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Determinants of the Product Innovation Implementation in Japanese Agricultural Corporations

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Abstract

Innovation is considered as an important component of productivity growth and is expected to more contribution in changing of rural and agricultural structure. However, the driven factors of innovation implementation that were supposed as the first step to understand the innovation implementation were unclear in agricultural corporation. Therefore, the objective of this study is to identify the factors associating with the product innovation implementation in Japanese agricultural corporations. Probit model was used to identify these driven factors by using the data of 308 corporations from the national survey in 2019. The results showed that 20.5% (n=63) of corporation was rice corporation, and sales as an economic scale indicator, corporations with the annual scale of 100 to 300 million accounted the most with 38.6% (n=119). The implementation rate of product innovation that is defined by a corporation started to produce and sales of new or significantly improved goods or products, and/or launched new or significantly improved services was 50.0%. The results also found that determined high annual sales and determined target sales, determined target profit margin, and the corporations who believe more strongly in their ability to develop the new technologies tend to implement the product innovation. While the corporations with the profit margin in a range of 1-10% tend to reduce the probability of product innovation implementation compared to the corporations at break-even point, and the corporations with the main product were facility vegetable, or livestock tend to not implement the production innovation compared to the corporations with the main product were rice. These results imply that the suitable annual sales for the innovation might exist, and the innovative farms are looking for their growth and have feasible plans. Therefore, to promote product innovation in Japanese agricultural corporations, these factors should be noticed.

Keywords: agricultural innovation adoption, Japanese agricultural corporation, product innovation implementation

Introduction

Japanese agricultural management has been described as smaller in scale compared to Europe and the US. However, when we focus on agricultural corporation management, its agricultural management economic share on an economic scale of over 500,000 Euros (percentage of the total economic scale of all agricultural management) is almost at the same level as Germany and higher than Switzerland, France, Spain, and Italy (Nanseki, 2019, p. 337). In such agricultural corporation management, aside from the introduction of ICT in production management and business management, innovations such as processing and direct sales of agricultural goods that were produced are being promoted. Such innovations in agricultural management may have a significant impact on agricultural and rural structures in the future. Nanseki (2021) showed basically the status of innovation implementation in Japanese agricultural corporations by 12 categories of four types of innovation that are product, process, marketing, and organizational innovations as classified by OECD (2005). All of them were adopted by less than 50% of agricultural corporations, especially, “starting the production and sales of new or significantly improved goods or products”, belonged to product innovation, is implemented by the largest proportion of the corporations with 41.9%.

Therefore, it is important to understand the driving factors of implementing these innovations to enhance the innovation implementation rate that implies on the agricultural structure changes. Factors associated of agricultural innovation adoption at micro level with individual technologies as a proxy for agricultural innovations have been reviewed by Feder et al. (1985). Moreover, recent years, factors associated with agricultural innovation adoption that is treated as overall innovation adoption have been shown by L äpple et al. (2015) and Castillo-Valero et al. (2021). However, based on our limited knowledge, there is no studies on the factors associating with agricultural innovation adoption as the overall innovation that is not specified the individual innovations in Japanese agricultural corporations. Moreover, among four types of innovation, product innovation is adopted by the most of Japanese agricultural corporations (Nanseki, 2021) as well as among Japanese firms (OECD, 2009). Therefore, the objective of this study is to determine the factors associating with the product innovation implementation in Japanese agricultural corporations.

The next section is data and methodology that expressed the source of data and empirical model with description of all variables were used. Results and discussion section were followed to present the general information of Japanese agricultural corporation as well as the factors contributed to enhance the implementation rate of product innovation. The final section is conclusion.

Data and methodology

Data

The data of this study was based on the results of the questionnaire survey: “Questionnaire on Business Development and Innovation in Agricultural Corporation Management conducted by the authors in 2019 through the mailing method on agricultural corporations nationwide. The questionnaires were sent to 2,885 corporations that were identified through an independent search of agricultural corporation names as they appear on websites (Japan Association of Agricultural Corporations, etc.) or relevant literature. By December of the same year, responses were received from 505 corporations (response rate: 17.5%). However, the number of valid answers for each item varies. The outline and basic survey results is shown in Nanseki (2021). Although, the total number of corporations response on the question of product innovation that included two categories are starting the production and sales of new or significantly improved goods or products and launching new or significantly improved services were 504 and 505, respectively. However, the number of valid observations with the available data of all the variables used for analysis of this study was 308.

