LINKAGES BETWEEN AGRICULTURE AND FOOD INDUSTRY, AND FOOD PROCESSING BY FARMERS IN KOREA*

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Keywords

food system, agriculture, vertical coordination, index of power of dispersion, index of sensitivity of dispersion,

Abstract

The food industry's development is relatively closely linked with the development of upstream industries such as farming that supply raw ingredients. As a result of this study, it is proven that agriculture and the food industry are closely connected in the food system structure and input structure of agricultural products. Using an effect analysis, we confirmed that the food industry has the characteristic of having bigger backward linkage effect than forward linkage effect.

The farmers' attitude toward food processing varies from product to product. In the case of fresh agricultural products that are difficult to store long term, the ratio of farmers making use of processing to get rid of low-quality off-grade agricultural products was high. However, in the case of bean, which is easy to store long term, it was shown that farmers prefer processing since they can sell it as a raw ingredient at a higher unit price.

It is necessary to prepare measures that would allow stable procurement of raw ingredients by expanding the transaction volume through farmers' alliance. Moreover, it is necessary to build a foundation for stable production of processed foods by developing various processed food products using fresh products and by opening up new markets.

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1. Introduction

Agriculture and the food industry are closely connected industries. The food industry is usually divided into food manufacturing and the eating-out industry. Even though food manufacturing is part of the manufacturing industry and the eating-out industry is a service industry, the two industries are relatively closely related as they both require agricultural products as raw ingredients. Agriculture is the industry that supplies major raw ingredients of the food industry, and agricultural products can increase the value added through the food industry. Under such an understanding, the South Korean government established and operates the Ministry for Food, Agriculture, Forestry, and Fisheries, which oversees agriculture, forestry, fisheries, and the food industry.

The fact that agriculture and the food industry are closely connected does not mean that the food industry's development always contributes to increasing the value added of agriculture. In an industrial structure where the food industry is highly dependent on agricultural imports rather than domestic agricultural products, the food industry's development does not directly result in the development of agriculture. In order to transfer the value added created by the food industry to agriculture, the food industry should be systematically linked with agriculture. The vertical integration which coherently links agricultural production with distribution and food processing is a system that can efficiently transfer the value added created in the food industry to the production sector of agriculture. However, Korean agriculture does not have an efficient system linking agricultural production with the food industry because the industrial structure of Korean agriculture has the characteristic of being composed mostly of small family farms.

In this study, we aim to empirically analyze the current state of the Korean food industry and the linkage structure connecting the industry with agriculture. Also, we will conduct surveys and analysis to find out about the actual state of the linkage between agricultural production and food processing. Based on this, we plan to present ways of efficiently linking agriculture with the food industry and identify the tasks for improvement of farmers' income.

2. Agriculture, Food Industry, and Food System

2.1. Size of Agriculture and Food Industry

The agricultural production in 2008 was valued at 39.7 trillion won and the value added was worth 20.1 trillion won. The sales amount of the food industry in 2008 was about 120 trillion won and food manufacturing took up about 46% of that amount. The total amount of the food industry's value added was 35.5 trillion won, and of this amount, food manufacturing accounted for 58%. This indicates that food manufacturing has a higher added value ratio than the eating-out industry. Since the intermediate input ratio of agriculture is low compared to food manufacturing or the eating-out industry, its added value ratio is relatively high.

TABLE 1.   Size of Agriculture and Food Industry, 2008

in million won

	Agriculture	Food Industry		
		Food Manufacturing	Eating-Out Industry	Total
Production	39,662,638	55,211,670	64,711,923	119,923,593
Value Added	20,734,220	20,651,160	14,838,637	35,489,797

1) The sales amount and the value added of food manufacturing are calculated from the data on enterprises with over 10 employees or more.

Source: Statistics Korea(www.kosis.kr), annual data from 「Mining and Manufacturing Survey」, 「Wholesale and Retail Survey」

2.2. Concept of Food System

Food system is a concept that covers diverse activities related to food supply, including production of agriculture and fisheries, and production and distribution of food. Although the concept is defined variably by different countries and researchers, it is generally used as a concept that covers a chain of processes related to food consumption, such as production, harvesting, storing, processing, packaging, transportation, distribution, consumption, and disposal.

