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# **Assessing China's Potential Import Demand for Distillers Dried Grain: Implications for Grain Trade**

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## **Abstract**

A team of U.S. analysts visited China to assess the potential for use of distillers dried grain plus solubles (DDGS) in China's livestock sector. They examined the economics of the use of DDGS in feeds, the policy issues surrounding the use of the product, and transportation-logistic constraints in the expansion of DDGS imports. The team collected actual and secondary data to conduct a micro-economic analysis of the impact of DDGS on feed cost, solicited official and expert opinions through interviews, and conducted site visits. They found the development of the DDGS import market in China to be very promising. The microeconomic analysis showed a clear economic incentive for feed millers and livestock producers to use DDGS in their feed ration, with a potential savings of \$1 per hundredweight of mixed feed, representing a 6% feed cost savings. Moreover, China has the livestock numbers to support a DDGS market. Concerns about mycotoxin contamination and nutrient profile variability must be addressed, however. Clearly differentiating imported DDGS from domestic DDGS is key in positioning U.S. DDGS in the Chinese market. Also, a science-based, and pro-active approach is needed to address policy-induced barriers.

**Keywords:** DDGS, distillers grain, feed demand, livestock sector, optimal feed ration.

## **Executive Summary**

With its decades of sustained economic growth, China's changing consumption pattern (i.e., more meat and dairy products) and growing consumption level exert additional pressure on its limited land resource, posing a real food policy issue.

It is projected by the U.S. Department of Agriculture and the Food and Agricultural Policy Research Institute that at the time when China needs to import 1.5 to 2 mmt of corn for its livestock and dairy sectors, the U.S., which supplies 66% of the world corn market, will have to grind 37% of its corn production to meet its new ethanol mandate of 15 billion gallons in 2015, likely resulting in a short supply of corn and a high price in the world market. However, the high ethanol production in the U.S. will also produce a surplus supply of 6.7 mmt of distillers dried grain plus solubles (DDGS), a co-product of ethanol production that can be a substitute source of energy in a livestock feed ration. Whether China will exploit this market situation to import less corn and more DDGS remains uncertain and will impact market outcomes in the world grains market. In particular, it will depend on whether Chinese feed compounders and livestock producers adopt and use DDGS as a major feed ingredient in their animal feed ration, and whether China has the logistical capability to import more DDGS from the world market, store, and distribute it to feed users. Using a very conservative assumption, China's import demand for DDGS can easily reach 3 mmt, accounting for 37% of the exportable surplus in the U.S., but China's 2008 import level is only at 0.008 mmt. The potential for growth is enormous.

A team of U.S. analysts, experts in their own respective commodity fields, visited China to assess the economics of DDGS use in feeds, policy issues, and transportation-logistic constraints in the expansion of DDGS imports. The team collected actual and secondary data to conduct a micro-economic analysis on the impact of DDGS on feed cost, solicited official and expert opinions through interviews, and conducted site visits to markets, processors, and transportation-logistic facilities.

The development of the DDGS import market in China is very promising. The microeconomic analysis showed a clear economic incentive for feed millers and livestock producers to use DDGS in their feed ration, with a potential savings of \$1 per hundredweight of mixed feed, representing a 6% feed cost savings. Moreover, China has the livestock numbers to support a DDGS market. However, two key factors need to be addressed in order to realize this market potential. The first is the DDGS product itself. Concerns about mycotoxin contamination and nutrient profile variability are of paramount importance, likely reflecting quality concerns primarily about domestically produced DDGS. All stakeholders in the DDGS value chain unanimously echoed these concerns. Clearly differentiating imported DDGS from domestic DDGS is key in positioning U.S. DDGS in the Chinese market. Second, a transparent, science-based, and pro-active approach is needed to address policy-induced barriers such as unnecessary delays in registration and other required testing.