Empirical model

Also, this study used Probit model to determine the product innovation implementation as following:

$$Y^* = \beta_0 + X\beta + e \quad (1)$$

$$\text{with } Y = 1 \text{ if } Y^* > 0 \text{ and } Y = 0 \text{ if } Y^* \leq 0$$

In which: Y^* is an unobserved variable or latent variable; Y is an observed variable of Y^* , $Y=1$ if the corporation implemented product innovation that means that the corporation started to produce and sales of new or significantly improved goods or products, and/or launched new or significantly improved services, 0 otherwise. X is the full set of explanatory variables that included a range of characteristics of agricultural corporations: for example, major crop, sales and profit, self-evaluation of strongness and weakness of corporation on developing new technologies, profile of corporation representative, and so on (Table 1.); β is a set of parameters. e is independent of X and has the standard normal distribution.

Table 1 Description of variables

Results and discussion

Characteristics of the Japanese agricultural corporation and its implementation of

product innovation

The result of basic analysis showed that the implementation rate of product innovation of the Japanese agricultural corporation was 50.0% (n=154) (Table 2). This rate means that 50.0% of corporations started to provide at least one of the two following types of product innovation that are new or significantly products and services in the 3 year before survey. More details of distribution of corporations implemented product innovation by its category showed in Appendix 1.

Table 2 Descriptive results of product innovation implementation and explanatory variables

Regarding the characteristic of agricultural corporation shown in Table 2, it is noticed that some common characteristics are as follows. 86.1% of corporations was in form of stock company and limited company that were established based on the Companies Act. 89.9% of corporation was agricultural land ownership qualified corporations. Although agricultural corporations were established based on various backgrounds, especially having from the non-agricultural sectors joining in the agriculture recently, 41.6% of corporations still had a background based on single farmer established a single corporation, followed by 28.6% of corporations based on a background of being a farmer and jointly established cooperation with other members. Regarding sales as an economic scale indicator, corporations with 100 to 300 million yen had the highest percentage at 38.6% (n=119), followed by corporations with sales of 50 to 100 million yen with 22.7% (n=70). Together with corporation with sales less than 50 million yen, 78.9% of corporations had sales amount less than 300 million yen. However, 85.3% of corporations targeted their sales in next 5 years of increase at least 1.2 times comparing to the current sales. This promised that there will be a significant structure change in sales in the future. Regarded profit margin target, corporation targeted to get their profit margin from 5-10% accounted for the largest proportion with 33.8%, followed by the scale from 10-15%. Additionally, the type of corporation in term of main product that have the total annual sales accounts at least 60.0% in total sales, 20.5% (n=63) of corporation was rice corporation, followed by house vegetable and mixed farm with 14.3 and 11.7% (n= 44 and n=36), respectively.

Especially, this research focused on the implementation of product innovation of the corporation. Therefore, the corporation was asked about their self-evaluation on the strength and weakness in new product and technology development. The result showed that their self-evaluation was 2.805 with the scale ranged between 1 (weaker than others) and 5 (stronger than others). It means that on average they evaluated their ability in developing new products and technologies being lower than the level of neither weaker nor stronger than others. There was 22.4% of them evaluated their self-ability was stronger than others in developing new products

and technologies.

Regarding to the characteristics of the representative of corporation in term of age, various types of education, and non-agricultural experience, the age of representative: varied from 20 to more than 70 years old with the largest contribution of 60-70 was 35.7%. Education was analyzed by variety level of educations that the representative graduated. The results showed that the representative of corporation graduated high school, vocational school, educational institution, junior college, university, graduated school and other type of education reach 53.2%, 9.4%, 14.3%, 4.9%, 32.1%, 3.2%, 2.6%, respectively. Lastly, 75% of them had at least 1 year experiencing in non-agricultural activities.

