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Research on the Comparative Advantage and Complementarity of China–Ghana Agricultural Product Trade

Benjamin Kofi Tawiah Edjah ^{1,2} , Jianping Wu ³ and Jinjin Tian ^{1,*}

¹ International College, Central South University of Forestry and Technology, Changsha 410004, China

² School of Economics and Management, Wuhan University, Wuhan 430072, China

³ College of Science, Hunan University of Science and Engineering, Yongzhou 425199, China

* Correspondence: t20152270@csuft.edu.cn

Abstract: As trade partners, China in Southeast Asia and Ghana in Africa both play a major role in the China–Africa economic and trade cooperation and have strengthened their bilateral trade. The trade cooperation between China and Ghana has progressed, and there currently exists a large agricultural product trade between the two countries. China has become one of Ghana’s largest trading partners in recent decades, and bilateral cooperation has become stronger. This paper analyses the comparative advantage and complementarity of trade in agricultural products between China and Ghana in terms of twenty major agricultural products from 2016 to 2020, based on the revealed comparative advantage index, trade complementarity index, and their status quo. The results showed that the trade volume of China–Ghana agricultural products has continuously increased, and China is currently in a surplus state, but their total agriculture trade volume proportions had been decreasing. From the perspective of comparative advantage and complementarity, the results showed that the comparative advantage and complementarity coexist, but their comparative advantage is more obvious showing strong competitiveness. The result further shows that the comparative advantage of Ghana was stronger than that of China and the complementarity of China’s exports and Ghana’s imports of agricultural products has not been fully exploited; likewise, the complementarity of China’s imports and Ghana’s exports of agricultural products has not been fully exploited since 2018, and there is a large potential for further cooperation and development. Finally, based on the current situation and our analysis of agricultural trade between China and Ghana, suggestions were put forward to seek new and continuous development opportunities for agricultural trade cooperation between the two countries.

Keywords: China–Ghana; agricultural trade; competitiveness; complementarity



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1. Introduction

Many researchers have been interested in the competitiveness and complementarity of agricultural trade between countries, particularly between China and other countries, over the last few decades. Agriculture has played a major role in national development and has been the backbone of the economic well-being of many countries. According to OECD research conducted in 2010 using 16 developing countries as sample data, agriculture contributes to a 56 percent reduction in poverty, including in China and Ghana [1]. The cooperation between China and Africa is improving [2]. Beijing hosted the China–Africa Cooperation Summit in 2006, during which China began to increase its involvement in African agriculture once again. The summit called for the creation of 14 agricultural centers, the deployment 100 Chinese agricultural experts, and the training of 15,000 people. According to Gro Intelligence (2015) [3], China’s commitments in these three areas have increased, including the establishment of more agricultural centers than previously stated, the dispatch of more experts, and the training of more people. China has also become more involved in its work and investment in African agriculture, leasing, and land development [4]. The trade and economic cooperation between China and Ghana have shown

real improvement in recent decades, particularly within the framework of China–Africa cooperation. China has had a long history of agricultural cooperation with Ghana since 1979 and longstanding diplomatic relations since 5 July 1960 [5]. The total trade proportion between China and Africa continues to increase annually, and with Ghana, both countries have benefited from their trade relations and cooperation. The Ghana–China bilateral trade volume reached USD 7.46 billion in 2019, ranking among the highest in Africa, with China’s exports to Ghana accounting for the majority of the increase in total trade volume and value between the two countries. Ghana’s number one trading partner globally in both exports and imports in 2019 was China, and Ghana is China’s seventh largest trading partner in Africa, according to the Ghana Embassy in Beijing (2021) [6]. This is one of the leading reasons for this study. Furthermore, China and Ghana are traditionally agricultural countries, and the foundation of their economies heavily depends on agriculture. There is no study on the comparative advantage and complementarity of China–Ghana agricultural product trade; thus, it is vital to carry out this research on the comparative advantage and agricultural product complementarity between the two countries to find out the current situation of agriculture trade between China and Ghana in terms of their competitive advantage and complementarity.

1.1. Literature Review

1.1.1. Comparative Advantages and Competitiveness of Agricultural Trade

David Ricardo first proposed the theory of comparative advantage in 1817, and in 1990, Michael Porter, in his book *The Competitiveness of Nations*, also put forward the theory of international competitiveness. The research on agricultural competitiveness includes the following literature: Zhiguang Guo and Hong Luo (2018) [7], applying the RCA and ESI, analyzed the competitiveness of China–Vietnam agricultural product trade based on “the Belt and Road” initiative. Arisoy Hasan (2020) [8] studied the impact of agricultural support on the competitiveness of agricultural products in Turkey’s market. Yuli Long (2021) [9] also found in his studies that the competitiveness of a country’s agricultural products is related not only to its capacity to export agricultural products but also to the sustainability of its agricultural sector. The researcher used two evaluation indices, namely, the trade competitiveness (TC) index and the revealed comparative advantage (RCA) index, to measure and analyze the international competitiveness of six of China’s representative agricultural products and to examine the changing trends in these products’ competitiveness during 1994–2013. Feng Lianyue, Xu Helian, Wu Gang, Zhao Yuan, and Xu Jialin (2020) [10] explore the structure and influencing factors of trade competitive advantage networks along the Belt and Road. Ch. Shuai, X. Wang (2011) [11], by adopting the RCA, CMS, TCD, SI, and TCI models, conducted an empirical analysis of the comparative advantages and complementarity of agricultural trade between China and the United States using sixteen major agricultural products since 1997. One of their results showed that the exporting agricultural products between China and the United States reflect the characteristics of the resource endowments of each country. According to Li Peng (2021) [12], competitiveness and complementarity can be found in the agricultural trade between China and Myanmar, but complementarity is more significant. His study was analyzed using the RCA and TCI indices.