In a broad sense, food system is a very extensive concept that covers all industries related to food supply and economic activities of and mutual rela-

tionships among all participants in the food system from production to con-sumption, as well as various institutions and policies affecting them. In a nar-row sense, however, food system covers economic activities of food-related in-dustries and final consumers. In economic analysis, food system refers mostly to the food system in a narrow sense. The food-related industries are businesses that play an important role in the production, processing, and distribution of food. These include manufacturing and distribution of food and the eating-out industry.

As for raw ingredients of food, both domestic and imported agricultural products can be used, and imported processed foods, too, are consumed through the food system. Simple food processing, such as sorting and packaging of food, and preparation of fresh-cut, ready-to-eat foods, and food processing of processed foods, and such functions as provision of meals constitute the inter-mediate stage of the food system. The final consumers consume agricultural products as raw food or processed food or food provided by the eating-out in-dustry and meal suppliers.
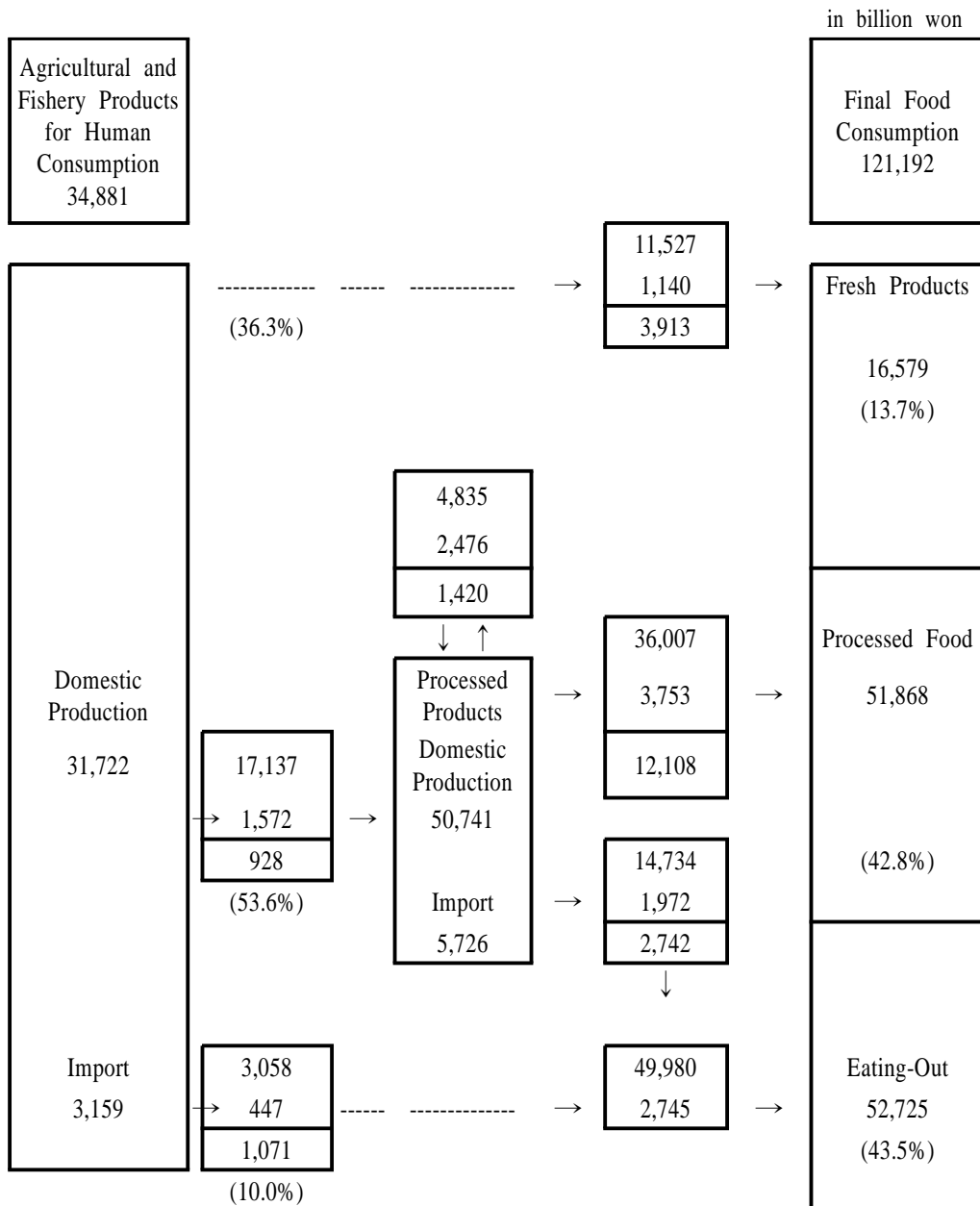
FIGURE 1. Food System: Conceptual Model
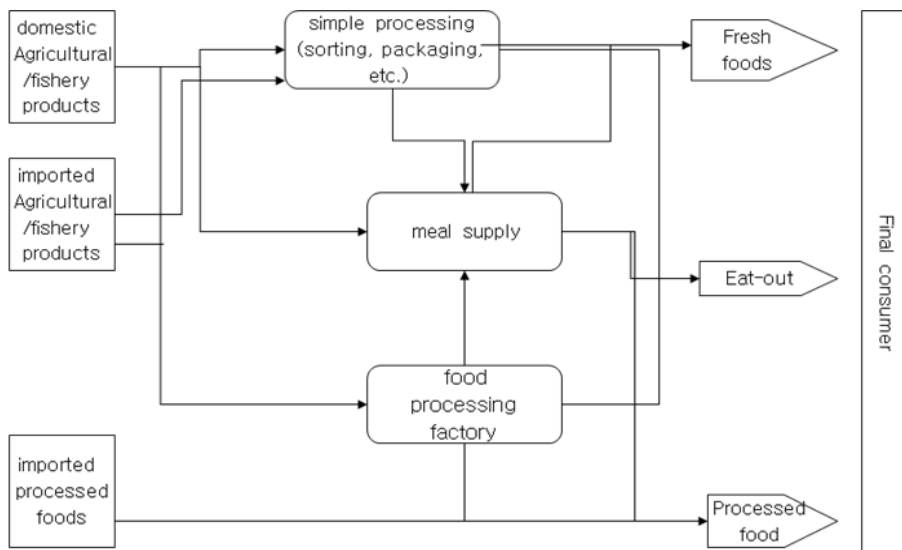
2.3. Structure of Food System

