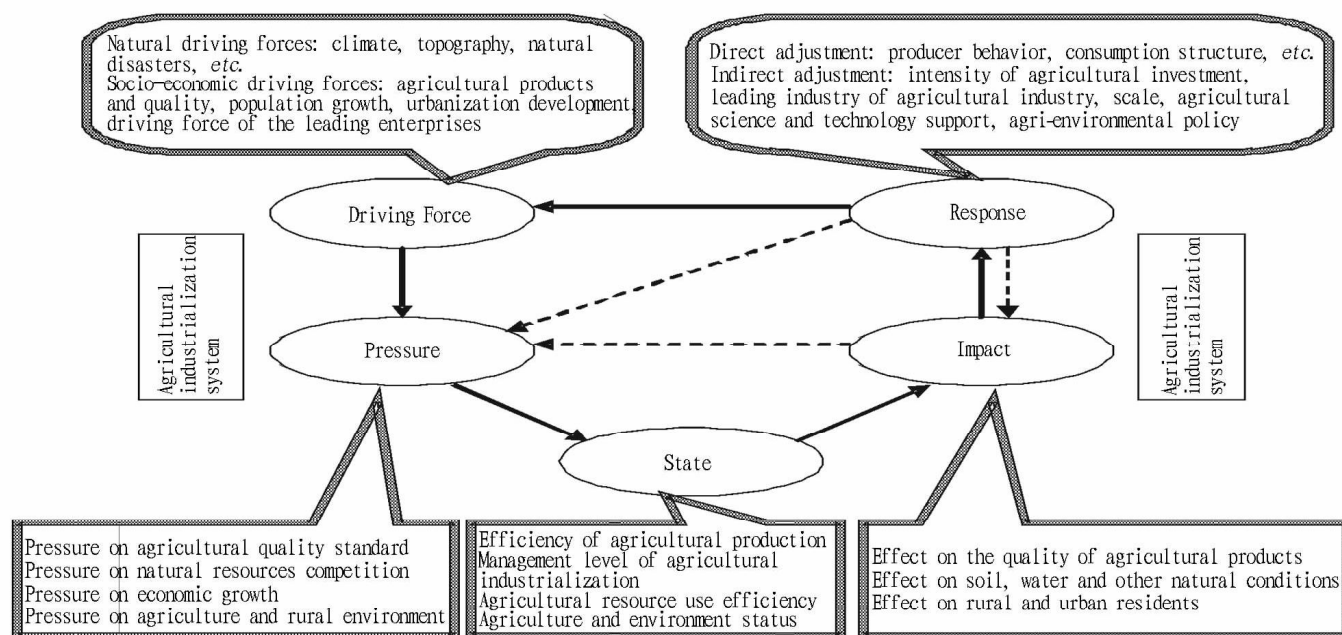
Fig. 1   DPSIR analysis model affecting the development of agricultural industrialization

2   Evaluation on the sustainable development of agricultural industrialization system

2.1   Extraction of agricultural industrialization indices based on DPSIR

Sustainable development of agricultural industrialization includes specialization and large scale of agricultural industry, standardization and high quality of product quality, standardization of agricultural enterprise management, service socialization and agricultural environmental protection. These factors have hundreds of indices in DPSIR model. According to the principles of practicality and operability, purpose and mechanism, systematization and dominant nature, a total of 23 index factors with symbolic significance are extracted from the aspects of Driving Force (D), Pressure (P), State (S), Impact (I) and Response (R) to analyze and evaluate the sustainable development of agricultural industrialization[5-6].

2.2   Construction of the index system of agricultural industrialization

Analytic Hierarchy Process (AHP) is adopted in the index system of agricultural industrialization[7]. Taking sustainable development of agricultural industrialization as the goal layer and the five aspects of DPSIR model as rule layer, the extraction indices mentioned above are used as the target layers of five aspects of rule layer to construct the sustainable development evaluation index system for the agricultural industrialization of the North Bay Economic Zone (Table 1).