1.1.2. Sino-Africa Trade Relations and the Competitiveness and Complementarity of Agricultural Trade

With the development and extension of the Belt and Road initiative and with the further development and cooperation between China and Africa, there has also been much research on China–Africa relations and individual African countries in terms of their agricultural trade complementarity and competitiveness. Many African countries and developing countries are known as producers of primary (agricultural) products. De Souza and Joao Paulo A (2015) [13] confirmed that there exists a growth of complementarity between agriculture and industry in developing countries and the effects of agricultural

growth on industrial growth are positive and robust. According to AfricaNews (2021) [14,15], China is set to import more African agricultural products to expand the sale of African agricultural products across China's e-commerce platforms, according to a senior Chinese foreign ministry official. Cui Chunxiao, Li Jianmin, and Meng Xia (2013) [16], by adopting TII, RCA, and TCI, analyze the complementarity of the trade in agricultural products between China and Africa and the influencing factors. Xiangyu Wei and Ze Tian (2018) [2] also studied the competitiveness and complementarity between China and Guinea trade under the "Belt and Road" initiative. The study further shared a mechanism for the two countries to improve their trade and promote the construction of Belt and Road infrastructure and build a China–Guinea economic and trade industrial park for economic and trade cooperation. Xu Xu (2019) [17] studied the status quo and prospects for Sino–Africa agricultural cooperation, and identified the potential and development prospects that exist in China and Africa's agricultural cooperation. Sunday Aninpah Khan, Francis Menjo Baye, and Godwill K. Tange (2009) [18] emphasized the importance of China's trade relations with Africa. Their study examines the key features of trade with China and its impact on Cameroon's economy.

However, no study has been conducted on the comparative advantage and complementarity of agricultural products between China and Ghana.

2. Status Quo of China–Ghana Bilateral Trade in Agricultural Products

2.1. Current Situation of Agricultural Trade between China and Ghana

From 2016 to 2020, China's agricultural exports to Ghana showed an overall increasing pattern. From 2016, the export trade volume at USD 264.6 million increased to USD 347.2 million in 2020, with an average annual growth rate (AAGR) of 7.42%. The trade volume of agricultural products exported to Ghana in 2020 accounted for 0.44% of China's agricultural products exported to the world, attaining the highest proportion in the selected sample period. This shows that China's agricultural products to Ghana are crucial and play an important role in its bilateral trade. The trade volume of agricultural products exported from Ghana to China, on the other hand, showed an overall relatively stable trend. As shown in Figure 1, the trade volume, which was high in 2016, decreased in 2017, then increased slightly in 2018 above the 2017 volume, and then remained relatively stable and finally decreased again in 2020. From 2011 to 2020, Ghana's import volume from China was generally higher than its export volume to China, which means China was in an overall trade surplus. In 2020, China had a trade deficit of USD 254.6 million, indicating the highest agricultural trade surplus. At the end of 2021, China revealed measures to improve its agricultural imports from Africa. The director-general of the ministry's department of African affairs, Wu Peng, made it known that China has never pursued a trade surplus with Africa [14,15]. Development with Ghana could be further strengthened with obvious potential for improvement and cooperation in their agricultural sectors. Agricultural product value has decreased annually. Again, this is because the value of the agricultural products was used, not the net weight; however, in recent years, the appreciation of the renminbi against the dollar and the Ghana cedis might contribute to the high value of trade export to Ghana and explain the trade surplus. In the same years, the Ghana cedis depreciated against the dollar, which might lead to overall stability and a slight decrease in the value of the agricultural products exported to China in 2020.

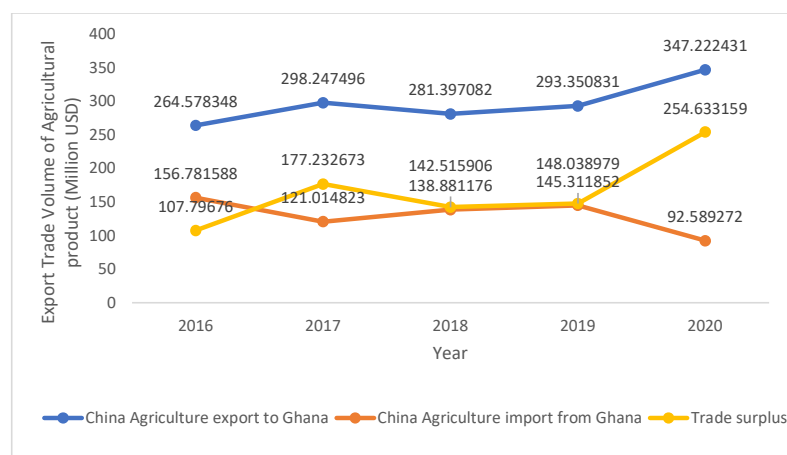


Figure 1. Agricultural Product Trade Volume between China and Ghana from 2016 to 2020. Data Source: UN Comtrade Database.