Factors associating with the product innovation implementation

The objective of this research is to unfold factors driving the implementation of production innovation of Japanese agricultural corporations by the characteristics of agricultural corporations and the profile of corporation representative. The results showed in Table 3.

Table 3 Factors associating with product innovation implementation

Firstly, the value of likelihood ratio chi-square was 116.2, significant at the 1% level that shows that the current estimated model is statistically significantly better than a model without any explanatory variables. The model had Pseudo R^2 of 0.277 and correctly classified 72.9%.

Secondly, factors associating with the product innovation implementation of the Japanese agricultural corporations were identified in Table 3. The sign of coefficients showed the relationship of that variable and the innovation implementation. If the sign of a coefficient is positive, it means that one unit increase of that variable will increase the probability of implementing the product innovation in agricultural corporations. Conversely, if the sign of a coefficient is negative, it means that one unit increase of that variable will reduce the probability of implementing the product innovation. However, in this study all continuous variables are non-significant while the categorical variables were transformed to dummy variables and are expressed conditional on the base group that are the first group in its category. In detailed, this study found that the coefficients of annual sale amount of three categories are from 300 – 500 million yen, from 500-1000 million yen and from 2 billion yen and above were significantly positive (Table 3). It means that the corporations with the sales amount from 300 million yen to less than 1 billion yen, and from 2 billion yen and above tend to increase the probability of product innovation implementation compared to the corporation had the sales amount less than 30 million yen. From this result, higher annual sales amount of the corporation as an economic scale factor contributed to their more likelihood of innovation implementation. This finding was considered as a consistency with the finding of L äpple et al. (2015) who found that a farm with larger farm size measured by utilizable agricultural area tend to more implementing innovation. However, our finding was not supported by all higher levels of annual sales

Additionally, the coefficients of target sales of four categories are 1.5 times, 1.8 times, 2.0 times and from 3.0 times and above were significantly positive (Table 3). This means that the corporations targeted their sales in next five years were higher from 1.5 times comparing the current sales tend to adopt the product innovation compared to the corporations planned to remain their current business, except for corporations having target sales of above 2 times to less than 3 times. Moreover, the coefficients of target profit at 5-10% and from 10-15% were significantly positive too (Table 3). This result mean that the corporations with the target profit margin of 5-15% tend to implement the product innovation compared to the corporations at break-even point. The last factor with the significantly positive coefficient was self-evaluation in new product and technology development (Table 3). It means that the corporations who self-evaluated that they more strongly in their ability to develop the new technologies tend to implement the product innovation. This finding was reasonable because the corporation was strong in ability to develop new product and technologies, they could pursue their own products and they were more engaged in innovation activities (Sauer & Vrolijk, 2019).

In contrast to above factors, the coefficients of profit margin from 1-5% and from 5-10% were significantly negative. This shows that the corporations with the profit margin in a range of 1-10% tend to reduce the probability of product innovation implementation compared to the corporations at break-even point. The coefficients of main product at facility vegetable and livestock production were significant negative as well. This implies that the corporations with the main product were facility vegetable, or livestock tend to not implement the production innovation compared to the corporations with the main product were rice.

These above results showed that all factors associated with the implementation of production innovation belonged to the characteristics of the corporation while there are no significant factors related to the representative of the corporation. Especially, age of representative did not effect on the product innovation implementation in the corporation when aging population is the most concern in Japanese agriculture. This result was in contrast with the results of previous studies (L äpple et al., 2015; and Feder et al., 1985) who found that older farmers tend to less adopt agricultural innovations and technologies because they considered the time in investment in innovation and a payoff of that innovation might be not effective at their age. Our result showed that the age of representative is not a problem with the corporation because the corporation could continue easier their business (MAFF, 2019).

Conclusion

In summary, product innovation is implemented by 50.0% of the Japanese agricultural corporation. They are continuing increased in the numbers because of their easier employment and business continuation (MAFF, 2019) and made the changing of the agricultural structure. Especially, the implemented rate of product innovation of the Japanese agricultural corporations

tends to increase in the corporations with sales from 300 million yen to less than 1 billion yen and with sales from 2 billion yen and above. The corporations with their target sales of from 1.5 times except for 2 times to less than 3 times tend to implement the product innovation compared to the corporations planned to remain their current business. The corporations with the target profit margin of 5-15% tend to implement the product innovation compared to the corporations at break-even point.

