Smallholder Agrofood Contracting for Food Security, Poverty Reduction, and Sustainability in China

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ABSTRACT

China comprises, now and for the foreseeable future, about one fifth of humanity. At the same time, the country's borders encompass only 7% of world's arable land and 5% of renewable fresh water resources. These macro conditions reveal the overarching risks to the food security of the world's second largest economy, and have implications for global agrofood resources as well. In this research, we examine the potential to increase China's food productivity through new technology adoption via contracting mechanisms. This approach is intended to achieve three objectives:

1. Enhance national food security by introduction of agricultural technologies that extend growing seasons.
2. Advance the livelihoods of the rural poor but using contracting to facilitate technology transfer, higher yields, and smallholder market access.
3. Promotes sustainable development by increasing water and other input use efficiency.

Introduction: Agricultural Contracting Prospects in China

The new consumption demands of in China are evolving along with the rising Chinese per capita income, presenting significant challenges about how to satisfy the diverse consumption needs of the population and to also increase incomes for nearly 500 million farmers (Ying: 2000). "China's agricultural sector is overall very poor, which is reinforced through inadequate infrastructure, a deteriorating ecological environment, vulnerability to natural disasters, low technological adoption levels, low degrees of supply chain integration, specialization, education and technical knowledge among

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farmers, over reliance on primary raw material processing, limited value-added from processing."

Overall, the biggest problems identified in China's agrofood industry include: (1) quality, consistency, and timeliness cannot meet the needs of processors and the agro-processing industry technology; (2) "Raw material supply is scattered and limited, without the support of large production bases; processing of agricultural product lacks sizeable and standardized raw material guarantees"; (3) "The mechanisms for developing relationships of mutual interest between processing enterprises and farmers is not well established.". Combined with such previously mentioned problems, smallholder farmers in developing countries often face challenges in accessing information and working together in a low-cost and low-risk agrofood system (Jia, "Contractual arrangements"). China has large numbers of farmers involved in small scale and scattered production, and most of them are semi-commodity producers; their agricultural production is not intensive and the professional level is rather low, with raw material production on a small scale. Moreover, most farmers only hold a "simple distribution or client relationships with processing enterprises" as there are fairly few intermediate players between farmers and the market. Even if there are client relationships between farmers and processing enterprises, most relationships only include a short-term plan where enterprises do not even provide seed, fertilizers, or techniques for farmers to use (Ying 38). Most of the times, contracts are violated as farmers do not recognize the binding power of law and contract. "In the field of distribution, difficulties of selling and purchasing agricultural products often occur, and the ability of processing enterprise and farmers to combat market risks is weak".

Recent contracting arrangements in China—Farmer Professional Cooperatives, or FPC's

To meet the demands of consumers in China, the government has been trying to improve the agrofood market by targeting the supply chain mainly through the facilitation of vertical coordination. With vertical coordination, each successive stage in the production, processing, and marketing of a product is ensured to be thoroughly managed, thus allowing decisions about what and how much to produce of a product to be easily communicated from consumer to producer. The Farmer Professional Cooperatives (FPCs) have been part of an institutional innovation from the Chinese government to assist vertical coordination in the agrofood industry to "set and enforce formal rules to overcome coordination problems in the agrofood system" (Jia, "Contractual agreements" 656).

“The use of contracts in the agrofood chain arises when: (a) Firms attempt to reduce the transaction costs of marketing; (b) a small volume of transactions in both production and marketing limits the economies of scale; (c) limited opportunities exist for processors and retailers to source farm produce in a traditional marketing approach; and (d) smallholder farmers have a limited capacity to obtain inputs, and lack the knowledge to use these inputs” (Jia, “Contractual agreements” 655). FPCs in China serve a large number of farmers who may participate as formal members by formally joining the FPC and possibly paid a membership fee or as informal members by being more loosely associated with the cooperative yet included in multiple activities (Deng 500). Most of the services provided by the FPCs in rural China include supplying technological or information services, purchasing agricultural inputs for members, providing output marketing services for members, and providing credit services (Deng 501). “Production technology services mainly included services such as the provision of crop management approaches, breeding techniques, pest and disease control suggestions and animal disease prevention and control” (Deng 501). FPCs provided output marketing services not only by supplying information about prices and market access, but also provided input marketing services such as providing fertilizers, feeds, pesticides, and seeds (Deng 501). A small number of FPCs were also reported to have purchased agricultural outputs from their members as well and then reselling to outside purchasing agents (Deng 501).