2.2. The Proportion of Agricultural Product Trade in the Bilateral Trade between the Two Countries

Table 1 shows that the proportion of bilateral China–Ghana agricultural product trade is relatively small, averaging only 6.04% per year. However, since the value was used and agricultural products are categorized as primary products, their import and export value cannot be compared with other products [7]. Specifically, China’s export of agricultural products to Ghana accounts for 5.76% of its export products each year, and it has been relatively stable in recent years. In contrast, Ghana’s export of agricultural products to China accounts for 7.05% of its export products, but the volume has been declining annually, from 11.97% in 2016 to 5.32% in 2020.

Table 1. The Proportion of China Additionally, Ghana Agriculture Product Trade in Total Bilateral Trade.

Year	Total Bilateral Trade Volume of Agriculture Goods (USD Million)	Total Bilateral Trade Volume of All Goods (USD Million)	The Proportion of Bilateral Agricultural Product Trade in Bilateral Trade of All Goods (%)
2016	421.36	5976.25	7.05
2017	419.26	6677.74	6.28
2018	420.28	7248.03	5.80
2019	438.66	7450.89	5.89
2020	439.81	8496.98	5.18

Source: Calculated by the author using Data from the UN Comtrade Database.

2.3. Commodity Structure of Agricultural Product Trade

From the perspective of exports, most of China’s agricultural products exported to Ghana are concentrated in category 0, with an annual average of 89.872%. Specifically, they are mainly concentrated in code 07 (coffee, tea, cocoa, and spices), code 03 (fish and fish products), and code 05 (vegetables and fruits), which accounted for an annual average of 26.292%, 20.814%, and 16.746%, respectively, of the exports of agricultural products in category 0 in the last 5 years. The second is category 2, with an annual average of 8.68%. Specifically, they were mainly concentrated in category 26 (textile fiber), which accounted for more than 8% of the exports of agricultural products in category 2 in 2016. The annual average of the total exports of agricultural products in category 0 and category 2 is as high as 98.552%.

From the perspective of imports, China’s imports of agricultural products from Ghana are mostly concentrated in category 2, with an annual average of 72.61%. Specifically, they are mainly concentrated in code 24 (cork and wood), which accounted for more than 75% of the imported agricultural products in category 2 in 2016, 2017, and 2019. The second is

category 0, with an annual average of 27.278%. The total imports of agricultural products in category 2 and category 0 have an annual average of 99.888%, including codes 24 (cork and wood), 07 (coffee, tea, cocoa, and spices), 23 (natural rubber), and 05 (vegetables and fruits). This indicates that China and Ghana's import and export of agricultural products are basically the same (category 0 and category 2), as shown in Table 2, but opposite in category concentration. More details about the commodity structure of each agricultural product can be found in Appendix A.

Table 2. Commodity Structure of China–Ghana Agricultural Product Trade-unit: %.

Year	China's Export to Ghana (%)				China's Import from Ghana (%)			
	Category 0	Category 1	Category 2	Category 4	Category 0	Category 1	Category 2	Category 4
2016	90.92	0.04	9.03	0	22.74	0	77.18	0.09
2017	90.28	1.83	7.64	0	24.26	-	75.6	0.13
2018	89.56	2.26	8.19	0	32.83	-	67.07	0.11
2019	89.27	2.85	7.88	0	21.82	0	78.11	0.06
2020	89.33	0.01	10.66	0	34.74	0	65.09	0.18
Mean	89.872	1.398	8.68	0	27.278	0	72.61	0.11

Source: calculated by the author based on data from the UN Comtrade Database.

2.4. Position of China–Ghana Agricultural Product Trade in China–ECOWAS Trade

The Economic Community of West African States (ECOWAS) consists of fifteen African countries out of the 17 countries in West Africa. This section uses all 17 countries for the paper. Among the 17 West African countries, Ghana has been the second largest agricultural trade partner with China in the last five years. The major import and export countries of China's agricultural product trade are Nigeria, Ghana, Ivory Coast, Senegal, and Togo, and the trade volume of agricultural products with other countries is relatively small. As shown in Table 3, the ratio of China's and Ghana's agricultural product trade to the agricultural product trade between China and West Africa has been decreasing, from 17.16% in 2016 to 13.14% in 2020, indicating that the proportion of the China–Ghana agricultural product trade of the total China–West African agricultural product trade has been decreasing in the last five years; however, it is still the second largest after China–Nigeria.

Table 3. The Proportion of China–Ghana Agricultural Product Trade In The Agricultural Product Trade Between China–ECOWAS.