## **Introduction**

China's food consumption pattern has changed significantly following the "trading-up" phenomenon common in many developing countries, in which better-quality food products such as animal-protein-rich food items from meat and dairy increase, while traditional grain-based staples such as rice decline. In the case of China, this change was driven by sustained real economic growth of 9.54% over the last decade coupled with a 0.64% growth in population and tremendous rates of urbanization. During the same period, per capita meat, dairy, and vegetable oil consumption increased by 2.3%, 24.2%, and 10.2%, respectively, while wheat and rice consumption declined by 1.2% and 0.64%, respectively. To meet this growing food requirement, China's meat and dairy production will need to expand significantly. As China's consumption pattern demands more animal protein products, China will need more land to supply the feed grains required for meat and dairy production. But land is a very scarce resource in China. The country has about 7% of the world's cultivated land and 21% of the world's population compared to North America, which has 17% of the world's cultivated land and 5% of the world's population. China's cultivated land-to-person ratio is at 0.71 hectares compared to 2.1 in the U.S.

With its limited land resources China faces major policy decisions. Will land be allocated to produce more feed grains rather than food grains? Will the domestic feed grain production be used for fuel or for feed for meat and dairy production? Will China import more feed grains, meat and dairy products, or biofuel?

Several research organizations, including the Food and Agricultural Policy Research Institute (FAPRI), project that China will become a net importer of all three meats in the next decade, with net imports reaching 375 thousand metric tons (tmt) for beef in 2018, 470 tmt for pork, and 612 tmt for poultry. Moreover, both the U.S. Department of Agriculture (USDA) and FAPRI also project that China will be a net importer of corn beginning in 2011, with imports reaching 2.7 tmt by 2018 according to USDA and 2.3 tmt according to FAPRI.

Although there is consensus that China will need to import more meat or feed grains to meet its fast-growing food demand, what remains uncertain is what mix of products it will import and at what level. A source of significant uncertainty about trade pattern outcomes is whether China will adopt the use of distillers grain (e.g., distillers dried grain plus solubles, or DDGS) for feeding its animals. All market outlooks indicate that at a time when China needs to import more grains for its livestock sector, the U.S. will grind 37% of its total corn production as feedstock for its ethanol production, creating a likely shortage of corn and a high corn price in the world market. The new Energy Independence and Security Act of 2007 (EISA) sets a renewable fuels standard of 15 billion gallons of fuel ethanol from starch (primarily corn) by 2015. This requires 5.3 billion bushels of corn, a level two times larger than what the U.S. exports to the rest of the world. Although the expansion of ethanol production in the U.S. means smaller corn exports from the U.S. and higher corn prices in the world because the U.S. accounts for 66% of the world corn market, ethanol production also produces a by-product called DDGS at a rate of 17 pounds of DDGS per 56 pounds of corn. At 15 billion gallons of ethanol, DDGS production would reach 40.9 million tons, 84% of which would be used for livestock feed in the U.S., and the rest, amounting to 6.5 million tons, would be exported.

It is uncertain whether China will exploit this market situation to import less corn and more DDGS. It will depend on many factors, including the following:

- Will Chinese feed compounders adopt the use of DDGS as a major feed ingredient in their animal feed ration?
- Does China have the logistical capability to import DDGS from the world market, store, and distribute it to feed compounders?

The major energy source of feed rations in China is primarily corn, with a share of 87.35%, followed by wheat, a distant second with a share of 10.25%, 1.41% for barley, 0.67% for sorghum, and 0.32% for other grains. For protein, soymeal accounts for 64.05%, followed by rapemeal with a share of 19.27%, cottonseed meal, 8.20%, peanut meal, 7.55%, and sunflower meal, 0.92%. China's potential to import DDGS is large, especially with the emergence of commercial farms (e.g., hogs). Commercial hog operations have increasingly gained production share over time in China. The share of pork production from households

(including backyard and specialized households) decreased from 97.50% two decades ago to 89.29%, while the share of commercial production (those with more than 500 hogs) increased from 2.5% to 10.71%. The trend toward commercialization is expected to continue at a faster pace in the future, driven by the reported increasing pockets of labor shortages and rising wages, high cost of using advanced technology (e.g., genetics and nutrition), improved farm management practices to increase productivity, and the rise of supermarkets whose procurement interest is better served by dealing with commercial suppliers to ensure food safety and reduce transaction costs.