Common Characteristics of Contracts with FPCs

Most FPCs had government departments involved in the administration (Jia, “Contractual arrangements” 658). Contracts themselves are often quite problematic as contracts in agriculture are mostly oral agreements (Jia, “Contractual arrangements” 659); once farmers sell their output, they are no longer held accountable for their product (Jia, “Marketing of farmer” 2). Most of the times, buyers only contracted with FPCs for committed and timely marketing, but duration, price, quantity, and quality are rarely specified (Jia, “Contractual arrangements” 659). Moreover, FPCs rarely “customize” farming practices and quality through vertical contracts (Jia, “Contractual arrangements” 659). Generally, most contracts with FPCs only held for less than a year (Jia, “Contractual arrangements” 659). Very few suppliers reported that there were food safety requirements from the buyers, and even fewer reported that buyers supervised the production stages and refused to purchase products that were unsafe (Jia, “Marketing of farmer”5). Furthermore, most of the membership within FPCs occurs within township boundaries (Jia, “Contractual arrangements” 660).

Contracts with FPCs normally occur for cash crops and livestock products, as such products are naturally the most production-stage intensive compared to other food

products (Jia, “Contractual arrangements” 658). Around half of the contracts in FPCs go to traditional buyers—which include small brokers and consumers—and the other half goes to modern supply chains or whole sale markets even though contracts are much more common with modern suppliers than with traditional buyers (Jia, “Contractual arrangements” 659-660).

Relationships between contracts and product attributes

Four common expectations, or predictions, about contracts instigated by FPC membership are as follows: (1) If production stages are long and involve multiple tasks, contracting is very likely to be used between FPCs and their mid- and downstream partners; (2) Products with high frequency of marketing—such as numerous harvesting cycles—generally will not be involved in contracts; (3) The more perishable a product is, the more contracts will be used; (4) Reputation encourages farmers and those bound under the agreement to respect the contract, and thus when a FPCs’ products has a brand or certification, contracts are more likely to emerge (Jia, “Contractual arrangements” 657).

While it is true that contracts would be used to reduce the moral hazard and risk that comes with products that undergo longer production stages, the first and third predictions are both unverified (Jia, “Contractual arrangements” 661). For example, livestock and orchard crops certainly have longer production stages compared to grains and greenhouse crops, but their production process are too different to be compared. Similarly, the third prediction is also unverified as the “non-significance of perishability in this study may be due to the market strategy of the producers” (Jia, “Contractual arrangements” 661); timely marketing is certainly crucial when products are more perishable, but different producers follow different marketing strategies that perhaps alleviate the problems related to perishability.

In contrast, the second prediction observed the exact opposite of its predicted result; the higher the marketing frequency of a product, the more written contracts were used (Jia, “Contractual arrangements” 661). Some examples of products with high marketing requency include eggs and dairy products. Naturally, a written contract reduces the coordination costs of gathering and exchanging information about demand, quality, timing, and price between farmers, consumers, and markets (Jia, “Contractual arrangements” 661).

The fourth prediction observed exactly what was predicted—“branding FPCs’ products facilitates the contractual arrangements between FPCs and their buyers” (Jia, “Contractual arrangements” 661). In fact, the percentage of written contracts increases when FPCs have their own private brand because “private brand names are actually the

commitment to ex ante specified high quality standards by a firm" thus placing reputation at stake (Jia, "Contractual arangements" 661).

However, while branding products may certainly elevate food safety and quality standards, certification to public food safety does not necessarily bring forth the same effect. Certification to public food safety is certainly another form of reputation, but it is "primarily used by Chinese cooperative and firms as a means to advertise and promote sales without affecting the production stage" (Jia, "Contractual arrangements" 663). In fact, when quality certification is advertised as a value-adding strategy, mid and downstream buyers would rather purchase from spot markets with lower prices and keep the value for themselves, thus lowering the incentive for FPCs to provide quality food (Jia, "Contractual arrangements" 663). Furthermore, "China's consumers do not consider [quality and safety standards] as a primary concern when purchasing food" (Jia, "Contractual arrangements" 663).