Year	Total Trade Volume of China–Ghana Agricultural Products (USD Million)	Total Trade Volume of China–ECOWAS Agricultural Products (USD Million)	The Proportion of China–Ghana Agricultural Product Trade in China–ECOWAS Agricultural Product Trade (%)
2016	421.36	2456.03	17.16
2017	419.26	2792.96	15.01
2018	420.28	3055.61	13.75
2019	438.66	3395.42	12.92
2020	439.81	3346.24	13.14

Source: calculated by the author based on data from the UN Comtrade Database.

3. Data Source and Methodology

3.1. Data Source and Description

According to the definition of agricultural products by the World Trade Organization (WTO) and in line with the current situation of China's agricultural product trade with Ghana, this study adopted the Standard International Trade Classification (SITC) Rev. 4 commodity classification codes to categorize agricultural products. This study selected the top twenty (20) agriculture product categories that are exported between China and Ghana as a sample data size. The categories included can be found in Table 4. This study selected

2016 to 2020 as the sample period, and the research data were mainly obtained from the United Nations Commodities Trade in Goods Database.

Table 4. SITC Rev.4 Agricultural Product Categorization.

Code	Agriculture Product Category	Code	Agriculture Product Category
00	Live animals	1	Beverages and tobacco
01	Meat and meat preparation	21	Hides and skins
02	Dairy products and birds' eggs	22	Oilseeds and oleaginous fruits
03	Fish and fish product	23	Natural rubber
04	Cereals and cereals preparation	24	Cork and wood
05	Vegetables and Fruits	251	Pulp and waste paper
06	Sugar, sugar preparation and honey	26	Textile fibre
07	Coffee, tea, cocoa and spices	29	Crude animals and vegetable materials
08	Feeding stuff for animals	4	Animal and vegetable oils, fats and waxes
09	Miscellaneous edible products and preparations	42	-

Data Source: Organized from UN Comtrade Database.

3.2. Materials and Method

3.2.1. Revealed Comparative Advantage (RCA) Index

The revealed comparative advantage (RCA) is an index commonly used in international economics to calculate a country's relative advantage or disadvantage in a specific class of goods or services based on trade flows [19]. It is formed from the Ricardian concept of comparative advantage.

The RCA denotes the ratio between the export share of a specific commodity over the total export of commodities of a specific country and that of a specific commodity over the total export of commodities of the world [12,20]. The model was proposed by Balassa in 1965; he proposed the revealed comparative advantage (RCA) index, which is commonly used to measure the comparative advantage of international trade [21]. If the ratio is >1, it means that a particular commodity of that country has revealed a comparative advantage and vice versa. The model can be defined mathematically as follows:

$$RCA = \left(X_i^k / X_i^t \right) / \left(X_w^k / X_w^t \right) \quad (1)$$

where RCA is the revealed comparative advantage index;

X_i^k is the export value of a commodity k from country i to country j ;

X_i^t is the total export value from country i to country j ;

X_w^k is the export value of commodity k from country i to the world;

X_w^t is the total export value from country i to the world during the same period.

3.2.2. Trade Complementarity Index

In addition, to examine how properly the agricultural product export structures of China and Ghana match each other, this research study applies the trade complementarity index C_{ij}^k for further analysis. A type of overlap index is the trade complementarity index. It assesses the degree to which one country's export pattern corresponds to another's import pattern. A high degree of complementarity is assumed to indicate better chances

of a successful trade agreement [22]. Changes in the trade profiles over time may indicate whether they are becoming more or less compatible. The TC index can provide helpful information on possibilities for trade cooperation that shows how well the structures of a nation's imports and export products match [20]. Kojima Kiyoshi was the first to propose the Trade Complimentary Index (TCI), and in 1967, Peter Drysdale perfected the TCI model [23]. The model can be described mathematically as follows:

$$C_{ij}^k = RCA_x^k \times RCA_m^k \quad (2)$$

where C_{ij}^k is the complementarity index between country i and country j for commodity k , RCA_x^k indicates the comparative advantage of country i in commodity k by way of exports, and RCA_m^k is used to show the comparative disadvantage of country j in commodity k by way of imports, the equations of which are given below:

$$RCA_x^k = \left(X_{iw}^k / X_{it}^k \right) / \left(X_w^k / X_w^t \right) \quad (3)$$

$$RCA_m^k = \left(M_{jw}^k / M_{jt}^k \right) / \left(M_w^k / M_w^t \right) \quad (4)$$

where X_{iw}^k and X_{it}^k represent the trade volume of agricultural product k exported from country i to the world and the total agricultural export volume from country i to the world, respectively; X_w^k and X_w^t represent the world export volume of agricultural product k and the world total agricultural export volume, respectively; M_{jw}^k and M_{jt}^k represent the import volume of agricultural product k of country j from the world and the total agricultural import volume of country j , respectively; and M_w^k and M_w^t represent the world import volume of product k and the world total agricultural import volume, respectively. The greater the RCA_x^k is, the greater the comparative advantage of country i in exporting product k ; and the greater the RCA_m^k is, the greater the comparative advantage of country j in importing product k . If both countries have obvious comparative advantages, that is, $C_{ij}^k > 1$, then the exports of country i and the imports of country j have strong complementarity.

