Development Strategy of Sugarcane Industry in Guangdong Province

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Abstract Guangdong Province is one of the main producing areas of sugarcane in China, and one of China's three regions with dominant advantage in sugarcane, having good basis and conditions for developing sugarcane industry. In this research, using the SWOT - AHP method, we set 20 assessment indicators (such as the regions with dominant advantage in sugarcane, huge demand for domestic sugar, increased production costs and backward system of sugarcane), to analyze the development strategy of sugarcane industry in Guangdong Province, from strengths, weaknesses, opportunities and challenges of sugarcane industrial development in Guangdong Province. The results show that in order to promote the development of sugarcane industry in Guangdong Province, it is necessary to adopt the SO development strategy (relying on its own strengths and using favorable external environment), to achieve the rapid development.

Key words Guangdong Province, Sugarcane industry, Development strategy

Sugarcane is the major sugar crop in China, occupying an important position in the agricultural economy, which is mainly planted in Guangxi Zhuang Autonomous Region, Yunnan Province, Guangdong Province, Hainan Province, and other provinces (regions) in China. Since the mid-1980s, China's sugarcane production distribution has gradually transferred from eastern regions to western regions, forming three major sugarcane areas with strengths (Central and southern Guangxi, southwestern Yunnan, western Guangdong and northern Hainan). Guangdong Province is one of China's three main sugarcane producing areas and China's production bases of sugarcane with strengths. In 2011, the planting area of China's sugarcane was 1.586 2 hm^2, and the planting area of Guangdong's sugarcane was 0.1467 million hm^2, an increase of 6.28%, accounting for 1% of the planting area of China's sugarcane.

At present, three major sugarcane producing areas have basically formed in Guangdong Province, namely western Guangdong sugarcane producing area, northern Guangdong sugarcane producing area, and the Pearl River Delta sugarcane producing area[1], of which western Guangdong sugarcane producing area is the main sugarcane producing area in Guangdong Province, and also one of China's three main sugarcane production bases, mainly including Suixi, Leizhou, Xuwen, Lianjiang, Huazhou, and Mazhang. In 2011, the planting area of sugarcane in western Guangdong sugarcane producing area (the main sugarcane producing area in Guangdong Province) was 0.128 7 million hm^2, accounting for 88% of the province's planting area of sugarcane. Northern Guangdong sugarcane producing area is located in the northern part of Guangdong Province, focusing on Yingde in Qingyuan City and Wengyuan in Shaoguan City. In recent years, the area of sugarcane has been keeping at about 8 000 hm^2, and it is also the main sugarcane producing area in Guangdong Province[2]. Due to developed economy, the planting area of sugarcane in the Pearl River Delta sugarcane producing area is very small. With the rapid development of domestic and international sugarcane industry, the structural adjustment and layout optimization of China's sugarcane industry, the prospects and constraints of sugarcane industry development in Guangdong Province, have become the focus of attention of the local government, sugar enterprises and sugarcane farmers in Guangdong Province[3].

In this study, using the SWOT analysis framework, we analyze the current situation of sugarcane industry development in Guangdong Province; using the Analytic Hierarchy Process (AHP), we determine the weight of the SWOT factors of the sugarcane industry development strategy, and discuss the sugarcane industry development strategy in Guangdong Province, in order to provide a reference for the good development of sugarcane industry in Guangdong Province.

1 SWOT analysis of the development of sugarcane industry in Guangdong Province

1.1 Strengths (S)

1.1.1 Suitable climatic conditions. Guangdong Province is the greatest tropical and subtropical climate zone in China, which accounts for more than 70% of the province's land area. Western Guangdong sugarcane producing area is located in Leizhou Peninsula, with the annual average temperature of 22.8 -23.4

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℃. The active accumulated temperature above 10 ℃ is 830 9 – 851 9 ℃, and the continuous days above 20 ℃ are up to 245 d, with great potential of illumination. The sunshine hours 1 817.7 –2 160.8 h[3-5], very suitable for the growth of sugarcane (C4 crop) with high light saturation point. Northern Guangdong sugarcane producing area is located in transition zone of the south subtropical zone and middle tropical zone, with the annual average temperature of 20.7 ℃. The active accumulated temperature above 10 ℃ is up to 7 576℃, and the average annual sunshine hours are 1 670.5 h[2], having the characteristics of warm and wet climate, abundant rainfall and long frost-free period, suitable for cultivation and the growth of sugarcane.