Other possible factors affecting the relationships between contracts and types of foods produced

Certain relationships were observed between the use of contracts and the types of foods produced along with the constitution of an FPC.

Generally, the longer an FPC operates, the more written contracts were used to do marketing (Jia, "Contractual arrangements" 659). Likewise, the earlier an FPC has been established, the more output goes through to modern suppliers (Jia, "Marketing of farmer" 6). In contrast, FPCs that were initiated from the government generally flowed less through modern suppliers (Jia, "Marketing of farmer" 6), but initiating sources do not affect the particular market channel of FPCs (Jia, "Marketing of farmer" 7). Moreover, as FPCs' membership expands outside of the township, written contracts increase but food safety requirements tend to decrease as the wide range of members' interests makes it difficult to organize or standardize production when FPCs have wider spatial coverage (Jia, "Marketing of farmer" 6).

In relation to the observation that branding facilitates the contractual agreements between FPCs and buyers, it can also be noted that "when FPCs have their own brand, the marketing shares through the modern supply chain and wholesale market are higher than that of FPCs without a brand" (Jia, "Marketing of farmer" 5).

Other possible factors that may affect the use of contracts include the surrounding market and the competition between FPCs. If the regional agrofood market and agribusiness are developed and highly commercialized, such as in the Jiangsu Province, market exchange will be chosen over contracting (Jia, "Contractual

arrangements" 663). Likewise, "when there are a number of FPCs producing the same type of products within the local township, competition undermines the written contract" (Jia, "Contractual arrangements" 663).

Effects of contracting with FPCs on small farmers and their incomes

Contracting between farmers and FPCs to gain access to the market was meant to bring equal access to modern supply chains for small farmers. However, studies have shown that the emergence of modern supply chains have mixed results on the welfare of farmers (Huang 2). "Small and large farmers have equal access to modern supply chains…there is no evidence that relatively rich farmers (or those with more per capita assets) have any greater propensity to participate in any type of marketing channel, including modern marketing channels" (Huang 4).

The evolving market really has not penetrated China's rural areas or villages; results show that most farmers still sell their products into traditional marketing channels where there is almost "no traceability in the system" (Huang 6). "China's farmers, on the whole, are making production and marketing decisions mostly on their own or relying on informal associations with their village, and such a pattern may constrain farmers' access to technologies, market information, and institutionalized insurance to hedge risks" (Huang 4).

Possible improvements to be made on contracts to ensure the safety and quality of food

As mentioned before, China faces a great challenge in ensuring the safety and quality of foods to its consumers. Almost no activity is based on contracts, and there are nearly no implicit contracts for inputs as all seed, fertilizer, and credit were obtained by the farmers themselves (Huang 5). Very few reported for their products to have been tested for safety, and once farmers sold their product, they were free from all accountability (Huang 5).

The challenge for China lies in wanting to keep the market accessible to small, poor farmers, but also meet the growing demand for food safety from the people (Huang 6). Keeping the market accessible for small, poor farmers is rather easy, but to meet the demands for food safety implies increased regulations and testing—obstacles that may deter small farmers from entering the market.

As different foods require different production stages and requirements, contracts naturally differ from agricultural area to area. It will be difficult to find a particular standardized contract that works for everyone, but from previous studies, it appears that contracting has become "an institutional response (or adaptation) to technological

advances, market volatility, and the demand for high quality and safety of food products" (Jia, "Contractual arrangements" 664). Branding builds reputation, leaving it as a possible tool through contracts to elevate food quality standards. By building reputation specificity of FPCs, there is incentive for farmers who join FPCs to seek contractual agreements with buyers into the market.

Case Study: Enclosed High Value Vegetable Production in Harbin

Sector Case: Eurofresh Farms Inc.

Eurofresh Inc. is a Dutch company, owners and technologies are entirely from Holland. They relocated to the United States because the home industry there is so intense. (This may suggest a good reason for them to move to China.) The greenhouses have been there for decades now. Holland has the most advanced greenhouse technology in the world. They came here also because in Holland the industry is space-limited there, so they are not able to expand large greenhouses on a confined space. (For northern provinces of China this could also be an advantage.)