4. Results Analysis and Discussion of Competitiveness and Complementarity of Agricultural Trade between China Additionally, Ghana

4.1. Results Analysis and Discussion on the Competitiveness of Agricultural Trade between China and Ghana

- a. In general, the calculated RCA indices of agricultural products exported from China and Ghana, as shown in Figure 2, indicated a fluctuating decrease. However, Ghana's trend showed a greater rise and fall, and there was also a large difference between the two countries. The comparative advantage of agricultural product exports in Ghana was stronger than that in China. From 2016 to 2017, exports from both China and Ghana fell and rose to attain their highest peak in 2018; the values were 1.13 for China and 3.89 for Ghana. Figure 2 shows that the difference in the comparative advantage of agricultural products exported between the two countries is larger.
- b. China's agricultural products have a comparative advantage in category 0, and Ghana's agricultural products have a comparative advantage in category 2. We can see from Figure 2 and Table 5 below that the China–Ghana agricultural product trade has a significant comparative advantage.

The study also demonstrates that while China has always been a largely agricultural country, there is a lack of homogeneity in the agricultural product structure in terms of supply. China's food demand is quite high [24], and the scarcity of arable land in China has put the comparative advantage of category 2 and category 4 products at a disadvantage in recent years. This has led Ghana to edge up in exports of category 4 agricultural products to China because of the country's forestry raw materials production advantage. The strong comparative advantage of China's agricultural products in category 0 demonstrates

that China has more labor-intensive agricultural products than land- and forest-intensive agricultural products. The result builds existing evidence of China's comparative advantage in their agriculture product category. However, while most previous study shows that China has a stronger relative comparative advantage, this study demonstrated that Ghana rather has the stronger relative comparative advantage. As a result, China should fully implement "China Africa Cooperation" win-win strategies, particularly in the agriculture sector, to boost the competitiveness of Chinese agricultural products with Ghana and Africa.

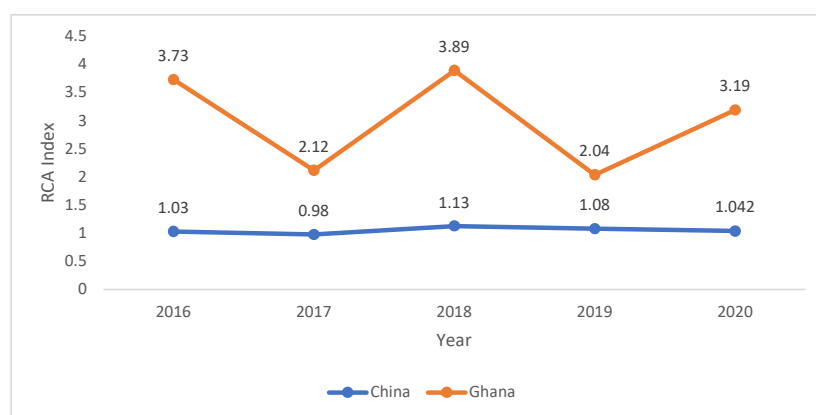


Figure 2. The Calculated RCA Index of Agricultural Products Exported from China and Ghana from 2016 to 2020. Data Source: U.N Comtrade Database.

Table 5. The RCA of the China–Ghana Agricultural Product Trade in product categories.

Year	China					Ghana				
	Category 0	Category 1	Category 2	Category 4	Comprehensive Agricultural Products	Category 0	Category 1	Category 2	Category 4	Comprehensive Agricultural Products
2016	1.123	0.008	0.665	0.005	1.026	0.280	0.003	4.980	0.032	3.732
2017	1.116	0.413	0.569	0.002	0.985	0.277	0.00	11.53	0.026	2.120
2018	1.118	0.503	0.579	0	1.13	0.365	0.00	12.109	0.030	3.890
2019	1.107	0.669	0.578	0.002	1.085	0.260	0.003	13.180	0.011	2.036
2020	1.082	0.005	0.853	0.002	1.042	0.303	0.002	16.74	0.01	3.191

Data Source: calculated by the author according to data from UN Commodity trade Database.

4.2. Result Analysis Discussion of the Complementarity of Agricultural Trade between China and Ghana

- a. Figure 3 shows that the complementarity index of the agricultural trade between Ghana and China calculated using the TCI formula indicates complementary agricultural trade between China and Ghana; however, there is a difference in the level of complementarity. From 2016 to 2018, the trade complementarity index of agricultural products exported by China and imported by Ghana and the trade complementarity index of agricultural products imported by China and exported by Ghana fluctuated, showing a huge rise and fall, with maximum values of 4.29 and 2.66, respectively, in 2017 and minimum values of 0.87 and 0.43, respectively, in 2018. They then remained relatively stable from 2018 to 2020, indicating that the complementarity of China's exports and Ghana's imports of agricultural products had not been fully exploited. Likewise, the complementarity of China's imports and Ghana's exports of agricultural products has not been fully exploited since 2018, and there is a large potential for cooperation and development. In 2017, the trade complementarity index reached a maximum value of 4.29, showing that there is strong trade complementarity with sustained and stable development. The data, figure and table below show a clear understanding of their complementarities