If China's hog sector becomes dominated by large commercial operations, the question of interest is how this structural change will impact the demand for feed grains given that commercial farms are more grain intensive in their feeding practices. Assuming a 10% share of pork production contributed by commercial producers, a feed conversion ratio of 3 pounds of feed for every pound of meat produced, and a maximum DDGS inclusion rate of 20%, the potential DDGS use from this sector alone can easily reach 3 mmt. Or, alternatively, according to reports, feed industry output in China in 2007 was 120 mmt, with output value of 330 billion yuan. Assuming a conservative DDGS adoption rate of 20% and a low inclusion rate of only 10%, DDGS use would still easily reach 2.4 mmt. If all this DDGS is imported from the U.S., this market would account for 35% of the projected U.S. export surplus of 6.4 mmt. However, China's DDGS import level in 2008 was 0.008 mmt. This study examines the likely factors that can restrict the use of DDGS in China and limit its import potential.

Several studies in the U.S. (Fabiosa, 2008a, 2008b; Shurson, n.d.; Stein, 2007; Thaler, 2002; Tjardes and Wright, 2002; and Trenkle, n.d.) have indicated that using DDGS in the livestock feed ration reduces feed cost without compromising productivity and meat quality. That is, in a cost-minimization problem for formulating a least-cost diet, DDGS comes out as a dominant ingredient that is always included in the ration at its maximum allowable limits. Assuming similar price relationships of feed ingredients in China, it is very likely that the same economic advantage in the use of DDGS in the U.S. can be gained in China as well. The most important factor is of course the bottom line; that is, will the use of DDGS lower cost of feeds and improve profits in China? U.S. DDGS is more expensive than DDGS in China, but the price difference has narrowed in 2009. China's tariff on "brewing or distilling



dregs and waste” is 5%. The value-added tax for feeds is 13%. Chinese officials might treat DDGS imports favorably by waiving the 13% value-added tax and cutting the tariff if these imports are viewed as adding to domestic feed supplies and easing upward price pressure.

There may also be other factors that are particular to China that may influence the use of DDGS, such as the nutritional content levels and the stability of the nutrient profile of DDGS. Comparing DDGS from local sources in China to the supply coming from the U.S. may be important to Chinese feed compounders and livestock producers in their decisions about using imported DDGS.

Several Asian countries have increased their 2008 imports of DDGS, including Taiwan (189 tmt), South Korea (184 tmt), Japan (198 tmt), Philippines (113 tmt), Indonesia (118 tmt), Thailand (183 tmt), Vietnam (117 tmt), and Malaysia (58 tmt). Also, their rates of import growth between 2004 and 2008 have been dramatic. In contrast, China’s DDGS import was only 8 tmt. The team examines whether the growth in imports in these Asian countries can also happen in China.

### **Objectives of the Study**

The general objective of the study is to assess the potential of China to import DDGS and examine its implications for Chinese grain trade (e.g., corn).

The specific objectives are to

- conduct a micro-economic analysis of the impact of using DDGS in China on the cost of feed rations for various animal types including cattle, hogs, poultry, and fish for both backyard and commercial operations;
- estimate the potential import demand of DDGS in China;
- identify constraints in the adoption of DDGS by feed compounders and livestock producers, including those induced by the economics, technology, infrastructure (transport and storage), and policy; and
- compare drivers of increased DDGS imports in many Asian countries and evaluate if they can hold in the case of China.

## Findings

### Microeconomic Analysis

To a great extent, the potential of China to import DDGS will be determined by economic fundamentals, that is, whether DDGS can compete with currently used feed ingredients to supply the energy and protein requirements of various animal species grown in China, including aquatic products such as fish and shrimp. To assess the economic fundamentals in the use of DDGS in China, the team conducted a comparative economic analysis on the cost of optimal feed rations with and without DDGS in China and in the U.S. We employed a linear programming method to determine optimal feed rations and introduced several simplifying assumptions. First, we assumed that pig production in China has the same nutritional requirements as those reported by the National Research Council (NRC, 1998). The easy availability of advanced pig production technology, especially to commercial producers in China, makes this assumption reasonable. Second, we assumed that the major feed ingredients, including corn, soymeal, and DDGS, have the same nutritional profile as that reported in the same NRC publication (1998). We captured the economic fundamentals in China by using domestic prices of feed ingredients collected in China on July 2008 (Tuan et al., 2008). We did not account, however, for domestic prices of feed ingredients that supply the minerals and vitamins in the optimal feed ration. Table 1 shows the domestic prices of major feed ingredients in China. DDGS is cheaper than corn in the U.S. but is more expensive than corn in China. Comparing feed grain prices in China, DDGS is most expensive, followed by soymeal, and then corn. Following Fabiosa (2008a), we

$$\begin{aligned} &\text{Minimize } \rho'x \\ &\quad Ax\{\geq=\leq\}b \\ &\text{Subject to } l \leq x \leq u \end{aligned}$$

