SEED BUSINESS AS A PROMISING NEW FIELD IN CHANGING FOOD SUPPLY CHAIN

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SUMMARY

- Amid consumer needs diversifying, in the seed industry, the market-in business strategy based on consumer needs, instead of the traditional product-out approach under which development, production, and sales are pursued from the perspective of the suppliers (manufacturers and farmers), has begun to spread. This consumer oriented-style of seed business is attracting attention as a new business field.
- Advancements in plant breeding technologies have begun to give newcomers impetus to entering the seed industry.
- The vegetable segment within the seed market is likely to be the target for companies considering entry into the seed business. As for market entry methods, business participation in small- and medium-sized seed companies and providing them with the functions to improve their business value will likely become key strategies.

1. CHANGES TAKING PLACE IN THE FOOD AND AGRICULTURE SECTORS

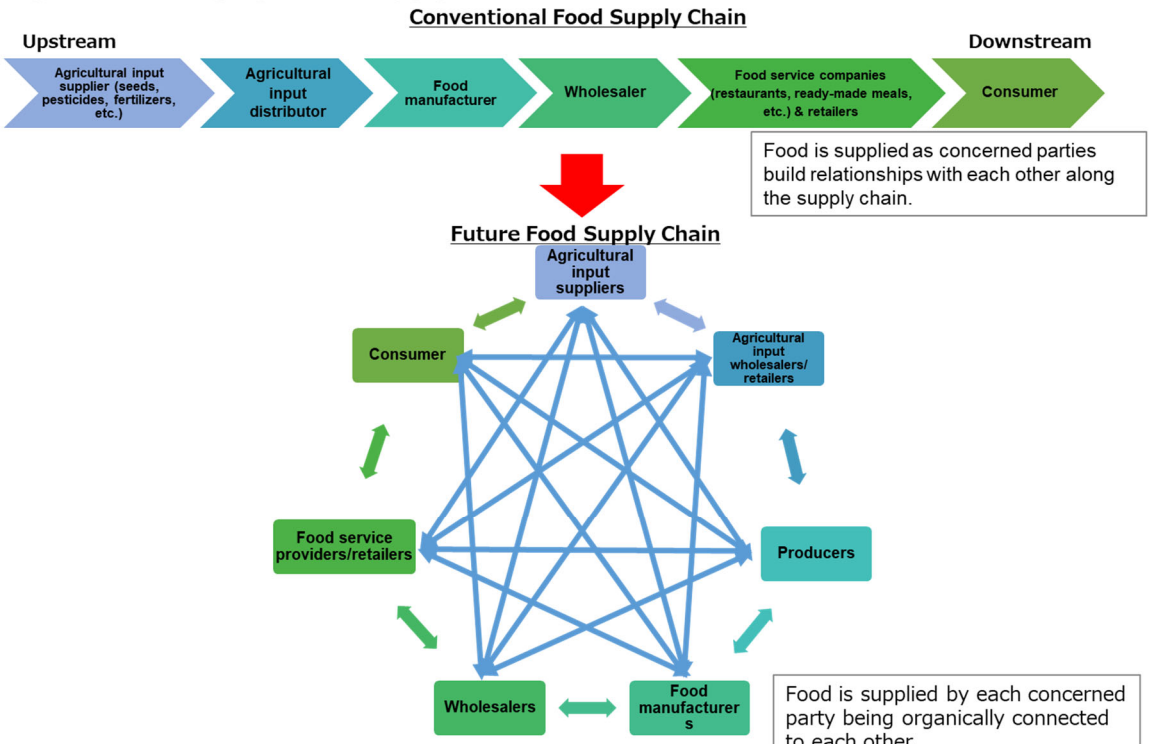
Demand Side Changes

Fundamentally, food is consumed for the purpose of sustaining life by taking necessary nutrients, such as carbohydrates, fats, proteins, vitamins, and minerals. In general, quantitative needs arise in accordance with an income rise, and once those quantitative needs are met, qualitative needs come up. Quantitative needs reflect consumers' desire to be able to enjoy eating many delicious foods, and that tends to increase demand for animal proteins, flavorings, colorings, and seasonings. Qualitative needs, meanwhile, include demand for healthier, safe, and reliable foods, as well as for contribution to a sustainable society, such as those that have been produced with low environmental impact and with consideration given to animal welfare. In recent years, qualitative needs have begun to appear in emerging countries, while quantitative needs still remain in advanced countries, suggesting that consumer demand for food is diversifying globally.