1.1.2 Rich land resources. There is an area of 333 000 hm^2 farmland in western Guangdong sugarcane producing area, accounting for 10% of the province's farmland area, with flat, concentrated and connected topography, suitable for mechanized farming. It has been established into the only mechanization experiment and demonstration base of sugarcane in China. In Yingde City and other counties, districts in the northern Guangdong sugarcane producing area, the area of dry land and wasteland that can be used for sugarcane cultivation is about 66 700 hm^2. In Wengyuan County and other counties, districts in Shaoguan City, there is an area of 22 700 hm^2 land resources that can be reclaimed, providing adequate land resources for the further development of sugarcane industry in Guangdong Province.

1.1.3 Good industrial base. Western Guangdong sugarcane producing area has a long history of sugarcane cultivation. As early as the Spring and Autumn and Warring States Periods (3rd century BC), Zhanjiang began to plant sugarcane to refine sugar. There is a long history of planting sugarcane and processing sugar[6], and the operation procedures suit the local climate, topography, and soil. The industrial chain is complete; the raw materials with strengths, deep sugar processing, comprehensive utilization of byproducts and waste of sugar refining, etc., gradually form new industrial chain of circular economy. Guangdong Agribusiness Group Corporation, Guangdong Jinling Sugar Group, Hengfu Sugar Group, and many other leading enterprises are leading the development of sugar industry in Guangdong Province. The enterprises are regarded as the main body; production, teaching and research are linked closely; scientific and technological resources are rich. Zhanjiang Sugarcane Research Center of Guangzhou Sugarcane Industry Research Institute, Guangdong Ocean University and other research institutions and universities, provide human resources and technology support for industrial technology innovation.

1.1.4 Sufficient labor resources. The sugarcane industry is a significant traditional industry related to people's livelihood. Western Guangdong sugarcane producing area is economically underdeveloped area, with many surplus labor forces. The majority of farmers have been used to growing sugarcane for a living for generations. Since the sugarcane cultivation can create good benefits, they have high enthusiasm for growing sugarcane, willing to put labor and financial resources into it. Northern Guangdong sugarcane producing area is located in the limestone mountain area, where the economy is relatively underdeveloped, with surplus labor forces, also having the conditions for the development of sugarcane industry.

1.1.5 Convenient transport conditions. Western Guangdong sugarcane producing area is located at the junction of Guangxi, Hainan and Guangdong, with three sides surrounded by the sea, east to the South China Sea, west to Southeast Asia, north to Southwest China, the center of Guangdong, Guangxi and Hainan coastal areas. It is the main access to the sea in Southwest China, and the important port in China with the shortest voyage to Southeast Asia, Europe, Africa, and Oceania. With the establishment of the ASEAN Free Trade Area, it not only brings more opportunities for the agricultural cooperation between China and ASEAN countries, but also provides convenience for cross-border cooperation in the sugarcane industry. Zhanjiang – Haikou Railway, Litang – Zhanjiang Railway, G207 and G325 National Highway, and Chongqing – Zhanjiang Highway, run across Zhanjiang, with convenient transportation.

1.1.6 One of China's regions with dominant advantage in sugarcane. According to the layout planning of the regions with dominant advantage in sugarcane in China (2008 –2015), the regions with dominant advantage in sugarcane in China are the central and southern Guangxi, the southwestern Yunnan, western Guangdong and Northern Hainan. The western Guangdong sugarcane producing area includes Suixi, Leizhou, Xuwen, Lianjiang, Huazhou, and Mazhang. There are 8 state-owned farms with sugarcane as the major industry, and a large number of large-scale specialized sugarcane planting households. In the period 2002 –2006, the average planting area of sugarcane was 0.105 5 million hm^2, producing 7.705 6 million t of sugarcane, 0.87 million t of sugar, with the planting area of sugarcane per household up to 0.33 hm^2. Western Guangdong sugarcane producing area, as one of major sugarcane producing areas in China, greatly promotes the development of the local sugarcane industry.

1.1.7 Sugar economy at the leading position. During 2011/12 production period, Guangdong Province produced 0.872 million t of sugar, accounting for 1% of the national sugar yield, an increase of 14 300 t of sugar on year-on-year basis, with growth rate of 1.67%. It is the only province achieving an increase in sugar yield, of which Zhanjiang produces 0.776 4 million t of sugar. As of September 2011, the sugar sales volume in Guangdong Province was 0.812 million t, and the sugar sales rate was up to 93.12%.