In 1992 the major production site was moved to Willcox in Arizona. They chose Willcox mainly for the following concerns:

1. Perfect sunlight: Willcox boasts 330 sunny days per year among the largest number in the nation which is perfect for growing tomatoes in greenhouse.
2. Altitude and temperature: mild days and cool evenings, which accommodate their computerized temp-control system as well as help kill pests and diseases in winter. The low humidity enables evaporating cooling. Also the area has relatively plenty availability of clean and fresh water.
3. Marketing issues: labor pool and convenient transportation.

Technology Basic and Specialty

Eurofresh produces vine based tomatoes using hydroponic technology in greenhouses.

Greenhouse structure: they use lightweight relatively tall and is covered with glass (glass being a common material but not as common in China now). The structure itself is large span gutter-connected greenhouse which was chosen for its strength and durability, also because it was one of the newer technologies in Holland, where it came from. The covering or glazing is all glass to allow high transmittance of light. It's very durable and also it's cost-effective compared to other similar glazing out there that

would offer the same amount of light transmittance. The greenhouses they use are of considerable height. The reason is because it allows more of a buffer, an air buffer layer above the crop. That way in times of heating they can effectively keep a warm blanket above the crop and also in times that they need to cool the air allows them time or energy savings with the fans. They use a special cooling system when the natural venting could not fulfill the need. They use a cooling system similar to a home evaporative cooler, with the fans on one side and the cooling pad on the other side of the greenhouse. They will pull the air through the greenhouse and exchange the air in the greenhouse with the cooled air coming in from the outside through the pad. This system also helps keep the greenhouse in certain humidity level.

(the greenhouse's roof and cooling system)

When it comes to heating the greenhouse in cold times, they use two main methods. They have both a movable and stable pipe, the movable one can go up and down in the crop to add heat and to make the microclimate acceptable up and down the canopy of the crop. The stable one mainly functions by letting hot water going through it to heat the greenhouse.

(The movable pipe, which can go up and down across the vines.)

(The stable pipe on the floor to run hot water.)

The source of energy that they use to heat the hot water that they use for these two kinds of pipes is natural gas. They have three boilers for each site of which the byproducts of consumption are water and CO_2. We condense the water out of the exhaust leaving only the CO_2, which they then pump into the greenhouse to enrich the greenhouse with CO_2 because the plants will use the CO_2 as part of their photosynthetic process to create sugars.

For the related video introducing its structure:

http://www.youtube.com/watch?v=hZwyWfqSck4

Computerized system control.

One of the most critical part of Eurofresh's production is their computerized system control. The entire greenhouse is run by computer. Everything is computerized; the climate-control system, the irrigation system, the alarm system. The two different software they use are Hoogendoorn and Priva, which offer computer-control software and they two are competing ones. They're both Dutch-based greenhouses again because that's where the industry is so intense and the new technologies come from there. They are trying them both out obviously because they can get the same service and maybe a cheaper price from one of the separate companies.

Below are the links of the two computer software firm's links:

http://www.hoogendoorn-uk.com/

http://www.priva-tech.com/webroot/pages/company/overview.html

They will keep record of the data during the production 's system and check it from year to year or month by month to figure out what had been done in the past for reference and work out what they should do in current situations. Computerized control is the crucial part of their production to make their products vegetative and generative. Since otherwise they have to hire large amount of labor force to complete each detailed work manually, while computer easily finish all these remotely and more accurately.

The following is the link related to their computerized control:

http://www.youtube.com/watch?v=B3Cg_C9YINY&NR=1

Nutrition and Irrigation Systems

All procedures start from an irrigation room. In the irrigation room the fertilizers are mixed. They use soluble salts. Fertilizer technician will mix the stock tank then the computer will take those stock tanks and dose it into fresh water into a mixing tank. From there the water is mixed to a certain fertilizer level and it comes to the greenhouse pump via underground piping. The water is pumped through the main line into sub-laterals and there it's pumped into the dripper where it is delivered to the crop. It is delivered to the crop several times a day depending on the season. In the summer they give up to 30 maybe even 40 irrigations every 15 minutes, one every 15 minutes. In the winter, they may go every 4 to 5 minutes every hour.