Supply Side Changes

Moves to address the diversifying needs of consumers are being seen within the food supply chain, which is the sequence of food flow beginning from agricultural input suppliers to agricultural input distributors, farmers, food manufacturers, wholesalers, retailers, through to delivery to end consumers (Figure 1). For example, the food and beverage company PepsiCo develops potato varieties and manages their production with partnered farmers for its Lay's brand potato chips. In addition to giving attention to quality assurance, the company is also responding to consumer needs by promoting the use of agricultural inputs with low environmental impact to achieve sustainability by itself, while aiming to take the initiative in the food chain.

Figure 1: Changing Food Supply Chain



Source: Created by MGSSI based on materials published by the Ministry of Agriculture, Forestry, and Fisheries, and others

Cargill, which provides food manufacturers with a wide range of foods in addition to grains, has contact with the frontline, close to consumers to strengthen its own business by identifying and responding to consumer needs For example, the company collaborates with chefs to create recipes that use Cargill brand beef, then monitors consumer reactions to the recipes to gain insight into consumer trends. In addition, in a partnership with Lindt & Sprüngli, a manufacturer and retailer of chocolate and other confectionery products, Cargill is implementing a program to supply high-quality, consumer-conscious cocoa butter products.

Under such circumstances, the seed industry, which is one of agricultural input suppliers, is also making efforts to respond to consumer needs. To date, plant breeding (development of new varieties with genetic technologies) has mainly targeted producer needs, such as increasing yields and pest resistance. Products with functional benefits for consumers have also been developed, but have been based on a product-out strategy of promoting development, production, and sales from the perspective of the supplier (manufacturer, producer). But now the evolution of breeding-related technologies has enabled plant breeding to be drastically more efficient and to be accomplished in a shorter timeframe. As such, it has gained flexibility to respond to consumer needs, the consumer-targeted seed business, based on the market-in approach that is oriented to the needs of the consumer, is starting to spread. Moreover, in the past, the seed industry required a large amount of funding and strong R&D capabilities, creating high barriers to entry, but now the evolution of breeding-related technologies has lowered those barriers. The consumer-oriented seed business, in particular, is attracting attention as a promising new business field.

2. EVOLUTION OF PLANT BREEDING-RELATED TECHNOLOGIES

Behind the technological evolution in plant breeding is the agricultural industry's utilization of technologies developed in the fields of medicine, ICT, and materials. Especially, advancements in breeding optimization are being achieved with simulation-based prediction models for breeding using big data analysis and genome editing technologies. In addition, with the use of technologies for sensing the types of substances that constitute taste and smell, food taste and smell can be digitized, and this also starts the visualization of consumer preferences with quantitative data.

Breeding Optimization Technologies

In plant breeding up until now, companies have carried out such as crossbreeding, artificial mutation, genetic recombination, using plant germplasm (all plants, including native and developed varieties) that mainly from those they themselves own. They have repeatedly carry out cultivation tests and selection by relying on the experience and five senses of breeders who specialize in plant breeding. However, even though conventional crossbreeding methods are technically straightforward, many cycles of trial and error were needed to obtain the targeted characteristic. In the case of artificial mutations as well, the breeding period has been lengthy due to the low probability of success in introducing the targeted mutation. As for gene recombination, not only adding the desired characteristic is not necessarily possible, but the time needed to obtain permission for commercial cultivation/sales is long, which ended in enormous amount of expense. Today, however, simulation-based breeding prediction and genome editing technologies have made development more efficient, allowing for a drastic reduction in development time as well as a decrease in costs. Such technological advancements are expected to shorten the breeding period from the previous requirement of about 20 years, to as short as 3–5 years.

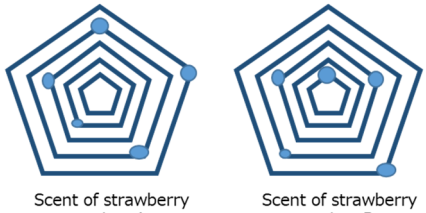
In-silico Breeding technology for performing simulation-based breeding predictions on a computer is used to accumulate not only genomic information, but also “phenotype” data of characteristics that are actually expressed, such as the sweetness of fruit, and environmental data that affect the phenotype. Big data analysis of such information allows for high-accuracy predictions of crossbreeding results and other breeding outcomes. The results of these analyses help determine what germplasm should be used and how breeding should be carried out in order to obtain the desired traits, thus making it possible to conduct plant breeding more efficiently.

In addition, genome editing can be used to mutate genes at specific target sites by introducing special restriction enzymes and repair sequences. As a result, it will become easier to acquire desired characteristics and accelerate the development of new varieties, compared to conventional methods.