According to a study on the structure of the domestic food system based on the 2005 input-out table, the market value of agricultural and fishery products that entered the food system is 35 trillion won and the market size of final food consumption is 121 trillion won. The size of agricultural products that flowed into the food system increased by 10% from year 2000 but final food consumption was increased by 24% from 2000. What this means is that the purchased amount of intermediate goods additionally put into the food system and the amount of value added have increased rapidly.

At the entry stage where agricultural and fishery products flow into the food system, the ratio of fresh products, processed food, and eating-out was 36%, 54%, and 10% respectively. But at the final consumption stage, the ratio was 14%, 43%, and 43% respectively. When compared with year 2000, the ratio of both the entry and consumption of fresh and processed foods declined, whereas the ratio of eating-out was increased.

TABLE 3. Food System Structure in 2005

in billion won

Agricultural and Fishery Products for Human Consumption
34,881

Final Food Consumption
121,192

11,527
1,140
3,913

(36.3%)

→ Fresh Products

16,579
(13.7%)

4,835
2,476
1,420

↓ ↑

Domestic Production
31,722

17,137
1,572
928
(53.6%)

Processed Products Domestic Production
50,741

Import
5,726

36,007
3,753
12,108

→ Processed Food

51,868

(42.8%)

14,734
1,972
2,742

↓

Import
3,159

3,058
447
1,071
(10.0%)

49,980
2,745

→ Eating-Out

52,725
(43.5%)

1) Last-digit numbers may not add up due to rounding.
2) The three-row numbers represent the amount of domestic products, the amount of imported products, and distribution cost from top to bottom.

3. Linkage Structure of Agriculture and Food Industry

3.1. Final Food Consumption

The sales amount of food supplied by producers to consumers rose to 90.2 trillion won in 2007 from 86.5 trillion won in 2005. In 2007 the amount of agricultural and fishery products that were sold by producers to final consumers was 14.3 trillion won and the sales amount of processed food was 34.8 trillion won. The production amount of the eating-out industry increased continuously from 2005 to 2007 to about 41 trillion won in 2007.