Table 1   Index system and weight of agricultural industrialization and sustainable development in North Bay Economic Zone of Guangxi Province

Rule layer	Index layer	Weight
Driving force(D)	Population growth rate(D_1)	0.125
	Urbanization level (D_2)	0.609
	Industrial increasing rate of leading enterprise(D_3)	0.204
	Driving ratio for peasants household(D_4)	0.062
Pressure (P)	Arable land per capita(P_1)	0.124
	Fertilizer application per unit area(P_2)	0.250
	Pesticide load per unit area(P_3)	0.033
	Plastic use per unit area(P_4)	0.054
	Agricultural processing rate of leading base(P_5)	0.539
State (S)	Scale of agricultural labor force(S_1)	0.435
	Scale of agricultural production(S_2)	0.265
	Scale of pillar industries in agriculture(S_3)	0.075
	Scale of agricultural base(S_4)	0.183
	Agricultural labor productivity(S_5)	0.042
Impact (I)	Return rate of farmers in base(I_1)	0.653
	Market share of agricultural products(I_2)	0.043
	Growth rate of rural per capita net income(I_3)	0.120
	Average grain yield per unit area(I_4)	0.184
Response (R)	Total power per unit area of agricultural mechanization(R_1)	0.052
	Effective irrigation area of farmland (R_2)	0.123
	Electricity consumption in rural area(R_3)	0.292
	Total output of agricultural zone(R_4)	0.085
	Index of agricultural production structure(R_5)	0.448

Table 1 indicates that the main driving force is the agricultural products demand, and the tache effect of leading enterprises on peasant, base and market brought by urban population and market growth during socio-economic development. Pressure mainly comes from the improving requirement for green products at present, as well as from how to increase the efficiency in processing of agricultural products. State is mainly reflected in the scale indices of agricultural demonstration park at present. And the response of impact is the development performance of agricultural industrialization, as well as the new ideas, demands and methods for sustainable agricultural development.

2.3 Determination on the source and weight of data indices

Data are from the 2008 *Guangxi Statistical Yearbook* and the statistics of township enterprises, agricultural bureau and demonstration parks in the North Bay Economic Zone.

According to the hierarchy structure, judgment matrix is filled out by expert judgment, data statistics and analyzer's judgement. And mathematical method is used to conduct hierarchical ranking. Before determining relative weights of factors in judgment matrix by hierarchical ranking, normalized standardization treatment is conducted on the above-mentioned index data in order to eliminate the effects of the nature of indices. If indices promoting the sustainable development of agricultural industrialization are positive factors, we use equation (1); otherwise, we use equation (2):

$$C = (X_i - X_{min})/(X_{max} - X_{min}) \qquad (1)$$
$$C = 1 - (X_i - X_{min})/(X_{max} - X_{min}) \qquad (2)$$

According to the standardized data identified by indices in Table 1, sum and product method is used to calculate the largest eigenvalue and eigenvector of indices, so as to determine the relative weight of indices in agricultural industrialization development, to satisfy $\sum_{i=1}^{n} W_i = 1$, and to conduct consistency check.

2.4 Comprehensive evaluation method

Based on the data standardization of index layer and the establishment of weight, weighted method is applied in evaluation. And the equation is

$$S = \sum_{i=1}^{n} W_i R_i \qquad (3)$$

where *S* is the sustainable comprehensive index of regional agricultural industrialization, W_i is the index weight, and R_i is the valuation result of index. Value of *S* is $[0, 1]$, representing the sustainable development degree of regional agricultural industrialization. The rank of comprehensive index of regional agricultural industrialization reflects the changes of their advantages and disadvantages. Evaluation result is divided into five grades: ideal state (0.8 – 1.0), good state (0.6 – 0.8), alert state (0.4 – 0.6), poor state (0.2 – 0.4), and bad state (0 – 0.2).

3 Result and analysis

3.1 Direct evaluation

Evaluation factor score of the sustainable development of agricultural industrialization in North Bay Economic Zone of Guangxi Province is evaluated by comprehensive evaluation method, the result of which is shown in Table 2.

Table 1 and Table 2 show that the sustainable development of agricultural industrialization in North Bay Economic

Zone of Guangxi Province is still at its initial stage. In the DPSIR model system, driving force factors are still in a poor state. Among them, low level of urbanization and slow increasing rate of leading enterprises are important reasons for the good regional environmental quality. But they have also seriously hampered the development of agricultural industrialization in North Bay Economic Zone of Guangxi Province. Industry, house sites and unreasonable agricultural productive ways have caused obvious pressure on agricultural industrialization, mainly reflecting in low processing rate of agricultural products, big occupation rate of industrial housing on agricultural land, and incomplete popularization of green agricultural products. Evaluation result of "State" and "Impact" factors shows that agricultural output scale, labor force scale and peasants' income are still at the initial stage. In response stage, government has relative superficial understanding and low implementation intensity on the aspects of agricultural environmental protection, sustainable development of agricultural industrialization, agricultural industrial structure, and consumption structure. Therefore, it is unable to adapt to the development of agricultural industrialization.