Sugarcane is the most principal crop in Zhanjiang City, and the sugarcane industry has always been the pillar industry in Zhanjiang. The maximum planting area of sugarcane in the city is up to 0.147 million hm^2. The annual taxes of sugarcane products in the city levied are more than 2.6 billion yuan, and the composite taxes of sugarcane industry chain products levied annually is as high as 4 billion yuan. The taxes annually provided by the entire sugarcane industry chain account for about 12% of the local fiscal revenue, thus the sugarcane industry becomes an important industry for the growth of local fi-

nance[7]. The sugarcane industry in the western Guangdong, different from that in other cities of Guangdong Province, is one of the most competitive traditional industries with characteristic advantages.

1.2 Weaknesses (W)

1.2.1 Generally low quality of sugarcane. Mismanagement of the sugarcane field, too long backlog period of sugarcane, and insufficient freshness, affect the quality of sugarcane. The distribution of varieties in the sugarcane producing areas is irrational; the phenomenon of single varieties is increasingly prominent; the periods of planting vary and the damage by disease and insect is serious. In addition, the sugarcane farmers never harvest the sugarcane by the principle of first ripe then cutting, but arrange harvest according to the labor situation and the sugarcane price, resulting in the loss of sugarcane, the reduction of purity of sugarcane in the sugarcane producing areas, decline in the sugar yield rate of sugar mills, and increase in the costs of refining sugar, affecting improvement in the economic efficiency of refining sugar in the refinery and the sugarcane farmers' economic income[8].

1.2.2 High costs of refining sugar. Due to warming trend in winter and spring, serious pests and diseases, soil acidification and other factors, the sugar content and sugar yield rate of sugarcane in the western Guangdong sugarcane producing area is generally low[9]. In Zhanjiang, in 5 production periods, the sugar content in the sugarcane averages only 11.68 %, 2% (absolute value) lower than that in Guangxi; the sugar yield is even lower, only 9.93%; 1 t of sugar consumes as high as 10.07 t of sugarcane, 1.8 t more than that in Guangxi, 2.3 t more than that in Australia ((average sugar yield rate of 13%). The low sugar content increases the production cost of sugar per ton[9]. At present, the cost of sugarcane per ton in Zhanjiang City is 70 to 200 yuan generally higher than that of the same industry at home and abroad[10].

Due to unusual weather and other environmental factors, coupled with variety aging, serious degradation, late planting stage, excessive consumption of available nitrogen fertilizer, serious pests and weeds and other cultivation management factors, in northern Guangdong sugarcane producing area, there is a universal phenomenon of low sugar content and low yield in sugarcane[2, 11].

1.2.3 Backward sugarcane system. From the 1999/2000 production period, western Guangdong sugarcane producing area began to comprehensively implement "three opening-up" policy (opening-up of the sugarcane producing areas; opening-up of the sugarcane price; opening-up of business), so that the sugarcane in the sugarcane producing areas was frequently circulated into other sugarcane producing areas, resulting in the disputes due to sugarcane sources[14], the phenomena of disorderly competition and vicious sugarcane grabbing, affecting the normal production of sugar mills.

The government and sugar refining enterprises' subsidy for sugarcane farmers is almost zero. Farmers' costs of sugarcane production increase, and the management is extensive, with low yield per unit area and poor returns; the sugarcane farmers then blindly follow the trend of growing other cash crops, resulting in increasingly shrinking planting area of sugarcane. At the same time, nobody wants or shows any interest in the roads for transporting sugarcane due to unclear responsibilities of renovation, also having a serious impact on the sound development of sugarcane industry in western Guangdong sugarcane producing area.

1.2.4 Great impact of natural disasters. Zhanjiang is near Western Pacific Ocean, greatly affected by the typhoon. In the typhoon landing season, it just coincides with the strong growth phase of sugarcane, which is easily torn by the winds, affecting the normal growth of sugarcane, resulting in decline in the yield and sugar content. In the years with serious windy weather, it can cause a loss of about 14% of the sugarcane[3].