Technology to Visualize Consumer Preferences

Food and fragrance manufacturers have relied on the sense of sensory panelists’ taste and smell for evaluating new products and quality. Since both objective evaluation and panelists’ training are difficult, there has been demand for a sensor with the capability to digitize taste and smell. However, what with the vast variety of taste and odor substances and the synergistic and inhibitory effects among the substances, development of such sensors has been considered a challenge. With the advancement of technologies, such as those related to semiconductors, crystal resonators, and biomimetics, sensors have been developed and brought about further digitization of taste and smell. For example, by measuring a given odor with a sensor, the odor molecule is patterned based on quantitative data of various parameters (Figure 2), and this patterned information is then combined with human sensory evaluations (five senses evaluation) to visualize a smell or taste. Traditionally, plant varieties have been selected according to the breeder's preferences, but in the future, as breeding will be carried out to reflect consumer needs, the use of digital information, including visualized information of preferences and nutritional value, will likely to promote the concept of “consumer-assisted selection,” which is the selection of varieties (products) with scents and tastes based on consumer preferences.

Figure 2: Image of Odor Molecule Patterning



Source: MGSSI

Future Developments and Points to Keep in Mind

The fusion of technologies, such as simulation-based prediction models for breeding, genome editing, taste and smell digitalization, is expected to promote innovative advancements in plant breeding oriented to consumer needs. As germplasm represent the foundation of breeding, it will become important to increase access to germplasm to ensure quality and quantity. Moreover, in order to accelerate breeding, simulation-based prediction models for breeding require the accumulation of environmental data related to phenotypes and the elucidation of the relationship between genotypes (the genetic characteristics) and phenotypes. Genome editing, meanwhile, is handled differently in each country (Figure 3) and social acceptance can become an issue, so the use of genome editing is a matter requiring thorough attention. As for the technology for visualizing consumer preferences, the digitization of taste and smell is advancing, but analyses combined with sensory evaluation and consumer information are needed to improve accuracy.

Figure 3: Handling of Genome Editing in Various Countries/Regions

Country/region	Trends related to genome editing applications
US	Crops for which foreign genes have not been introduced are exempted from the regulations for genetically modified crops.
Japan	Crops for which foreign genes have not been introduced are exempted from the regulations for genetically modified crops, but companies are required to submit notifications.
China	Currently, crops derived from the use of genome editing are treated as genetically modified crops. A working group has been established within the Ministry of Agriculture and seems to be studying how to handle the issue further.
EU	The European Court of Justice has ruled that crops derived from the use of genome editing are to be treated as genetically modified crops.
New Zealand	Technologies developed since July 29, 1998 are treated as genetic recombination technologies, including genome editing.

Source: Compiled by MGSSI based on materials issued by the governments of each country

3. CONSUMER-ORIENTED DEVELOPMENT ACTIVITIES AT SEED COMPANIES

As seed-related companies recognize the need to respond to diversifying consumer needs, they have started to approach consumers, aiming for a consumer-oriented seed business based on a market-in strategy that makes the most of advanced technologies, instead of the conventional product-out strategy. This movement is spreading not only to the biotech companies, but also to leading seed companies and startups, among others (Figure 4).

Figure 4: Consumer-oriented Development Activities at Seed Companies

Company	Business type	Advanced technologies in use	Downstream companies approached
Corteva Agriscience	Biotech company	Cooperating with companies that have technologies for simulation-based breeding prediction and genome editing	Food manufacturers, food service companies
Benson Hill Biosystems	Startup	Owns proprietary technologies for simulation-based breeding prediction and genome editing	Food manufacturers
Calyxt	Startup	Has its own genome editing technology	Wholesalers
Driscoll's	Major seed company	Makes use of digital taste and smell as well as sensory evaluation data	Retailers

Source: Compiled by MGSSI based on materials released by each company and other data

In order to accelerate the breeding process, the US company Corteva Agriscience has been actively promoting cooperation with companies that have simulation-based prediction models for breeding and genome editing technologies, and has been endeavoring to increase breeding efficiency and shorten breeding time. The company is also reaching out to the downstream, and in one example, is collaborating with an oil and fats company (a food manufacturer) to develop and supply oil with high oleic acid content and other products.

Furthermore, through a service called CoNNEXT, the company connects farmers with food manufacturers and food service providers/retailers, and supports the provision of high-quality products required by downstream players.

Another US company, Benson Hill Biosystems, has accumulated a large amount of genomic information and has developed proprietary simulation-based breeding prediction technology based on this genomic information, and is also developing genome editing technologies in-house. With a strong intention to predominate over the food supply chain, Benson Hill Biosystems acquired an upstream soybean seed company and is also cooperating with food manufacturers (food companies and food ingredient companies) to apply its proprietary technologies to develop new varieties as it sets its sights on the consumer market.

Calyxt, also a US company, has taken up the concept of “consumer-centric” and is carrying out breeding with the use of its own editing technology. Working together with wholesalers, the company developed a high oleic soybean oil for use in salad dressings or frying foods, and commercialized its first product in February 2019 in the US.