Table 2 Comprehensive score of sustainable development evaluation factor in agricultural industrialization in North Bay Economic Zone of Guangxi Province

Evaluation factor	Excellent (0.8,1.0)	Good (0.6,0.8)	General (0.4,0.6)	Poor (0.2,0.4)	Bad (0,0.2)
Driving force				0.218	
Pressure		0.637			
State			0.552		
Impact			0.596		
Response					0.155

3.2 Analysis on developmental environment

In the whole sustainable development process of agricultural industrialization, harmonious development of resources, environment and human production and life are the ultimate development goals. Therefore, reasonable analysis on indices of resources and environmental carrying capacities can help to promote the sustainable development of agriculture.

Table 3 reports that per capita GNP and Engel's Coefficient that represent economic goals have reflected the relatively slow growth of regional economic development level. Regional income level, living standards and wealth degree are also in a phase of slow growth, but Engel's coefficient of the whole North Bay Economic Zone is between 40% and 50%, representing the regional living standard has reached a well-off level. Proportion of people enjoying social security and proportion of criminal case clearly show that the urban economic development within the region, social distribution level, social development status, social management and order are at a balanced and safe state. However, arable land per capita, a resource capacity index, shows a downward trend. Thus, agricultural productivity is reduced, which has an enormous impact on agricultural development.

The above analysis shows that there are both challenge and opportunity in the overall development of regional agricultural industrialization. Opportunity includes that ① consumption

of residents in the region is at well-off level, indicating that the deep processing products and green products of agricultural industrialization have great market potential; ② a orderly and fair status of social development offers a great platform for the safe operation of labor force, capital, market and manage order in the production of agricultural industrialization. Challenge is manifested in ① agricultural land resources are occupied by construction and industry, which becomes the deep reason for the reduction of agricultural development potential, as well as the latent factor for crisis of agricultural surrounding environment; ② slow growth of per capita GDP is an important reason for the loss of agricultural initiative among low incoming social stratum of peasants, the reduction in agricultural labor force and the slow growth of rural urbanization.

Table 3   Logarithmic index of agricultural industrialization sustainable development in North Bay Economic Zone of Guangxi Province

Year	Per capita GDP∥yuan	Engle's coefficient ∥%	Proportion of population enjoying social security in total population∥%	Proportion of criminal case∥%	Per capita farmland∥hm²
2000	5 075.40	40.15	0.41	0.22	0.045
2001	5 460.35	40.20	0.34	0.18	0.052
2002	6 214.55	41.53	0.97	0.26	0.052
2003	4 765.66	42.71	0.80	0.21	0.056
2004	5 041.26	46.37	0.81	0.19	0.056
2005	6 187.59	44.75	0.73	0.20	0.055
2006	7 282.40	44.45	0.74	0.19	0.054
2007	8 468.12	45.44	0.58	0.18	0.053

4   Countermeasures for promoting the sustainable development of agricultural industrialization in North Bay Economic Zone of Guangxi Province

4.1   Speeding up the urbanization construction; preventing the unhealthy competition of agricultural land resources   According to the spirit of national conference on rural work, speeding up the urbanization construction in rural areas is the demand of rural surplus labor force and the needs of agricultural production efficiency, which can enlarge the spatial scope of agricultural markets and increase peasants' income. But along with the urbanization construction and the unreasonable and disordered land acquisition, land resource is declining year by year, and unhealthy competition of land resources is formed. Therefore, to protect agricultural land resources and to accelerate urbanization in rural areas, rural land laws and institutions must be improved and implemented strictly to protect the fundamental interests of peasants.

4.2   Vigorously developing agricultural industrialization; increasing the income of farmers   Agricultural industrialization is a link among farmer, agriculture and rural area, which promotes the peasant's richness, rural urbanization, and deep processing of agricultural products. Different management modes of organizational structure and interest relationship, as well as the management body of agricultural industrialization, have promoted the interests of farmer, agriculture and rural area, and have realized the specialization and scale of agricultural production, and the regionalization and collaboration of layout.

4.3   Increasing the inputs rate of agricultural science and technology; improving the quality of agricultural products   By increasing the contribution rate of scientific and technological progress in agriculture, we can improve the level of agricultural mechanization and the rate of improved variety, reduce the use of chemical fertilizers and pesticides, and achieve quality standardization of agricultural products, including international ISO900 certified products, famous brand above provincial level, and green food certified products. Gradually, environmental protection agricultural brands with the characteristics of North Bay Economic Zone of Guangxi Province are introduced, and the special position of the regional cross point can realize the economic development model combining the extroversion and introversion of regional agricultural industrialization.