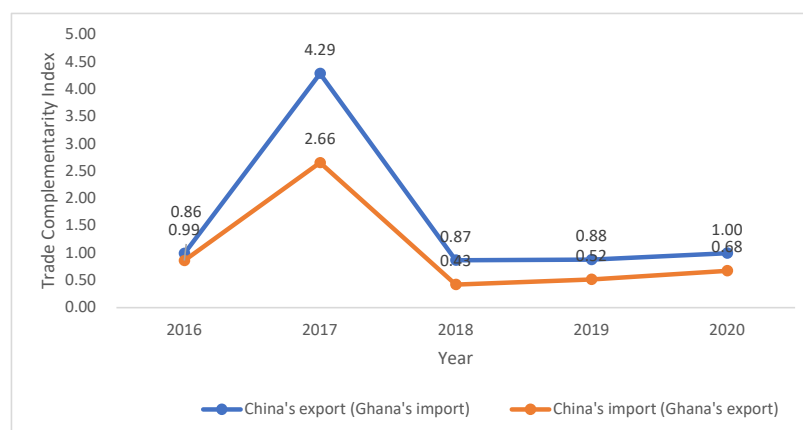


Figure 3. The Calculated Trade Complementarity Index of Agricultural Products Exported from China and Ghana from 2016 to 2020. Data Source: U.N Commodity trade Database.

- b. Table 6 shows more details of the complementarity index of China–Ghana agricultural product trade measured with China’s exports and imports in categories. More details about the complementarity index of each agricultural product can be found in Appendix B. In 2017, there was a high level of trade complementarity in their agricultural products in all categories except category 1, measured with China’s imports. The trade complementarity of the agricultural products in category 0 measured with China’s exports are all higher than 1, and the trade complementarity indices measured with China’s imports are lower than 1, which indicates that there is strong one-way trade.

Table 6. The TCI of China–Ghana Agricultural Product Trade.

Year	Measured with China’s Export (Ghana’s Import)					Measured with Ghana’s Export (China’s Import)				
	Category 0	Category 1	Category 2	Category 4	Composite Index	Category 0	Category 1	Category 2	Category 4	Composite Index
2016	1.31	0.14	0.78	0.19	0.99	0.23	0.02	1.94	0.45	0.86
2017	5.68	1.07	3.03	2.42	4.29	1.06	0.31	5.65	3.89	2.66
2018	1.18	0.21	0.57	0.53	0.87	0.27	0.05	0.68	0.63	0.43
2019	1.09	0.17	0.73	0.45	0.88	0.30	0.03	0.83	1.04	0.52
2020	1.16	0.23	0.94	0.54	1.00	0.31	0.01	1.23	1.07	0.68

Source: calculated by the author according to data from UN Comtrade Database.

5. Conclusions and Recommendations

5.1. Conclusions

In recent years, with the introduction and strengthening of “China Africa Cooperation”, the overall trade volume of China–Ghana agricultural products has shown a significant increase [18]. However, in the trade of agricultural products between the two countries, China is basically in a trade surplus, and the proportion of China and Ghana agricultural product trade is still at a relatively low level. From the perspective of the competitiveness of China–Ghana agricultural product trade, the analysis of the revealed comparative advantage index shows that the export competitiveness of China’s agricultural products is far lower than that of Ghana’s agricultural products in the world over the same period. From the perspective of complementarity analysis, the complementarity of China–Ghana agricultural product trade is quite low, but the trade complementarity of China–Ghana agricultural products is much higher than that between China and other countries of West Africa. The strong revealed comparative advantage shows that China and Ghana take advantage of their differences in terms of seasons, labor, land and geographical advantages to develop their agricultural trade. The study selected five periods with two trade indicators. The result of the study is also limited by their distance. Even with these limitations, we believe the period studied confirms the status of the agriculture trade of both countries and

provides valuable results for policy decision making. Additionally, future studies can take their distance into account.

Based on the current situation and the analysis results of the comparative advantage and complementarity of agricultural trade between China and Ghana, this paper then proposes suggestions and recommendations to seek new and continuous development for agricultural trade cooperation between the two countries.

5.2. Recommendations

5.2.1. To Improve the Agricultural Trade Structure

Both countries have a role to play in enhancing the trade structure while complementing each other's strengths. The trade complementarity of agricultural products exported and imported by both countries is low in the majority of the years recorded. Moreover, it shows that Ghana is at a disadvantage in terms of the trade of agricultural products exported by Ghana to China. As a result, China and Ghana should expand agricultural production technology exchanges and learn from one another, maximizing the highly complementary qualities of trade in some agricultural product categories. The two countries should also strengthen their weak complementarity by combining their strong relative comparative advantages and resource advantages of agricultural products to complement each other's advantages. Furthermore, we explore potential agricultural product trade to optimize the structure of bilateral agricultural trade and strive to match the strengths of each with those of the other.

5.2.2. To Further Open their Agricultural Trade Markets

Furthermore, they opened their market for zero tariffs of export on most agricultural items. Trade in agriculture can greatly raise incomes, and its benefits spread widely. It serves as an important source of foreign exchange and acts as a catalyst for the overall development of a country. However, tariffs can hinder trade. The tariffs present between China and Ghana are the general duty rate and the most favored nation duty rate treatment. In 2019, the import tariff for agricultural products from China entering Ghana was high at a 65% rate, while the import tariffs for products from Ghana entering China were high at 35%, also on agricultural products. Furthermore, China and Ghana can implement agricultural trade policies such as lowering tariffs and raising subsidies, as well as lowering nontariff barriers, resulting in favorable trade conditions for both nations and achieving win-win outcomes.