The US company Driscoll's uses consumer taste and smell data, including sensory evaluations, when breeding its strawberries, blueberries, and other berries, to provide the kind of products preferred by consumers. In connection with this, the company also collaborates with retailers, such as Walmart and Kroger, to collect consumer information and develop customized varieties for each retailer. Furthermore, in addition to its breeding activities, Driscoll’s is developing its own brands by outsourcing their production and quality control operations.

4. NEW OPPORTUNITIES IN THE SEED BUSINESS

According to the market research firm Mordor Intelligence, the seed industry market was estimated at US$59.71 billion as of 2018, expanding at CAGR of 7.9% from 2011 to 2018. The market is forecast to grow to $90.37 billion by 2024. Although the seeds harvested in a previous season can be used by the farmers themselves, the seeds play a significant role in determining the quality of agricultural products, and sales growth of high-quality seeds produced commercially is expected to continue going forward. In this respect, there are high expectations for the seed business.

A breakdown of the seed market by crop type shows that cereals (corn, wheat, rice, barley, etc.) and oilseeds (soybean, sunflower, rapeseed oil, cotton, etc.) account for roughly 70%, and vegetables account for about 15%. According to a list of the “Top 20 Global Seed Companies in 2017,” published by AgroPages, the top 10 companies — which includes biotech companies, such as Bayer-Monsanto and Corteva Agriscience, along with leading seed companies, such as Limagrain (France) and KWS (Germany) — account for approximately half of the market, and the remaining half is occupied by many small- and medium-sized seed companies.

Given such a competitive environment, the vegetable segment is considered to be the target for newcomers entering into the seed business. In the future, demand for vegetables is expected to grow in line with an increase in health consciousness and other factors. Moreover, as vegetables are high value-added products and are associated with strong consumer preferences, responding to diversifying needs will be important for securing a competitive advantage, and as such, advanced technologies will play a key role. In the cereal and oilseed markets, which are the focus of the biotech companies, the business approach being pursued places emphasis on scale, but the needs of the vegetable market are diversified and subdivided according to region and application. Therefore, if the biotech companies put focus on the vegetable market, they will need to compete in a segmented market. Moreover, because the vegetable market for them is in lower priority than that of cereals and their other operations, the vegetable segment is expected to become a market where newly entering companies can compete on a par with the biotech companies.

For market newcomers, one of the key strategies will be to target the vegetable seed market and pursue business participation in small- and medium-sized seed companies, which make up the other half of the market, or provide those companies with the functions to enhance their business value.

Specifically, we expect newcomers to enter the market in three ways. The first is by expanding their germplasm portfolios. As germplasm is essential for the development of new plant varieties, it is necessary to ensure the quantity and quality of germplasm. Since small- and medium-sized seed companies have limited germplasm, it will become important for each company to increase access to various germplasm. Therefore, newly participating companies are expected to work to accumulate a variety of excellent germplasm not only in Japan but also through foreign small- and medium-sized seed companies, build a platform for mutual use in the development of new varieties, and offer those platforms to the small- and medium-sized seed companies. They are also expected to provide support for promotion of business for the plant varieties developed using the platforms.

Next, the newcomers could promote the use of advanced technology. Small- and medium-sized seed companies face difficulties accessing leading-edge technologies due to cost issues. For this reason, the market newcomers could provide those given access to the above-mentioned development platforms, with the means to enhance R&D capabilities by promoting active use of technologies that optimize breeding or visualize consumer preferences.

Lastly, the entry into the market could be done by establishing and maintaining contact with consumers. In order to increase the business precision of the market-in strategy employed by small- and medium-sized seed companies for the consumer-oriented seed business, it may be necessary to consider entry into the food service/retailing segment, in addition to the seed business. From this point of view, bridging across the industry for food service provision/retailing and the small- and medium-sized seed companies could become another approach to market entry. By utilizing consumer data obtained mainly from the retail business, and developing and designing products that are sought by the market from the seed stage, it will become possible to realize product development based on a market-in approach quickly and efficiently. In addition, the product development that accurately captures consumer needs is also expected to have a competitive edge in the retailing sector, and on other fronts as well.

Furthermore, as potential business through which small and medium-sized seed companies could increase profits, it would be possible for the companies to provide comprehensive products and services that supplies optimal agricultural inputs to maximize the benefits from the seed characteristics of each developed seed. There are examples of seeds and pesticides being sold together as a package in order to effectively prevent disease. In the future, the companies could expand their business into a comprehensive agricultural service operation by supplying not only seeds, but also agricultural inputs, such as agricultural chemicals, fertilizers, and machinery, bundled together as a total package. In order to promote development of such packaged services, opportunities for market entry are expected to arise due to the need for intermediation between small- and medium-sized seed companies and other agricultural input companies.