The main sugarcane producing areas in Guangdong Province are mainly distributed in dry slope land in need of water in western Guangdong and northern Guangdong; the infrastructure construction of sugarcane field lags behind, susceptible to the threat of drought. In Leizhou Peninsula, the drought may happen nine times in ten years, and in some years, the duration of drought can be up to 250 days, resulting in serious water shortage in sugarcane plantations, slow growth of sugarcane and low yield[12].

1.3 Opportunities (O)

1.3.1 Huge demand for domestic sugar. Since the beginning of the 21st century, with the improvement in people's living standards, and especially the changes in consumption patterns and consumer population structure, China's per capita sugar consumption has grown continuously and rapidly; the annual per capita sugar consumption has exceeded 10 kg; the sugar consumption has formed the long-term trend of annual growth rate of 6.2%.

In 2015, China's sugar consumption will be close to 20 million t, but at present, the national sugar yield is only 11 million t. In 2010/11 production period, China provided nine batches of national sugar reserve, 1.866 7 million t in total. However, there is still a gap between supply and demand in the market, and China still needs to expand sugar imports to supplement domestic demand. In the first three quarters of 2011, China imported 1.669 6 t of sugar. According to the report released by the International Sugar Organization (ISO) on September 7, 2011, it is estimated that in the 2011/12 production period, China's demand for sugar imports will increase to 2.75 million t, becoming the world's fourth largest sugar importing country.

1.3.2 High sugar prices. Domestic sugar prices have been high. In October 2011, the prices of the domestic spot sugar were kept at 7 300 yuan/t. High sugar prices make the provinces and autonomous regions increase the purchase prices of sugarcane. In 2011/12 production period, the purchase prices of sugarcane in Guangdong Province were unified at 500 yuan/t, and the corresponding sales prices of the white sugar were 7 000 yuan/t (containing tax); the prices of sugarcane were 6.5% of the prices of sugar. The purchase prices of sugarcane in Zhanjiang City implement the provincial pricing, and comprehensively implement the sugarcane hook linkage and secondary

settlement for the first time.

1.3.3 Increasing national policy support to sugar industry. Sugar industry can obtain the support of various projects, such as the Central Financial Project, the National 863 Plan, Special Funds for the Construction of Modern Agricultural Industrial Technology System, the National Natural Science Foundation, Science and Technology Project of Guangdong Province. Increasing funds for scientific research, make the achievements in scientific research emerge constantly, and applied in production.

1.3.4 Technological progress conducive to the development of sugar industry. Sugarcane industry has the great potential for innovation and upgrade. There are abundant scientific and technological resources, and research and development have support. There is one research institute specializing in breeding of sugarcane varieties and research of comprehensive sugar utilization. In addition, there are a number of advanced international and domestic technology research and development equipments, national and provincial key labs.

The research achievements are significant in the field of variety breeding, biotechnology, fertilization based on soil analysis, plastic film mulching, full mechanization of sugarcane cultivation, pest and disease forecasting technology research and application. The science and technology content of sugarcane industry is increasing, greatly promoting the rapid development of sugarcane industry.

1.3.5 Ceaseless emergence of new excellent varieties. The current main sugarcane variety (ROC 22) degrades seriously; there is general serious infection of the smut in the sugarcane producing areas; the variety's ability to prevent risks is not strong, and once a disease rages, there is the risk of great decline in the yield.

Through painstaking research, the research staff in Guangzhou Sugarcane Industry Research Institute has successfully bred the good new sugarcane varieties with high yield and strong resistance, such as Yuetang 93 – 159, Yuetang 00 – 236, Yuetang 53, Yuetang 55, and Yuetang 60, which have been promoted and applied in the sugarcane producing areas, promoting the upgrade of sugarcane varieties, and ensuring layout diversification of varieties in the sugarcane producing areas.

1.4 Threats (T)

1.4.1 Increased production costs. With the socio-economic development and acceleration of urbanization, the costs of means of agricultural production rise year by year, and the rural labor forces continue to flow out. In addition to low level of sugarcane mechanization, the material costs and labor costs for sugarcane production sharply climb, and comparative efficiency of sugarcane cultivation is low.

1.4.2 Dwindling land for planting sugarcane. With increase in the population and ceaseless decline in the area of farmland, we can no longer rely on expanding the area to develop sugarcane production, but improve yield per unit area through technological innovation, cultivation measures and other technical means.