(Irrigation room) (Soluble salts) (Computer-controlled mixer)



(Mixing Tank) (Main irrigation line) (Dripper)

Also, Eurofresh has a very good water recycling system. They get water from the underground wells. Each site has its own water well. They pump up the fresh water, put it in the mixing tank and it comes to the plant. The plants will use what they need and then the drainage is collected in the troughs under the plant. All the drainage goes to the back of the greenhouse. It is collected in the silo and it is run through ultraviolet filters.

This ultraviolet filter what it will do is kill all bacteria, fungi, and some viruses. This system allows them to collect 100% of our drainage and recycle about 45 to 50% of the water.

(Silos collecting water)

(Troughs under the plant)

The Video related to nutrition and irrigation is:

http://www.youtube.com/watch?v=wYzy6rYGqBw&playnext=1&list=PLDE1DD3408997871C

More about Plant Management

They came in from when they were real tiny. Eurofresh gets the plants in from a nursery company. The plants come as transplants. They come in little cube of roughly 10 inches tall. They then plant them on the Rockwool mat (still a Dutch company supplying greenhouse vege-growing structures and accessories: http://www.grodan.com/home). Then the dripper is inserted into the Rockwool mat . Then they tie strings onto the vines, which is to support the plant because it is a vine-type tomato so they have to give it its support via these strings and hooks. The mat contains all the roots. They are a hydroponic greenhouse, so do not use traditional soil to do our growth. All the roots are contained inside slab and the slab and the slab is sitting on top of this trough system.

(Cube and the mat) (Movable Slab) (White strings tied)

The trough under the slab is used to collect the drain water. Each bag of the slab has slits in it. The water comes in via the dripper. It goes through the system and whatever drains out is collected to use later in the recycling system. The dripper (the black one) is used to actually give the water to each cube and the sub-main or the sub-lateral that which is connected to the big main valve. As the plant grows and matures they will support it via this string system here, connected to a high wire.

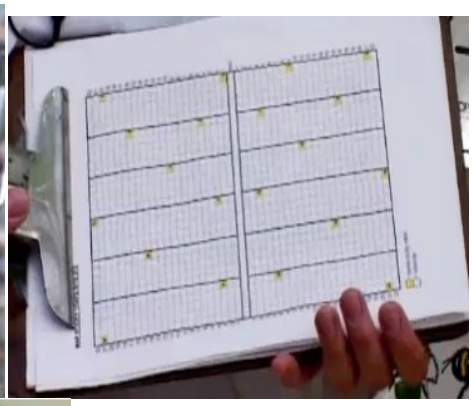
This is the video related to the life cycle of tomatoes introduced above

http://www.youtube.com/watch?v=eWGK66eEir8

Pest Control

The key to integrated pest management is scouting. At EuroFresh they have one scout per every greenhouse or one scout per about every 20 acres. They work very closely with the supervisors and the managers or the growers of EuroFresh. A grower can just go up to one of our scouts and say what do you see in our crop and the scout will be able to tell them.

For white flies, they put up sticky trap in different areas on the greenhouse to take account of the amount of a certain pests in certain areas and then put the number into a map of the whole greenhouse. They then put up a special kind of bag containing beneficial insects to fight against the pests in different areas according to the account they've made.


(Sticky trap for pests) (Account map) (Bag of beneficial insects)

Other common pests at Eurofresh are thrips, russet mite, spider mite.

Eurofresh believes an integrated pest control program is better than the traditional pesticide control, while it requires labor time and energy, it actually ends up being quite economical because those pesticides are pretty expensive a, or trained people are required in order to put them out and those people cost a lot more money based on their experience.

The video related to the pest control of Eurofresh:

http://www.youtube.com/watch?v=iFNY-P7VxMM

Location Case: Harbin, China

Geographic issues

Although this is a greenhouse technology that puts less importance on the climate issues, I suppose there should be still concerns considered with regard to Harbin's

illumination intensity. Harbin has very clear seasonal symptoms and the illumination intensity changes rapidly with the rotating of the four seasons. Basically the duration of sunshine is particularly long during the summer while particularly short during the winter. So seasoning attention of growing and harvesting should be paid for the production and the selection of the products. What I basically mean is that Harbin is good for its sunshine, also its advantageous chill winter to naturally control the possible pets. The technology should be movable, but we need to pay attention to the location and timing of the growing and production.