TABLE 4. Final Food Supply Trend

in million won

Year	Agricultural and Fishery Products	Processed Food	Eating-Out	Total
2005	13,169,256	35,178,478	38,108,176	86,455,910
2006	12,889,494	33,662,253	39,139,779	85,691,526
2007	14,258,769	34,752,616	41,157,763	90,169,148

Source: The Bank of Korea, the annual input-output tables

3.2. Food Industry's Input Structure of Agricultural and Fishery Products

The producers' sales amount of domestic agricultural, livestock and fishery products flowing into the food industry is increasing gradually and it stands at about 17 trillion won as of 2007. The producers' sales amount of agricultural, livestock and fishery products that flowed into the eating-out industry is about 10.5 trillion won and the producers' sales amount of the products put into food manufacturing stands at about 6.5 trillion won. The size of imported agricultural products that were directly put into food manufacturing was about 2.2 trillion won in 2007. The producers' sales amount of agricultural products that flowed into the food industry was 7.4 trillion won in 2007. Of this amount, agricultural products worth 5.1 trillion won were supplied to the eating-out industry. Also, livestock products were supplied to food manufacturing and the eating-out in-

dustry in the amount of 2.1 trillion won and 4.2 trillion won respectively. In the case of fishery products, the amount supplied to food manufacturing and the eating-out industry was 2.1 trillion won and 1.2 trillion won respectively.

TABLE 5.   Food Industry's Input Structure of Agricultural/Fishery Products

in million won

		Livestock Processing	Fishery Processing	Grain Processing	Fruit and vegetable processing	Seasoning	Other Food	Beverage	Eating-out	Total
A*	05	33,786	2,452	374,383	617,886	318,543	589,856	79,299	4,486,129	6,502,334
	06	33,168	1,962	394,453	754,857	320,855	572,865	80,008	5,324,228	7,482,396
	07	29,720	1,936	387,155	873,704	311,446	597,404	62,389	5,122,163	7,385,917
L*	05	1,702,780	4,316	116,903	208	145,592	122,870	12,303	4,008,464	6,113,436
	06	1,664,957	3,553	141,433	393	154,316	124,910	10,992	4,184,975	6,285,529
	07	1,690,718	3,596	127,116	342	160,091	126,903	9,624	4,227,019	6,345,409
F*	05	259	1,851,532	1,311	0	2,989	17,773	0	807,060	2,680,924
	06	335	1,915,891	1,589	0	3,795	21,880	0	1,082,107	3,025,597
	07	365	2,085,464	1,557	0	4,434	24,266	0	1,166,756	3,282,842
TOTAL	05	1,736,825	1,858,300	492,597	618,094	467,124	730,499	91,602	9,301,653	15,296,694
	06	1,698,460	1,921,406	537,475	755,250	478,966	719,655	91,000	10,591,310	16,793,522
	07	1,720,803	2,090,996	515,828	874,046	475,971	748,573	72,013	10,515,938	17,014,168

*The capital letters "A," "L," and "F" on the far left stand for "agricultural," "livestock," and "fishery" products respectively.
1) Since the input-out tables of 2006 and 2007 do not provide the transaction table at purchaser's price, the supplied amount was calculated based on the transaction table at producer's price.
Source: The Bank of Korea, the annual input-output tables

3.3. Production Inducement Effect of the Food Industry

The extent to which an industry buys the products of other industries as intermediate goods is called backward linkage effect and the extent to which the products of an industry are sold as intermediate goods to other industries is called forward linkage effect.

Two of the indicators that show the size of forward and backward link-

age effects are the index of power of dispersion and the index of sensitivity of dispersion. The index of power of dispersion is calculated by dividing the row sum of production inducement coefficients of an industry by the average production inducement coefficient of whole industries, and the index of sensitivity of dispersion is calculated by dividing the column sum of production inducement coefficients of an industry by the average production inducement coefficient of whole industries (Bank of Korea 2008a). The index of power of dispersion(e_j) and the index of sensitivity of dispersion(r_j) of industry j are calculated by the following formula.

$$e_j = \frac{\sum_{i=1}^{n} b_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}/n}, \quad r_j = \frac{\sum_{i=1}^{n} b_{ji}}{\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ji}/n}$$

B_{ij} = production inducement coefficient of industry j on industry i

It can be said that if the index of power of dispersion and the index of sensitivity of dispersion are bigger than 1, the linkage effect is larger than whole industry average. However, if the indices are smaller than 1, the linkage effect is smaller than industry average. In this study, the index of power of dispersion and the index of sensitivity of dispersion are calculated from the domestic production inducement coefficient table derived from the 168 sector input-output tables of 2000 and 2005.