5.2.3. To Expand Agriculture Imports

To strengthen "Sino Ghana Cooperation", China needs to expand the import of agricultural products. China's import of agricultural products from Ghana and Africa is quite low compared with its imports of minerals and other resources and sectors. The effectiveness of their cooperation can be achieved through balance. China should attempt to reduce the growing trade imbalance with Ghana by sourcing a more diverse variety of agricultural products from Ghana and Africa. The effectiveness of cooperation can be achieved through diversity and a comprehensive trade balance. It is necessary to encourage and guide domestic enterprises to strengthen agricultural cooperation and investment in Ghana.

Although China and Ghana are far apart and Ghana's current import strength is low, there are still some challenges to greatly expanding bilateral agricultural trade. However, in terms of agricultural resource allocation, China and Ghana had strong complementarity, which decreased starting in 2018; thus, there is still much room for agricultural trade development, and the potential is far from being fully realized. For example, although China imports many products in codes 01, 02, 1, and many other agricultural products each year, only a small amount is imported from Ghana, even though Ghana is ideal for the production and growth of such products.

5.2.4. To Enhance Policy

It is necessary to enhance the system of policy support for bilateral agricultural cooperation strategies. The first step is to improve the talent development training model because of the major differences in language, religion, culture, consumption structure, and agricultural policies between China and Ghana. In China, there is a lack of professional personnel who are fluent in the local languages and culture. As a result, China should expand talent training and exchange methods, as well as strengthen the training of people who understand Ghana's current agricultural situation. The second step is to improve financial and technical assistance. China should boost the share of agriculture-related funds in a special fund for foreign economic cooperation and provide more financial support to agricultural firms investing in Ghana. At the same time, China could take advantage of its strengths in planting technology and production expertise to provide experience, financial assistance, and agricultural production collaboration to Ghana.

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Appendix A

Table A1. Commodity structure calculation of China–Ghana agricultural product trade.

Code	China Export to Ghana						China Import from Ghana					
	2016	2017	2018	2019	2020	Mean	2016	2017	2018	2019	2020	Mean
00	-	-	-	-	-	-	0.01	-	0.12	0.32	-	0.15
01	0.04	0.06	0.03	0.04	0.01	0.036	-	-	-	-	-	-
02	-	-	0.00	0.02	-	0.01	-	-	0.00	-	-	0
03	18.91	16.95	23.32	19.31	25.58	20.814	2.24	1.40	1.41	2.35	1.58	1.8
04	1.92	2.03	3.49	2.67	2.82	2.586	-	-	0.00	0.00	0.00	0
05	19.11	21.25	13.81	15.90	13.66	16.746	0.11	3.55	3.27	1.47	6.68	3.02
06	7.41	6.70	8.93	9.67	9.38	8.418	-	0.00	0.00	-	0.00	0
07	29.06	29.52	23.74	25.42	23.72	26.292	20.38	19.31	28.02	17.68	26.44	22.37
08	0.62	0.43	0.24	0.18	0.19	0.332	-	-	-	0.00	0.02	0.01
09	13.85	13.34	16.00	16.06	13.97	14.644	-	0.00	0.01	0.00	0.02	0.01
1	0.04	1.83	2.26	2.85	0.01	1.398	0.00	-	-	0.00	-	0
21	-	0.00	-	0.00	-	0	-	-	0.48	1.16	2.49	1.38
22	0.00	0.00	0.00	-	0.02	0.005	0.02	0.05	0.03	0.01	0.01	0.02
23	0.47	0.32	0.75	0.78	0.84	0.632	0.72	0.04	0.06	0.58	14.35	3.15
24	0.02	0.02	0.33	0.77	0.18	0.264	72.13	75.46	66.23	76.36	48.24	67.68

Table A1. *Cont.*

Code	China Export to Ghana						China Import from Ghana					
	2016	2017	2018	2019	2020	Mean	2016	2017	2018	2019	2020	Mean
251	0.03	0.11	0.38	0.25	0.15	0.184	-	-	-	-	-	-
26	8.34	7.10	6.49	5.92	9.33	7.436	-	-	0.15	-	-	0.15
29	0.17	0.09	0.24	0.16	0.14	0.16	4.31	0.05	0.12	0.00	0.00	0.9
4	0.00	0.00	0.00	0.00	0.00	0	0.09	0.13	0.11	0.06	0.18	0.11

Data Source: calculated by the author according to data from UN Commodity trade Database.

Appendix B

Table A2. RCA calculation of China's agriculture products.