1.4.3 Industrial restructuring. With the upgrading of industrial structure and structural adjustment of industry and agriculture, the cultivation area of sugarcane has been greatly reduced. In 2001, some major projects were constructed in Zhanjiang City. In the next 3 to 5 years, the investment in major projects in Zhanjiang City will exceed 120 billion yuan; the land resources will be gradually transferred to the industrial land, and the farmers will be gradually transformed into industrial workers.

1.4.4 Brunt of other crops. Western Guangdong sugarcane producing area is located in south subtropical zone, with convenient transportation, having unique advantages in the development of tropical and sub-tropical crops. The comparative advantages in some cash crops and sub-tropical fruits are prominent[13].

2 SWOT-AHP analysis of the development of sugarcane industry in Guangdong Province

2.1 Construction of the strategic hierarchy Through the SWOT analysis of sugarcane industry development in Guangdong Province, we establish the strategic hierarchy of the development of sugarcane industry in Guangdong Province (Table 1).

Table 1 The strategic hierarchy of the development of sugarcane industry in Guangdong Province

Target layer	Criteria layer	Variable layer
Strategic analysis of the development of sugarcane industry in Guangdong Province	Strengths(S)	Climate advantage (S_1)
		Land advantage (S_2)
		Industrial advantage (S_3)
		Labor advantage (S_4)
		Transportation advantage (S_5)
		The regions with dominant advantage in sugarcane (S_6)
		Leading position of sugar industry economy (S_7)
	Weaknesses (W)	Generally low quality of sugarcane (W_1)
		Backward sugarcane system (W_2)
		Great impact of natural disasters(W_3)
		High costs of refining sugar (W_4)
	Opportunities (O)	Huge demand for domestic sugar (O_1)
		High sugar prices (O_2)
		Increasing national policy support to sugar industry (O_3)
		Technological progress (O_4)
		Ceaseless emergence of new excellent varieties (O_5)

(Table 1)

Target layer	Criteria layer	Variable layer
	Threats (T)	Increased production costs (T_1)
		Dwindling land for planting sugarcane (T_2)
		Industrial restructuring (T_3)
		Brunt of other crops (T_4)

2.2 Determining the weight of all SWOT factors and sequence it using Analytic Hierarchy Process Around 4 factors in the SWOT criteria layer and the factors in the variable layer, this research selects different expert groups in sugarcane industry, and conduct pairwise comparison between SWOT factors of sugarcane industry development strategy in Guangdong Province.

Based on the scaling method of 1 to 9 and their reciprocals for (Table 2), we determine the judgment matrix factor coefficient, and construct the judgment matrix, to calculate the weight of all factors (wi) and conduct consistency test of judgment matrix (Table 3 to Table 7). The random CR (consistency ratio) of all judgment matrices is less than 0.1. The judgment matrix has satisfactory consistency and the distribution of the weight coefficients is reasonable.

Table 2 Scale value and the signification of the judgment matrix

Scale value	Signification
1	x_i and x_j are equally important
3	x_i is slightly more important than x_j
5	x_i is obviously more important than x_j
7	x_i is strongly more important than x_j
9	x_i is extremely more important than x_j
2, 4, 6, 8	Mean value between the above two adjacent judgment scales
Reciprocal	If the ratio of importance of x_i to importance of x_j is a_{ij}, then the ratio of importance of x_j to importance of x_i is $1/a_{ij}$.

Table 3 Judgment matrix of strategy group of sugarcane industry development in Guangdong Province

	S	W	O	T	w_i	Aw_i	λ_{max}	*CI*	*CR*
S	1.000	8.000	2.000	7.000	0.527	2.143	4.198	0.066	0.073
W	0.125	1.000	0.143	0.250	0.042	0.178			
O	0.500	7.000	1.000	6.000	0.347	1.407			
T	0.143	4.000	0.125	1.000	0.084	0.370			

Table 4 Judgment matrix of strengths group of sugarcane industry development in Guangdong Province

S	S1	S2	S3	S4	S5	S6	S7	w_i	Aw_i	λ_{max}	*CI*	*CR*
S1	1.000	4.000	8.000	6.000	7.000	0.333	4.000	0.264	2.068	7.787	0.131	0.099
S2	0.250	1.000	7.000	4.000	6.000	0.250	3.000	0.148	1.141			
S3	0.125	0.143	1.000	0.200	0.333	0.125	0.200	0.020	0.163			
S4	0.167	0.250	5.000	1.000	3.000	0.143	0.250	0.053	0.412			
S5	0.143	0.167	3.000	0.333	1.000	0.125	0.250	0.032	0.246			
S6	3.000	4.000	8.000	7.000	8.000	1.000	5.000	0.388	3.034			
S7	0.250	0.333	5.000	4.000	4.000	0.200	1.000	0.094	0.729			