4.4   Enhancing investment in agricultural industrialization; realizing the industrialization management of agriculture   Agricultural industrialization not only reflects the early stage of processing, but more importantly extends the agricultural production chain, so as to realize the integration of production, supply and marketing, and the industrialization management of agriculture, which mainly reflects in improving the processing rate of farm products, the driving rate of leading enterprises in agricultural industrialization, and the drive ratio of peasant household. Only in this way, can we deal with market risk and expand market share of regional agricultural products.

4.5   Implementing regional agricultural policy; strengthening environmental protection efforts   Support of government is deeded during the absorption of funds and the rational development of agricultural industrialization. Through reasonable guidance of policies, laws and regulations, a series of environmental protection measures are implemented to strengthen the environmental protection efforts, to realize the carrying targets of resources, economy, society and environment orderly, regularly and intentionally, and to provide reasonable and effective protection for the development of farmer, agriculture and rural area.

5   Conclusion

Economic goals, social goals and ecological goals of resources carrying of agricultural industrialization are comprehensively evaluated in the whole North Bay Economic Zone based on the DPSIR model, so as to provide some guidance for promoting the protection, adjustment and development of agricultural resources and for improving the living standards of peasants and the rational development of rural urbanization. However, there are still some deep-rooted problems that need to be

further explored.

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基于 DPSIR 模型的农业产业化可持续发展评价研究

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摘要 在理清农业产业化内涵的基础上,从五方面介绍了基于农业产业化的 DPSIR 模型。"驱动力"指造成环境变化的潜在原因,包括自然驱动力和社会经济驱动力;"压力"指工业、住房宅基地等在资源利用方面的竞争力;"状态"指在驱动力和压力的作用下,整个农业系统所表现出的资源利用状态、农业生产效率及农业环境等方面的状况;"影响"指农业产业结构所形成的体系对人类生产、生活方面所产生的影响;"响应"指农业产业结构和消费结构的调整。以中国广西北部湾经济区为例,采用层次分析法选取 23 个指标构建了农业产业化可持续发展评价指标体系,并使用加权评分法对其农业产业化发展水平进行了综合评价。结果表明:驱动力因素处在较差的状态,城镇化水平低、龙头企业增加率慢是区域环境质量较好的重要原因,但也严重制约了广西北部湾经济区农业产业化的发展;工业、住房宅基地以及不合理的农业生产方式等对农业产业化发展产生了明显的压力;"状态"和"影响"因子的得分说明农业产值规模、劳动力规模以及农民收益等仍处于起步阶段;在响应阶段,政府对农业环境保护、农业产业结构调整等方面的认识程度较浅、实施力度较低,无法适应农业产业化的发展。研究了广西北部湾经济区的发展环境及机遇、挑战。基于此,提出了相关对策建议。
关键词 农业产业化;DPSIR;可持续发展;广西北部湾经济区

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to conduct differential marketing, to seize the opportunity, to concentrate our efforts to fill vacancies, and to maintain coordination in marketing. And the strategy of agricultural " going out" promoted by rural cooperative economic organization is promising.

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农村合作经济组织主导的农产品错位营销

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摘要 错位营销是与趋同竞争相对立的策略,对于引导企业树立自我品牌和自我特色风格、创造商机、让消费者从三维空间得到无限的拓宽和延展有着极其重要的意义,其特点主要是在差别中寻求发展,因此对农村合作经济组织主导的农产品营销有着极其重要的现实作用。以中国新疆玛纳斯县为例,以农村合作经济组织为主的农产品营销体系迅速发展,主要表现在:①依托特色产业和优势产业组件农业产业协会;②依托龙头企业和专业大户组建专业经济联合体;③依托科研院所和大专院校组建专业技术研究会;④依托基层供销和商业部门组建专业合作社。但是在以农村合作经济组织为主导的农产品营销中仍然存在一些问题,主要是农村合作经济组织过于分散,农村合作经济组织之间缺少一体化联动机制,现行的营销手段利用也不充分等,因此利用农产品错位营销能够提升农村合作经济组织的凝聚力。在当前金融危机的冲击下,为了更好地推动农业"走出去"的战略,在具体的农产品错位营销在策略实施中,应注意四个方面:一是深入市场调研,精准目标市场定位;二是提倡绿色环保,力推无公害农产品;三是建立完善利益联结机制,促进农业产业化发展;四是开发农产品营销网络平台,提升信息化服务水平。
关键词 农村合作经济组织;错位营销;农产品