Also, as mentioned earlier in the brief intro of Eurofresh Farm, a good practice of their Dutch-based greenhouse production needs plenty areas, which Harbin should be able to put a big plus here.

Harbin or Heilongjiang Province's related agriculture development

One of the leading agrotech researchers in the region is a professor at Northeast Agricultural University, who developed highly appraised seeds of tomatoes which are especially designed for northern provinces' adverse weather and hard growing environment. But basically there has not been much attention paid to the development and practice of advanced greenhouse and hydroponic technologies there. Even for the whole China as a whole, the advanced greenhouse & hydroponic technology seem not to be paid significant attention. While there is explanation saying that these sort of technologies are not the essential of agricultural science, This will likely become a more general concern for China. For this reason, greenhouse technology in China is growing fast, but it is still significantly behind the major advanced countries like Holland and Israel.

There are also indeed very successful companies in Beijing (Ruixue Global), Shanghai (Sunqiao Modern Agriculture Development Zone) and Chengdu who used the greenhouse and hydroponic combined technology to produce tomatoes and flowers, but based on my research, all their main techniques, equipment and programs are imported from Holland, Korea, etc. They basically imported the needed equipment, structures and techniques, and then hire respective technicians from abroad to help them accommodate the imported structures and techniques to the local conditions and update the technology from time to time. Judging from the above facts, we believe the Dutch-based greenhouse technologies can be moved to Harbin, but whether it be a total import, combined investment, or foreign direct investment requires further research.

Implementation Challenges

High-tech is high-tech, efficiency is a big plus, but its high cost is always a major source of concern. Eurofresh Farm Inc., it is an entirely Dutch –based company, from computer

program, greenhouse, to accessories. In the US, all its production facilities are imported from Holland, relatively expensive but very low risk. Since this is a sure thing, the products should not be only confined to tomatoes or other common vegetables, but should also include the high-value products such as valuable flowers etc. (Tomatoes are good definitely, but they are still a small part of Chinese diet, only as appetizers or condiments in Chinese dishes.) So adding high-value plants or flowers into production is a must to bear the costs of technical imports. (e.g. Ruixue Global in Beijing grows Tulips, Evita or cutflower.)

Labor Issues

The Dutch-based advanced technology could bring about efficient and integrated production, it saves labor significantly but also put a more demanding requirement on the enrolled labor force to run the business well. As mentioned in the tech introduction, nearly all the procedures need high-ability workers to run. You have to know the heating system, you have to know the irrigation system. You have to know the ventilation system, the cooling system and as a scout you have to be equipped with the technique to tell pests problems timely. Also the main computer control software requires highly knowledgeable workers to manipulate. All these techniques need a lot of time to train or you have to hire graduates students from abroad or matured technicians from abroad. All these needs time and another big cost maybe.

One thing that sets China's and even U.S.'s education system apart from say one from Europe, the UK or Holland is they require their students as part of their program to get so many hours of practical experience and it more or less equates to about sixteen to eighteen months of practical experience before they graduate. Those are the kinds of requirements that a high-tech based industry needs, too.

Other possible opportunities

Right now Heilongjiang Province has paid a lot of attention to the production of wild blueberries. They found that the city of Yichun is selected as a primary place for the development of blueberry industry. Again the problem is Yichun has a good natural source of wild blueberries, but the culture techniques and the production technologies are far behind the advanced countries in United States and Europe.

Similar to the status of tomato and greenhouse production, we are concerned tha related technologies and techniques should be imported as a start-up in order to study and develop in the future. Blueberries are high in nutritional value and have long been in the status of supply shortage in the international market. Blueberries are also suitable for greenhouse production, and blueberries are actually naturally suitable to grow in cold

environment as Harbin, maybe this industry could also be listed in the concern of Harbin.

Conclusion

Based on our research about the typical Dutch-based greenhouse hydroponic tomato producer Eurofresh, their technology appears to be mostly transferrable to Harbin. But certain accommodation in the structure and timing of the growing should be made to make the production more localized. In addition, production should be facilitated by growing certain species of high value plants or flowers such as Tulip, Evita etc. And special concern should be paid to the relatively high labor skill requirements in order to meet the demand of the advanced growing procedures.

In addition, importing advanced cultivating techniques from U.S. and Europe to assist the wild blueberry growing province may also be a good choice out there.

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