These results imply that: (1) the suitable annual sales for the innovation might exist; (2) the innovative farms are looking for their growth and have feasible plans. Therefore, to promote product innovation in Japanese agricultural corporations, these factors should be noticed. To be more concisely conclusion of the factors associating with the agricultural innovation implementation, in the future, it will be expanded to the rest types of innovation (process, marketing, and organizational innovations).

Author contributions

All listed authors have contributed on this manuscript. Nguyen Thi Ly carried out the study's design, statistical analysis and drafted the manuscript. Nanseki Teruaki designed the questionnaire, assisted to collect data, supplied data source, carried out the study' design, advised the data interpretation and edited the manuscript. Chomei Yosuke designed the questionnaire and assisted to collect data, assisted the study' design, advised the data interpretation and edited the manuscript. Uenishi Yoshihiro and Mi Jie assisted the study' design, advised the data interpretation and edited the manuscript. All authors have read and approved the final manuscript.

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Appendix 1 See Table 4.

Table 4 Distribution of corporations implemented product innovation (PI) by its category

Category	Description	Frequency	Percent
PI_only product	1 if a corporation started to provide only new or significantly products, 0 otherwise	105	34.1
PI_only_services	1 if a corporation started to provide new or significantly services, 0 otherwise	16	5.2
PI_both product and service	1 if a corporation started to provide both new or significantly products and services, 0 otherwise	33	10.7
PI_None	1 if a corporation had not yet started to provide both new or significantly products and services, 0 otherwise	154	50.0
Total		308	100.0

Source: Nanseki, 2021; n = 308

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List of Tables

Table 1 Description of variables

No	Variables	Description	Unit	Expected sign	Reference
I	Dependent variable				
	Product innovation (PI)	1 if a corporation started to produce and sales of new or significantly improved goods or products, and/or launched new or significantly improved services in the 3 year before survey, 0 otherwise	Dummy		
II	Independent variables				
1	Type of corporation	There are 4 types: 1 = Limited company; 2 = Stock company; 3 = Agricultural producer's cooperative corporation; 4 = Others	Categorical	+/-	
2	Own land	1 if a corporation qualified to own farmland, 0 otherwise	Dummy	+	
3	Region	Region where the head office is located. There are 7 regions: 1 = Hokkaido; 2 = Tohoku; 3 = Kanto; 4 = Hokuriku; 5 = Kinki and Tokai; 6 = Chugoku and Shikoku; 7 = Kyushu and Okinawa	Categorical	-	
4	Age of corporation	Numbers of years the corporation was established	Years	+/-	Ns: (Castillo-Valero & Garc ía-Cortijo, 2021)
5	Agricultural experience of corporation	Numbers of years the corporation started engaging in the agricultural activity	Years	+/-	
6	Background of corporation	There are 7 categories: 1 = Is a farmer established a corporation only one member/single corporation; 2 = Is a farmer and jointly established a cooperation with other members; 3 = Is a Farmer and has established corporations in collaboration with non-farmers and companies from other industries; 4 = Is a Non-farmer entered agriculture as individuals and established a corporation; 5 = Your company's main business is a separate/different business, but you have entered agriculture as a new business; 6 = Your parent/main company or group company has established a new corporation and entered agriculture; 7 = Others	Categorical	+	+ cooperative (Castillo-Valero & Garc ía-Cortijo, 2021)
7	Regular employees	The total number of regular employees	persons	+	(Castillo-Valero & Garc ía-Cortijo, 2021); (Hashi & Stojčić, 2013) as