**Table 1. Feed ingredient prices (U.S. dollars per metric ton), China and the United States, July 2008**

Feed Ingredient	U.S.	China
Corn	214	279
Soymeal	412	662
DDGS	163-195	234-350

Source: Tuan et al., 2008.

where  $\mathbf{x}$  is an  $n \times 1$  matrix of structural decision variables, which in this case are the levels of feed ingredients to include in a hog ration (e.g., corn, soymeal, DDGS, and supplements for minerals and vitamins);  $\mathbf{p}$  is an  $n \times 1$  matrix of feed ingredient prices;  $\mathbf{A}$  is an  $m \times n$  matrix of technological coefficients representing the amount of nutrient from the respective source of feed ingredient,  $\mathbf{b}$  is an  $m \times 1$  matrix of right-hand-side constants such as feed nutrient requirements (e.g., energy, protein, minerals, and vitamins);  $\mathbf{l}$  is an  $n \times 1$  matrix of lower bound such as the non-negativity condition of the decision variables; and  $\mathbf{u}$  is an  $n \times 1$  matrix of upper bound such as the maximum inclusion rate of DDGS in the ration.<sup>1</sup> The model solves for an optimal feed ration mix specifying the amount of each feed ingredient to use that minimizes total feed cost and meets all nutritional requirements, given current prices.

Table 2 shows that in this example, the optimal feed ration for finishing pigs in China is the same as that of the U.S., even if domestic prices of the respective two countries were used in solving the least-cost optimization problem for the ration. That is, corn has a share of 78.23% in the feed ration, soymeal, 18.78%, and DDGS, 0.0% in the baseline ration, and the remaining balance is for the minerals and vitamins. We suspect that this result derives from the fact that the relative prices between the U.S. and China are not too different and so do not generate a different optimal feed ration given that the limit on the inclusion rate is binding. We can only see the difference in the optimal feed ration if this constraint is released. In that case, the optimal solution calls for more DDGS in the feed ration in the U.S. than in China.

When 20 pounds of DDGS is introduced in the optimal ration, 18.77 pounds of corn and 3.57 pounds of soymeal are substituted. Other feed ingredients also need to be changed to reach a balanced ration. It is noted that the baseline optimal feed ration, which does not

**Table 2. Optimal feed ration (pounds) in the United States and China**

Ingredient	No DDGS	With DDGS	Difference
Corn	78.23	59.45	-18.77
Soymeal	18.78	15.21	-3.57
DDGS	0.00	20.00	20.00
Others	2.99	5.34	2.34
Total	100.00	100.00	0.00

Source: Solution from least-cost feed formulation.

<sup>1</sup> NCGA reports recommended maximum inclusion rate.

include DDGS, is more expensive in China than in the U.S. by \$4.40 per hundredweight of mixed feed and by \$4.50 per hundredweight in the ration with DDGS. This higher mixed feed cost in China can be explained by the higher prices of the three main feed ingredients—corn, soymeal, and DDGS—that supply the energy and protein requirements of the ration. Inclusion of DDGS in the optimal feed ration, at its maximum inclusion rate of 20%, lowers the cost of mixed feeds by a dollar per hundredweight of feed in both the U.S. and China. However, because of the higher feed cost in China in the base ration, the rate of feed cost savings with the use of DDGS is slightly higher in the U.S. at 8.76% compared to that of China, at 6.08%.

The main result of the microeconomic analysis strongly indicates that the use of DDGS in the feed ration lowers the cost of feeds for both the U.S. and China. This result provides strong evidence that sufficient economic incentives exist in the development of the DDGS market in China, which can potentially be supplied by imports from the U.S. With the same level of incentives, the DDGS market in the U.S. developed and expanded to reach the current outcome of the market. Table 3 shows the use of DDGS by animal type in the U.S. In 2008, 22.6 million tons of DDGS were consumed in the U.S. by the livestock sector, with 44% going to dairy, 42% to beef, 9% to swine, and 5% to poultry. One can argue that the same potential can be expected in China, which has half of the beef production of the U.S., 196% more dairy cows, 420% more pork production, and 76% more poultry production.