The index of power of dispersion of the food industry is showing similar patterns in year 2000 and 2005. It was shown that meat, processed meat, dairy products, processed fishery products and milled grains have larger backward linkage effect than industry average as their index of power of dispersion is bigger than one. In the case of milling and sugar manufacturing, the backward linkage effect is shown to be smaller than industry average as their index of power of dispersion is smaller than one.

FIGURE 2. Index of power of dispersion of Food Industry (Backward Linkage Effect)
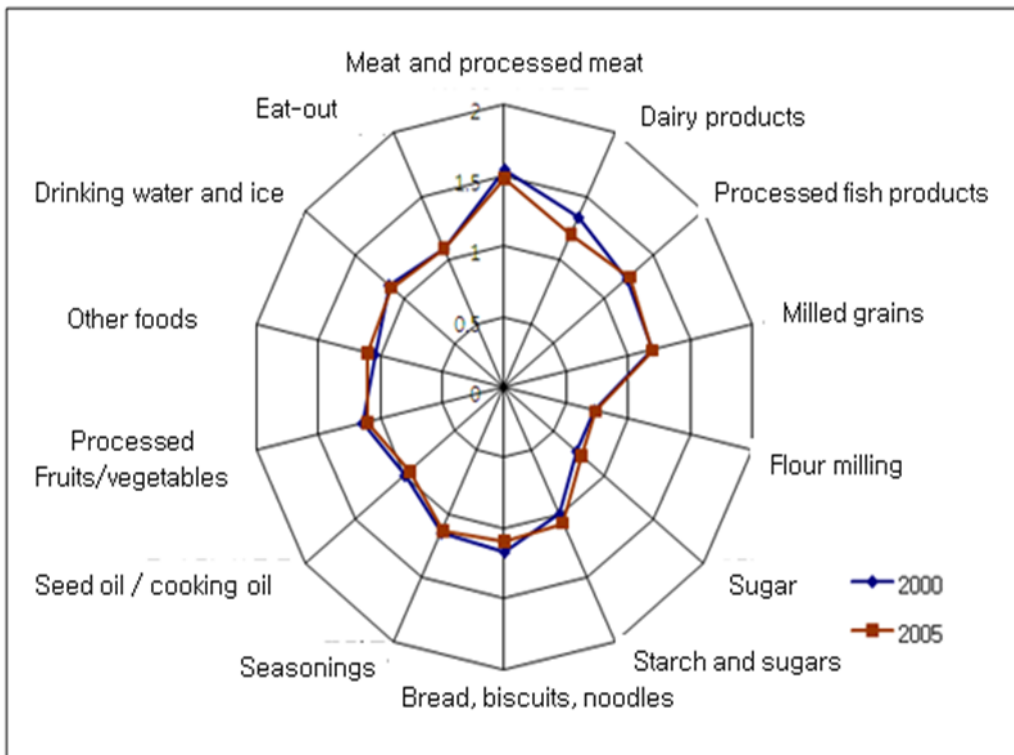
In the case of the index of sensitivity of dispersion, similar patterns are observed between year 2000 and 2005. Also, it was shown that the index of sensitivity of dispersion of eating out is more than twice the industry average, whereas the index of sensitivity of dispersion of other industries was smaller than one. It is thought that this outcome is the result of a low ratio of manufactured foods consumed as intermediate goods because the manufactured food consumption ratio in the final consumption stage is high. In the case of the eating-out industry, it is thought that the index of sensitivity of dispersion was shown to be high because the industry has the effect of inducing production in many industries other than the industries within the food system.