8	Annual sales	Sales amount for the latest settlement of accounts before survey: 1 = Less than 30 million yen; 2 = 30 - 50 million yen; 3 = 50 - 100 million yen; 4 = 100 - 300 million yen; 5 = 300 - 500 million yen; 6 = 500 - 1000 million yen; 7 = 1000 - 1500 million yen; 8 = 1500 - 2000 million yen; 9 = from 2000 million and above	Categorical	+	firm size + (Läpple et al., 2015) in term of farm area
9	Profit margin	Profit margin in latest accounts before survey. 1 = 0% (Break-even); 2 = 1-5%; 3 = 5-10%; 4 = 10-15%; 5 = 15-20%; 6 = From 20% and above; 7 = Deficit	Categorical	+/-	
10	Growth stage	Growth stage of the corporation. 1 = Starting; 2 = Growing; 3 = Mature; 4 = Recession; 5 = 2 nd starting; 6 = 2 nd growing; 7 = 2 nd mature; 8 = 2 nd recession; 9 = Others	Categorical	+/-	
11	Sales target	Amount of sales target in next 5 years: 1 = Remain as the current; 2 = 1.2 times; 3 = 1.5 times; 4 = 1.8 times; 5 = 2.0 times; 6 = Above 2.0 times or less than 3 times; 7 = From 3 times and above; 8 = Decreasing; 9 = There no target	Categorical	+	
12	Profit margin target	Profit margin target in next five years. 1 = 0% (Break-even); 2 = 1-5%; 3 = 5-10%; 4 = 10-15%; 5 = 15-20%; 6 = From 20% and above; 7 = There is no target	Categorical	+/-	
13	Main product	Types of corporation by main agricultural product that accounted more than 60% of annual sales. There are 14 categories: 1 = Paddy rice; 2 = Wheat; 3 = Beans and coarse cereals; 4 = Open ground vegetable; 5 = Facility vegetable; 6 = Flowers and foliage plants; 7 = Fruiter; 8 = Mushroom; 9 = Livestock production; 10 = Others; 11 = Mixed	Categorical	+/-	
14	Self-evaluation in new product and technology development	Self-evaluation of the "strengths" and "weaknesses" of the corporation in new product and technology development. 1 = Weaker than others, 2 = Slightly weaker than others, 3 = Neither weaker nor stronger than others; 4 = Slightly stronger than others; 5 = Stronger than others	Likert scale	+	
15	FTA participation	Overall evaluation towards the Free Trade Agreements (FTA) participation of Japan. 1 = Big crisis, 2 = Crisis, 3 = Neither a crisis nor a	Likert scale	+/-	

16	Age of representative	chance, 4 = Chance, 5 = Big chance The age of the representative of the corporation. 1 = 10-20; 2 = 20-30; 3 = 30-40; 4 = 40-50; 5 = 50-60; 6 = 60-70; 7 = more than 70	Categorical	-	(Läpple et al., 2015), (Feder et al., 1985);
17	High school	1 = if a corporative representative graduated high school, 0 otherwise	Dummy	+/-	
18	Vocational school	1 = a corporative representative graduated vocational school, 0 otherwise	Dummy	+/-	
19	Educational institution	1 = a corporative representative graduated educational institution, 0 otherwise	Dummy	+/-	
20	Junior college	1 = if a corporative representative graduated junior college, 0 otherwise	Dummy	+/-	
21	University	1 = if a corporative representative graduated university, 0 otherwise	Dummy	+/-	
22	Graduate school	1 = if a corporative representative graduated graduate school, 0 otherwise	Dummy	+/-	
23	Other type of education	1 = if a corporative representative graduated other type of education, 0 otherwise	Dummy	+/-	
24	Non-agricultural experience of representative	Values range from 1 to 6: 1 = None; 2 = 1-5 years; 3 = 5-10 years; 4 = 10-15 years; 5 = 15-20 years; 6 = 20-25 years	Categorical	+/-	(Feder et al., 1985); - (Läpple et al., 2015)

Note: +/- and Ns mean that positive, negative and non-significant effects, respectively on innovation implementation. For categorical variables are variable no.1, 3, 6, 8, 9, 10, 11, 12, 13, it shows the different effect of other groups of that variable with its reference group as its first group. For categorical variables are no. 16 and 24, they are treated as continuous variables.