Compared to its neighboring countries in Asia at present, however, China remains a small importer of DDGS, especially when seen in light of the size of its livestock sector. The difference between China and these other countries is the availability of surplus corn in

China. Ending stocks of corn in 2008 were 46 million tons, and China is projected to remain a net exporter of corn until 2009/2010 (FAPRI, 2009). After that period, however,

**Table 3. Distillers grain consumption by animal type**

<b>Animal Type</b>	<b>Share (%)</b>
Dairy	44
Beef	42
Swine	9
Poultry	5

*Source:* Arora, Wu, and Wang, 2008.

FAPRI projects that China will increasingly import corn, the level of which will reach 2.3 million tons in 2018. It is during this time of corn deficit when China will be faced with the issue of whether to import corn or DDGS to meet the feed requirement of its livestock sector.

### **Assessment of Market Potential and Constraints**

To assess the potential and constraints of DDGS market development in China, especially the country's potential to import from the U.S., the team consulted with various stakeholders in the DDGS market chain in China. China has a long history of using domestically produced DDGS in the livestock sector but with the DDGS mostly coming from the beer brewery sector. Use of DDGS from ethanol plants using corn as the main feedstock is a recent development in China; the plants are currently producing a total of 3.5 million tons annually. This long background in the use of domestically produced DDGS has both a positive and negative impact on DDGS market development. On the positive side, livestock producers are already familiar with DDGS as a feedstock. However, their perception of DDGS as a feed ingredient is strongly influenced by their long use of DDGS from the brewery sector, which is of poorer quality than the DDGS that is a co-product of ethanol production. For example, the team visited one of the largest beer breweries in Guangzhou City of Guangdong province and learned that the company separates the yeast from the DDGS and produces a by-product called yeast meal, which is usually mixed into commercial feeds. The remaining product is called spent grain, and this is what is commonly referred to as DDGS in the market. The yeast meal has a high crude protein content, while the crude protein content of the spent grain is very low at 8%, which is much lower than the crude protein content of 27% to 34% in standard U.S. DDGS. Moreover, all the spent grains are marketed in wet form, leading to common product spoilage in a very short period of time. It is this exposure that has formed the livestock producers' perception of poor quality of DDGS as an ingredient in animal feed rations.

The team also visited several research institutions to consult Chinese agricultural economists as well as animal nutritionists about the potential of using DDGS in China. These included the Chinese Academy of Agricultural Sciences in the province of Guangdong as well as their head office in Beijing, and other researchers at the Nanjing Agricultural

University. An agricultural economist at Nanjing Agricultural University expressed an opinion that DDGS use and imports have some potential in China because this does not conflict with the national government's policy objective of food security. The team learned that there has been very limited study of DDGS inclusion in animal feed rations in China. The lack of interest among researchers may again be a product of the low quality perception associated with DDGS. There was almost unanimity in the reply of researchers when the team asked them about the constraints in the use of domestically produced DDGS in China. At the top of their list is the presence of mycotoxin, especially aflatoxin, in DDGS. Since whatever is in the feedstock (e.g., corn) gets multiplied three times in the DDGS product, any presence of mycotoxin in corn can possibly translate into a serious problem in DDGS. This concern is most likely a reflection of the mycotoxin problem in corn in China because of its high-humidity production environment, which can be compounded by the lack of standard processing practices and access to adequate storage facilities among small farmers. The problem of mycotoxin in corn in the U.S. is not very serious because of good drying and storage practices performed by U.S. farmers. Moreover, the team suspects that there is very limited intervention to control any microorganism contamination during the fermentation process in beer production because the final product is for food grade quality. In contrast, in the case of the fermentation process for fuel ethanol production, intervention to control microorganism contamination is common.

The second most common problem cited is the variability of the nutrient profile in DDGS. This profile variability introduces an unwanted level of uncertainty in the feed formulation process. Fabiosa (2008b) has shown that risk-averse behavior of feed formulators can significantly lower the feed cost savings, by \$0.12 (around 13%), in the use of DDGS as formulators respond to the variability of the nutrient profile in DDGS.