Table 5 Judgment matrix of weaknesses group of sugarcane industry development in Guangdong Province

W	W1	W2	W3	W4	w_i	Aw_i	λ_{max}	*CI*	*CR*
W1	1.000	0.250	3.000	0.250	0.124	0.528	4.252	0.084	0.093
W2	4.000	1.000	5.000	3.000	0.523	2.212			
W3	0.333	0.200	1.000	0.250	0.068	0.285			
W4	4.000	0.333	4.000	1.000	0.286	1.225			

Table 6 Judgment matrix of opportunities group of sugarcane industry development in Guangdong Province

O	O1	O2	O3	O4	O5	w_i	Aw_i	λ_{max}	*CI*	*CR*
O1	1.000	4.000	6.000	8.000	5.000	0.519	2.843	5.393	0.098	0.088
O2	0.250	1.000	5.000	6.000	4.000	0.259	1.417			
O3	0.167	0.200	1.000	3.000	0.333	0.067	0.355			
O4	0.125	0.167	0.333	1.000	0.250	0.037	0.197			
O5	0.200	0.250	3.000	4.000	1.000	0.119	0.634			

According to the judgment matrix, we calculate the weight of each factor determined, and sequence all the factors. The results (Table 8) show that in the entire SWOT, the sequence of all factors in terms of their impact on the development strategy choice of sugarcane industry in Guangdong Province in descending order is as follows: the regions with dominant advantage in sugarcane; huge demand for domestic sugar; the climatic advantages; high sugar prices; the advantages of land; increased production costs; dominance of sugar economy; emergence of high-quality new varieties; labor advantages; in-

creased national policy support; backward system of sugarcane; adjustment of industrial structure; transportation advantages; technological progress; high cost of refining sugar; industrial advantages; reduced area of farmland for sugarcane cultivation; universally low quality of sugarcane; the impact of other crops; great impact of natural disasters.

Table 7 Judgment matrix of threats group of sugarcane industry development in Guangdong Province

T	T1	T2	T3	T4	w_i	Aw_i	λ_{max}	*CI*	*CR*
T1	1.000	6.000	5.000	7.000	0.647	2.608	4.141	0.047	0.052
T2	0.167	1.000	0.125	3.000	0.085	0.388			
T3	0.200	3.000	1.000	4.000	0.212	0.821			
T4	0.143	0.333	0.250	1.000	0.056	0.230			

For the four factors in the SWOT criteria layer, the weight of strengths and opportunities are both higher than that of weaknesses and challenges. The sequencing results in the SWOT variable layer, also shows that the weight of regions with dominant advantage in sugarcane, climate advantages, huge demand for domestic sugar, and high sugar prices is high, indicating that the current development advantages of sugarcane industry in Guangdong Province are prominent, with good environment.

Table 8 Overall sequencing of strategic layer of sugarcane industry development in Guangdong Province

	S	W	O	T	Overall sequencing of strategic layer
S1	0.264				0.139
S2	0.148				0.078
S3	0.020				0.011
S4	0.053				0.028
S5	0.032				0.017
S6	0.388				0.205
S7	0.094				0.050
S	0.527				
W1		0.124			0.005
W2		0.523			0.022
W3		0.068			0.003
W4		0.286			0.012
W		0.042			
O1			0.519		0.180
O2			0.259		0.090
O3			0.067		0.023
O4			0.037		0.013
O5			0.119		0.041
O			0.347		
T1				0.647	0.054
T2				0.085	0.007
T3				0.212	0.018
T4				0.056	0.005
T				0.084	

2.3 Strategic orientation analysis According to the calculation formula of intensity of total strengths, total weaknesses, total opportunities and total threats: $S(W, O, T) = \sum_{i=1}^{n} \frac{S_i(W_i, O_i, T_i)}{n}$, we get: $S=0.075$, $W=0.010$, $O=0.069$, $T=0.021$. Using four variables (total strengths, total weaknesses, total opportunities and total threats) to establish a coordinate system, the corresponding points in the axis are *S*, *W*, *O*, and *T*, respectively; the development strategy quadrilateral is derived after connecting the four points one by one (Fig. 1). The joint action result of the quadrilateral composed of *S*, *W*, *O*, and *T* is the development strategy, which is an important basis for choice of development strategy of sugarcane industry in Guangdong Province.