Table 2 Descriptive results of product innovation implementation and explanatory variables

No	Variables	Unit	Mean	Std. Dev	Min	Max	Numbers of corporations
I	Dependent variable						
	Product innovation (PI)	Dummy	0.500	0.501	0	1	154
II	Independent variables						
1	Type of corporation	Categorical					
	1 = Limited company		0.416	0.494	0	1	128
	2 = Stock company		0.445	0.498	0	1	137
	3 = Agricultural producer's cooperative corporation		0.130	0.337	0	1	40
	4 = Others		0.010	0.098	0	1	3
2	Own land	Dummy	0.899	0.301	0	1	277
3	Region	Categorical					
	1 = Hokkaido		0.026	0.159	0	1	8
	2 = Tohoku		0.192	0.394	0	1	59
	3 = Kanto		0.143	0.350	0	1	44
	4 = Hokuriku		0.101	0.301	0	1	31
	5 = Kinki and Tokai,		0.127	0.333	0	1	39
	6 = Chugoku and Shikoku		0.166	0.372	0	1	51
	7 = Kyushu and Okinawa		0.247	0.432	0	1	76
4	Age of corporation	Years	20.110	14.196	1	109	-
5	Agricultural experience of	Years	30.734	31.687	0	319	-

6	corporation						
	Background of corporation	Categorical					
	1 = Is a farmer established a corporation only one member/single corporation		0.416	0.494	0	1	128
	2 = Is a farmer and jointly established a cooperation with other members		0.286	0.452	0	1	88
	3 = Is a Farmer and has established corporations in collaboration with non-farmers and companies from other industries.		0.039	0.194	0	1	12
	4 = Is a Non-farmer entered agriculture as individuals and established a corporation.		0.055	0.229	0	1	17
	5 = Your company's main business is a separate/different business, but you have entered agriculture as a new business.		0.075	0.263	0	1	23
	6 = Your parent/main company or group company has established a new corporation and entered agriculture.		0.084	0.278	0	1	26
	7 = Others		0.045	0.209	0	1	14
7	Regular employees	persons	17.045	35.348	1	352	-
8	Annual sales	Categorical					
	1 = Less than 30 million yen		0.075	0.263	0	1	23
	2 = 30 - 50 million yen		0.101	0.301	0	1	31
	3 = 50 - 100 million yen		0.227	0.420	0	1	70
	4 = 100 - 300 million yen		0.386	0.488	0	1	119
	5 = 300 - 500 million yen		0.075	0.263	0	1	23
	6 = 500 - 1000 million yen		0.049	0.216	0	1	15
	7 = 1000 - 1500 million yen		0.039	0.194	0	1	12
	8 = 1500 - 2000 million yen		0.016	0.127	0	1	5
	9 = from 2000 million and above		0.032	0.178	0	1	10
9	Profit margin	Categorical					
	1 = 0% (Break-even)		0.104	0.306	0	1	32
	2 = 1-5%		0.321	0.468	0	1	99
	3 = 5-10%		0.192	0.394	0	1	59
	4 = 10-15%		0.127	0.333	0	1	39
	5 = 15-20%		0.042	0.201	0	1	13
	6 = From 20% and above		0.019	0.138	0	1	6
	7 = Deficit		0.195	0.397	0	1	60
10	Growth stage	Categorical					
	1 = Starting		0.081	0.274	0	1	25
	2 = Growing		0.347	0.477	0	1	107
	3 = Mature		0.179	0.384	0	1	55
	4 = Recession		0.068	0.252	0	1	21
	5 = 2 nd starting		0.149	0.357	0	1	46
	6 = 2 nd growing		0.120	0.326	0	1	37
	7 = 2 nd mature		0.042	0.201	0	1	13
	8 = 2 nd recession		0.003	0.057	0	1	1
	9 = Others		0.010	0.098	0	1	3
11	Sales target	Categorical					
	1 = Remain as the current		0.127	0.333	0	1	39
	2 = 1.2 times		0.318	0.467	0	1	98
	3 = 1.5 times		0.273	0.446	0	1	84