Several other problems were also cited by the researchers, with accompanying anecdotal evidence. One was the problem of non-protein nitrogen in DDGS. This concern might be an overreaction to the recent product safety problems in China, particularly the presence of melamine in feed and food products.

The team also consulted with ranking officials of the Ministry of Agriculture in Anhui, Jiangsu, Guangdong, and Beijing regarding the use of DDGS in their respective provinces.

These officials echoed the same optimism about DDGS market opportunities in China and identified the same constraints and problems in the development of the DDGS market as those mentioned earlier by the Chinese researchers.

A leading feed producer in China based in the province of Guangdong is an actual user (i.e., importer) of DDGS. The firm reported wide acceptance and use of DDGS, especially in the duck sector. It is reported that the use of DDGS enhances the yellowish pigmentation of the skin color as well as the egg yolk of ducks, a characteristic that is strongly preferred by Chinese consumers. The team was brought to the firm's feed mill plant to inspect an actual stock of imported DDGS. The firm also reported that the fastest-growing feed product is feed for aquatic products. Fish has high income elasticity relative to other sources of animal protein. With the strong and sustained economic performance of the aquatic sector in China for many decades, fish consumption has increased significantly. However, the use of DDGS in fish is the least studied aspect of DDGS use in the U.S.

Staff members of both the U.S. Grains Council and the Foreign Agricultural Service in Beijing highlighted for the team some of the policy-induced constraints in the development of the DDGS market in China. In particular, they singled out the difficult registration process under the Imported Feed and Feed Additive Registration Regulation (USDA-FAS, 2001), which is administered by the Ministry of Agriculture. The intent of the regulation is to strengthen the supervision of imported feed and feed additives and to protect animal production safety. Although the regulation includes a stipulation of a quick turnaround in the application for registration, the team was informed about cases in which the process took longer than two years. Also, DDGS imports may also be subject to the "Measures of Inspection and Quarantine on Entry-Exit GM Products" regulation (USDA-FAS, 2004), which may require conduct-of-proof tests. Although entry of DDGS into China is increasing in the recent period, especially through the southern ports, this entry can be quickly interrupted through regulatory intervention. Under such uncertain rules, it will likely be difficult for DDGS use in China to take root and develop into a mature market.

## **Summary and Conclusion**

The development of the DDGS import market in China is very promising. As shown in the microeconomic analysis, there is clear economic incentive for feed millers and livestock producers to use DDGS in their feed ration. Moreover, China has the livestock numbers to support a DDGS market. We focus our concluding remarks on two of the key factors that are crucial in realizing this market potential for DDGS in China, namely, product and policy.

### **Product**

Because of the long history of domestic brewer DDGS use in China, which helped to create a perception of poor product quality among its users, it is of primary importance that imported DDGS from the U.S. be clearly differentiated from domestic DDGS. This can be accomplished by promoting DDGS not as a generic commodity but as a differentiated and specialized product, following the development approach in the U.S. of branding DDGS products. More demonstration feeding trials at strategic farms may be necessary to overcome this long-established perception of poor DDGS product quality.

The mycotoxin contamination issue is another point of differentiation between U.S. and Chinese DDGS. Shurson reports that recent surveys in the U.S. have shown the percentage of DDGS samples containing mycotoxins is minimal, and if mycotoxins are present, they are below levels that concern the U.S. Food and Drug Administration. Mold growth, and potential production of mycotoxins, occurs when the moisture content exceeds 15%. Almost all dried distillers grain is well below this moisture level, typically ranging from 9% to 12% moisture, which prevents mold growth from occurring during storage.

Although inherent in the DDGS product, the issue of a variable nutrient profile can be addressed with better institutional arrangements, ensuring regularity of DDGS supplies from a few dependable suppliers.

### **Policy**

The policy regulations issued by China are legitimate but should not be allowed to become a barrier to the entry of DDGS from the U.S. into China. The best approach is to



proactively address all justifications used by China with regard to these issues. The U.S. should seek transparency in areas that are potentially sensitive for China in importing DDGS. For example, the U.S. should seek a science-based resolution to any concern China may have over DDGS that is produced using genetically modified corn as a feedstock. Additionally, the co-mingling of corn varieties in the U.S., including those varieties not yet approved in China, could potentially cause some friction in the future and should be proactively addressed.

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