The coordinates of center of gravity of sugarcane industry development strategy quadrilateral in Guangdong Province are as follows: $P(X, Y) = (\frac{\sum_{i=1}^{n} x_i}{n}, \frac{\sum_{i=1}^{n} y_i}{n}) = (0.016, 0.012)$. From Fig. 1, we see that center of gravity of P is in the first quadrant, thus the sugarcane industry development in Guangdong Province should focus on the use of the SO strategy.

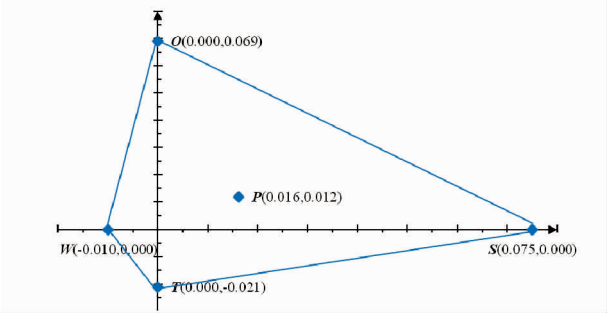

Fig. 1 Quadrilateral of development strategy of sugarcane industry in Guangdong Province

3 Conclusions and discussions

We conduct SWOT-AHP analysis of the sugarcane industry development strategy in Guangdong Province, and the results show that the sugarcane industry development in Guangdong Province should focus on the use of the SO strategy, namely the expansionary strategy. The advantages in the development of sugarcane industry in Guangdong Province are obvious. The main sugarcane producing area in Guangdong Province-western Guangdong sugarcane producing area, is the region with dominant advantage in sugarcane, where the climate is suitable for sugarcane cultivation; the land resources are rich; the sugar economy is at the leading position; the labor resources are abundant; transportation is convenient; industrial base is good. At the same time, the external environment is conducive to the development of sugarcane industry; the demand for domestic sugar is huge; the sugar prices are high; high-quality new varieties emerge; the national policy support is increased; new technologies are constantly applied to sugarcane production. At present, Guangdong Province has the advantages in the development of sugarcane industry, and the favorable external environment provides a favorable opportunity

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in Thailand[11].

2.6 Vegetable Due to climatic factor, vegetable varieties in Thailand are single, and the yield is low and planting area is limited. Local vegetables in Thailand are mainly peppers, eggplant, cabbage, spinach, asparagus, young corn spear, cowpea, bitter gourd, pumpkin, cucumber, watermelon and so on. Crucifer cold-resistant vegetables, lotus root and some heat tolerant vegetables are mainly imported from China. At present, China takes the opportunity of zero tariff between China and Thailand. Yunnan rapidly increases its vegetable export to Thailand. More than 20 types of vegetables exported from Yunnan are popular in Thailand. Along with opening of Kunming to Bangkok highway, more vegetables will be exported from Kunming to Thailand.

Although the vegetable production is limited in Thailand, its vegetable resources are rich. Thailand Tropic Vegetable Research Center, subordinate to Thailand Agricultural University, is specially responsible for collecting high quality seed resources from the whole world, and evaluating and storing appropriate resources. Besides, it has established the Thailand largest vegetable seed resource bank, which has 117 types and 14 448 varieties of vegetable resources. In addition, it has established 50-year long term bank (−196 ℃ for seed storage) and 10-year middle term bank[12]. The vegetable research in Thailand is mainly in universities and scientific research institutes like Thailand Agricultural University, whose horticulture department has rich experience in organic cultivation and promotion of vegetable. Nearly 1/3 of organic vegetable planting technologies come from Thailand Agricultural University. Seed selection of new variety of vegetable mainly comes from Thailand Tropic Vegetable Research Center, Chia Tai Group (also called Charoen Pokphand Group), and other famous companies. Vegetable production has two types, farmers' spontaneous action and farm owners' contracting. And seed used by farmers is mainly purchased from seed companies.

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for giving play to these advantages, therefore, Guangdong Province, especially the western Guangdong sugarcane producing area, should give full play to its internal advantages; use the favorable external opportunities, and draw on the powerful technological support and service of research institutions, to vigorously develop the sugarcane industry.

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