Code	2016	2017	2018	2019	2020
00	-	-	-	-	-
01	0.0125	0.0161	0.0078	0.0113	0.0028
02	-	-	0.0023	0.0124	-
03	0.7133	0.6512	0.8957	0.7913	1.0898
04	1.0425	0.9632	1.4171	0.9404	1.0807
05	0.6095	0.6654	0.4598	0.5090	0.4173
06	2.5040	2.2893	3.1504	3.3094	3.2676
07	5.5602	6.3873	5.0062	4.8772	4.0745
08	0.1693	0.1267	0.0630	0.0510	0.0499
09	2.8745	2.6312	2.7718	2.4977	1.9210
1	0.0082	0.4127	0.5032	0.6687	0.0046
21	-	0.0122	-	0.0224	-
22	0.0011	0.0000	0.0007	-	0.0103
23	0.6491	0.3405	0.7240	0.7700	0.7541
24	0.0194	0.0177	0.4018	1.0458	0.2464
251	0.1831	0.6127	2.4098	1.5456	1.0137
26	2.0392	1.5989	1.3512	1.3617	2.7182
29	0.0269	0.0169	0.0409	0.0271	0.0257
4	0.0056	0.0024	0.0001	0.0024	0.0022

Data Source: calculated by the author according to data from UN Commodity trade Database.

Table A3. RCA calculation of Ghana's agriculture products.

Code	2016	2017	2018	2019	2020
00	9.7859	-	2.5790	0.9645	-
01	-	-	-	-	-
02	-	-	0.0008	-	-
03	6.9552	0.2443	0.2934	0.4563	0.3162
04	-	-	0.0010	0.0004	0.0011
05	0.0038	0.2882	0.2428	0.1427	0.4189
06	-	0.0005	0.1224	-	0.0109
07	0.3958	0.2878	0.4031	0.2514	0.4260
08	-	-	-	0.0002	0.0616
09	-	0.0013	0.0178	0.0051	0.0408
1	0.0030	-	-	0.0034	0.0000
21	-	-	33.6718	0.0010	33.2421
22	0.0151	0.1643	0.0561	0.0097	0.0079
23	0.6058	0.0193	0.0477	0.3405	5.1965
24	5.6963	19.8774	19.4570	26.3201	11.2781
251	-	-	-	-	0.0000
26	-	-	0.6882	-	0.0000
29	13.7389	0.2892	0.7325	0.0011	0.0345
4	0.0325	0.0257	0.0297	0.0115	0.0278

Data Source: calculated by the author according to data from UN Commodity trade Database.

Table A4. TCI Measured with China's Export (Ghana's Import) of each code and its years.

Code	2016	2017	2018	2019	2020
00	0.2538	0.9543	0.1663	0.2231	0.2231
01	0.3818	1.9953	0.3247	0.1771	0.1771
02	0.0614	0.3475	0.0411	0.0384	0.0384
03	6.8860	23.5383	4.0488	3.6202	3.6202
04	0.5571	4.3184	0.8789	0.9555	0.9555
05	0.8507	0.0397	0.5731	0.5251	0.5251
06	2.3384	15.3014	3.5703	3.5148	3.5148
07	0.0733	0.4070	0.0801	0.0669	0.0669
08	0.5681	2.5122	0.6157	0.3841	0.3841
09	1.1378	7.3957	1.5059	1.4239	1.4239
1	0.1447	1.0704	0.2074	0.1744	0.1744
21	0.0181	0.0062	0.0017	0.0037	0.0037
22	0.0056	0.0174	0.0250	0.0027	0.0027
23	0.0058	0.0193	0.0049	0.0068	0.0068
24	0.0124	0.0796	0.0192	0.6950	0.6950
251	0.0013	0.0093	0.0031	0.0058	0.0058
26	4.0574	17.6831	3.1737	2.7298	2.7298
29	1.3265	3.3941	0.7853	1.6913	1.6913
4	0.1912	2.4197	0.5284	0.4547	0.4547

Source calculated by the author according to data from UN Comtrade Database.

Table A5. TCI Measured with China's Export (Ghana's Import) of each code and its years.

Code	2016	2017	2018	2019	2020
00	0.0002	0.0009	0.0058	0.0001	0.0039
01	0.0001	0.0024	0.0006	0.0013	0.0001
02	0.0146	0.2044	0.0200	0.0331	0.0532
03	0.0211	2.0995	0.4051	0.5733	0.4766
04	0.0348	0.2264	0.0353	0.0432	0.0483
05	0.6862	0.0159	0.3900	0.3280	0.4776
06	0.0028	0.0025	0.0008	0.0009	0.0012
07	1.4089	7.0729	1.6725	1.8454	1.9703
08	0.0161	0.1923	0.0272	0.0331	0.0383
09	0.1128	0.7498	0.0947	0.1394	0.0572
1	0.0176	0.3061	0.0466	0.0277	0.0144
21	0.1489	0.0191	0.0160	0.0098	0.9093
22	1.2465	1.8716	0.4472	1.1573	0.5491
23	1.7672	14.2939	1.5655	1.9971	4.1764
24	10.1609	18.6321	2.5202	2.4104	2.9416
251	0.0069	0.0537	0.0039	0.0011	0.0000
26	0.2649	0.6823	0.1762	0.1907	0.0479
29	0.0158	0.1496	0.0229	0.0248	0.0127
4	0.4529	3.8847	0.6300	1.0386	1.0738

Source calculated by the author according to data from UN Comtrade Database.

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