FIGURE 3. Index of sensitivity of dispersion of Food Industry (Forward Linkage Effect)
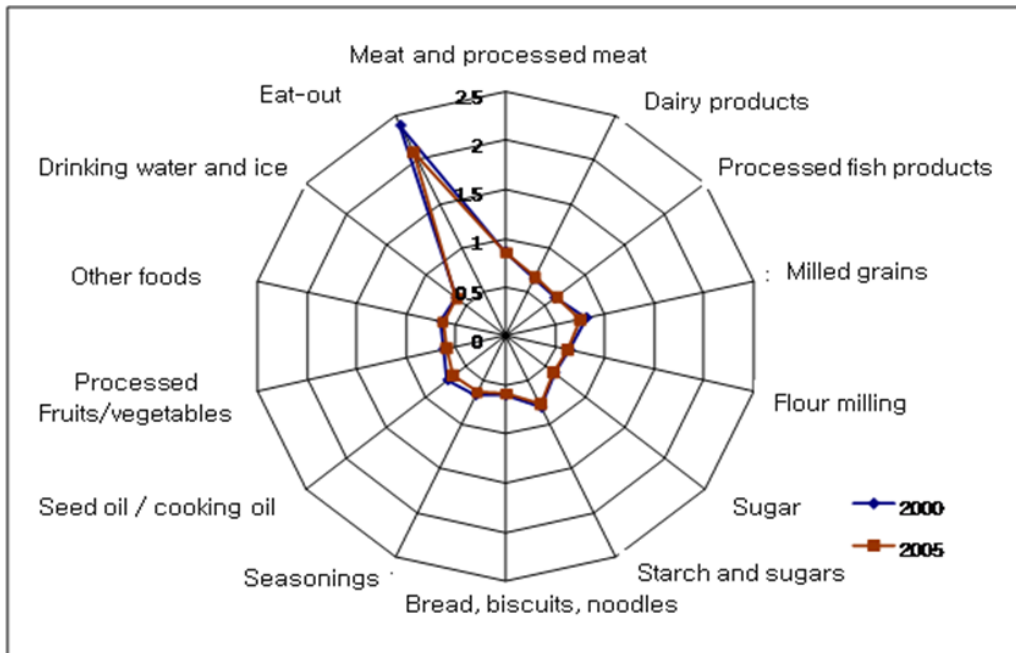
4. State of Farmers' Supply of Raw Ingredients for Processing

4.1. Survey Overview

The linkage of agriculture with the food industry can be classified broadly into vertical integration and supply of raw ingredients. Therefore, this study conducted a survey on the state of processing businesses of farmers and agricultural cooperatives and the state of supply of agricultural products as raw ingredients. The items selected for this survey are items that have relatively diverse processed food varieties and whose processing business is active enough to identify the state of various aspects of the linkage between agriculture and the processing industry with a small sampling. Also, the items were chosen because the extent to which the items are distributed in the wholesale market is relatively low. The livestock products beef, pork and chicken were excluded from the survey because they have the characteristic of being sold by farmers to slaughterhouses only as they are handled by affiliated organizations and dis-

tributors afterwards, thus making it difficult to identify the state of linkage with the processing industry through a survey of farmers.

The surveyed items are mandarin orange, strawberry, grape and bean, and 100 farm households were surveyed for each item. In the case of mandarin orange, it has characteristics dissimilar to the characteristics of grape which is cultivated across the country. It is relatively easy to control the production of mandarin orange since the cultivation region is limited and its processing industry, which is backed by the local government, is advanced. The average cultivated land of strawberry, mandarin orange, grape, and bean is 0.6ha, 1.4ha, 1.0ha, and 2.5ha respectively.

TABLE 6. Number of Surveyed Farm Households and Average Farmland Size

	Strawberry	Mandarin	Grape	Bean
No. of surveyed farm households	98	99	98	101
Average farmland(ha)	0.6	1.4	1.0	2.5

4.2. Survey Results

The ratio of agricultural products used for processing by producers themselves or the food processing industry was found to be 3% in the case of strawberry, 15% for mandarin orange, 5% for grape and 19% for bean. The ratio of product shipment for processing is high in the case of mandarin orange, and the ratio of self-processing by producers is high in the case of bean.

TABLE 7. Ratio of Producer Processing and Industry Processing

unit: %

	Producer Processing	Industry Processing	Total
Strawberry	1.2	1.8	3.0
Mandarin	3.0	12.0	15.0
Grape	3.0	2.0	5.0
Bean	13.4	5.4	18.8

From the standpoint of farmers, the biggest benefit they could gain from shipping raw ingredients to the food processing industry is that they could

dispose of off-grade products in the case of fresh agricultural products such as strawberry, mandarin orange, and grape. In the case of bean, however, the most advantageous feature was that it could be sold at a higher unit price than it would get from disposing it as "off-grade." In the case of fresh agricultural products, off-grade products which cannot be marketed as top-grade products are used mostly as raw ingredients for processing. In the case of bean, however, it shows the characteristic of being used as the main raw ingredient to produce high-quality processed products.

From the standpoint of farmers, the other benefit of supplying their products for processing as raw ingredients is that it is possible to sell them in large volumes continuously under a plan. In the case of mandarin orange, the farmers' perception that the product can be sold at a high unit price was shown to be the lowest, and this implies that the price received for selling the product as raw ingredient for processing is low relative to the price received for selling it directly to final consumers.

TABLE 8. Benefits of Supplying Raw Ingredients for Processing

unit: %

	High unit price	Off-grade selling	Selling in large volumes	Planned selling	Opening up of new markets
Strawberry	16.7	42.4	12.1	25.8	3
Mandarin	4.3	49.3	15.7	28.6	2.1
Grape	24.5	39.8	14.3	18.4	3.1
Bean	41.4	1.0	11.1	39.4	7.1

In the case of farmers producing strawberries and mandarin oranges, the biggest problem is shown to be low price of the products when selling them as raw ingredients for processing (56.3%, 73.7%). In the case of grape, the ratio of farmers who perceive low unit price as the problem is high, but the ratio is lower than that of strawberry and mandarin orange farmers and their satisfaction level of shipping grapes as raw ingredients for processing is shown to be generally high. In the case of bean, the ratio of farmers who perceive the higher cost of initial investment for bean as the problem was high.

TABLE 9.   Problems of Supplying Raw Ingredients for Processing

unit: %

	Low unit price	Strict standards	Contract nonfulfillment	Payment Delay	Unfair Contract	Initial investment
Strawberry	56.3	4.2	-	8.3	-	6.3
Mandarin	73.7	-	5.1	-	4.0	1.0
Grape	13.4	-	-	1.5	1.5	3.0
Bean	13.1	4.9	-	3.3	1.6	13.1

One important reason for not supplying agricultural products as raw ingredients for processing was that it is not difficult to sell them in their original shape, and the ratio of farmers who cited this as the reason was high in the case of fresh fruits and vegetables. In the case of bean, however, it was revealed that nearly half of the farmers have the intention to supply them as raw ingredients but they have not secured clients.

TABLE 10.   Reasons for Not Supplying Raw Ingredients

unit: %

	No need	No clients	Low unit price	Large volume	Stringent conditions	Experience of loss
Strawberry	55.1	20.4	16.3	6.1	2	-
Mandarin	71.4	14.3	14.3	-	-	-
Grape	46.4	15.9	33.3	-	-	4.3
Bean	24.5	49.0	8.2	10.2	4.1	4.1

5. Conclusion

It is proven that agriculture and the food industry are closely connected in the food system structure and input structure of agricultural products. Using an effect analysis, we confirmed that the food industry has the characteristic of having bigger backward linkage effect than forward linkage effect. In other words, the food industry's development is relatively closely linked with the develop-

ment of upstream industries such as farming that supply raw ingredients. In view of such characteristics of industrial structure, we think that promoting mutual development of agriculture and the food industry through linkage is a sound direction for development.

The farmers' attitude toward food processing varies from product to product. In the case of fresh agricultural products that are difficult to store long term, the ratio of farmers making use of processing to get rid low-quality off-grade agricultural products was high. However, in the case of bean, which is easy to store long term, it was shown that farmers prefer processing since they can sell it as raw ingredient at a higher unit price.

The farmers' attitude toward food processing is linked with consumers' preference in addition to physical characteristics of agricultural products. In the case of bean, relatively diverse products are on the market using domestic bean as ingredient, such as tofu and fermented seasonings, and consumers' preference of processed bean products is high. In the case of fruits and vegetables, however, processed products are not diverse and consumers' preference of such products is not high compared to the bean products. In other words, it can be said that if there is an increase in consumers' preference of processed products as a result of multi-faceted efforts to expand the market, it can be directly linked with improving the income of farmers who produce the raw ingredients.

In the case of bean, it was revealed that farmers have difficulty finding right buyers although they want to sell it as raw ingredient for processing. In the case of such agricultural product whose processed food market is relatively well-developed, it is necessary to reinforce the marketing ability through farmers' alliance and exert diverse efforts to secure new buyers.

In the case of fresh agricultural products, it was shown that there is a strong understanding to sell high-quality products in the original shape at a relatively high unit price and use low-quality products that are difficult to sell in the original shape as raw ingredient for processing. However, there is this aspect at the farm household level that it is difficult to secure raw ingredients that are sufficient enough to produce processed food products. Therefore, in the case of fresh agricultural products, too, it is necessary to prepare measures that would allow stable procurement of raw ingredients by expanding the transaction volume through farmers' alliance. Moreover, it is necessary to build a foundation for stable production of processed foods by developing various processed food products using fresh products and by opening up new markets.

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