	4 = 1.8 times		0.029	0.169	0	1	9
	5 = 2.0 times		0.120	0.326	0	1	37
	6 = Above 2.0 times or less than 3 times		0.055	0.229	0	1	17
	7 = From 3 times and above		0.058	0.235	0	1	18
	8 = Decreasing		0.010	0.098	0	1	3
	9 = There no target		0.010	0.098	0	1	3
12	Profit margin target	Categorical					
	1 = 0% (Break-even)		0.058	0.235	0	1	18
	2 = 1-5%		0.214	0.411	0	1	66
	3 = 5-10%		0.338	0.474	0	1	104
	4 = 10-15%		0.195	0.397	0	1	60
	5 = 15-20%		0.120	0.326	0	1	37
	6 = From 20% and above		0.055	0.229	0	1	17
	7 = There is no target		0.019	0.138	0	1	6
13	Main product	Categorical					
	1 = Paddy rice		0.205	0.404	0	1	63
	2 = Wheat		0.003	0.057	0	1	1
	3 = Beans and coarse cereals		0.010	0.098	0	1	3
	4 = Open ground vegetable		0.110	0.314	0	1	34
	5 = Facility vegetable		0.143	0.350	0	1	44
	6 = Flowers and foliage plants		0.039	0.194	0	1	12
	7 = Fruiter		0.097	0.297	0	1	30
	8 = Mushroom		0.036	0.186	0	1	11
	9 = Livestock production		0.146	0.354	0	1	45
	10 = Mixed		0.117	0.322	0	1	36
	11 = Others		0.094	0.293	0	1	29
14	Self-evaluation in new product and technology development	Likert	2.805	1.025	1	5	-
	1 = Weaker than others		0.110				34
	2 = Slightly weaker than others,		0.253				78
	3 = Neither weaker nor stronger than others		0.412				127
	4 = Slightly stronger than others		0.169				52
	5 = Stronger than others		0.055				17
15	FTA participation	Likert	2.851	1.003	1	5	-
	1 = Big crisis		0.104				32
	2 = Crisis		0.214				66
	3 = Neither a crisis nor a chance		0.471				145
	4 = Chance		0.149				46
	5 = Big chance		0.062				19
16	Age of representative	Categorical	5.292	1.199	2	7	-
	1 = 10-20		0.000				0
	2 = 20-30		0.003				1
	3 = 30-40		0.081				25
	4 = 40-50		0.198				61
	5 = 50-60		0.208				64
	6 = 60-70		0.357				110
	7 = more than 70		0.153				47
17	High school	Dummy	0.532	0.500	0	1	164
18	Vocational school	Dummy	0.094	0.293	0	1	29
19	Educational institution	Dummy	0.143	0.350	0	1	44
20	Junior college	Dummy	0.049	0.216	0	1	15
21	University	Dummy	0.321	0.468	0	1	99
22	Graduate school	Dummy	0.032	0.178	0	1	10
23	Other type of education	Dummy	0.026	0.159	0	1	8
24	Non-agricultural experience	Categorical	3.328	1.980	1	6	-



1 = None	0.250	77
2 = 1-5 years	0.198	61
3 = 5-10 years	0.140	43
4 = 10-15 years	0.081	25
5 = 15-20 years	0.049	15
6 = 20-25 years	0.282	87

Source: Nanseki, 2021; n = 308; \$1~109 yen (in 2019 from <https://www.stat-search.boj.or.jp/ssi/cgi-bin/famecgi2>)

Table 3 Factors associating with product innovation implementation

No	Variables	Coef.	Std. Err	z	P> z	[95% Conf. Interval]
1	Type of corporation (1 = Limited company is the base group)					
	2 = Stock company	0.011	0.238	0.050	0.964	0.477 0.455
	3 = Agricultural producer's cooperative corporation	0.005	0.348	0.010	0.989	0.688 0.678
	4 = Others	0.429	1.105	0.390	0.698	2.595 1.738
2	Own land (Dummy)	0.151	0.342	0.440	0.660	0.520 0.821
3	Region (1 = Hokkaido is the base group)					
	2 = Tohoku	0.156	0.617	0.250	0.800	1.054 1.366
	3 = Kanto	0.394	0.633	0.620	0.533	0.846 1.635
	4 = Hokuriku	1.169 *	0.676	1.730	0.084	0.157 2.494
	5 = Kinki and Tokai	1.064	0.657	1.620	0.105	0.224 2.352
	6 = Chugoku and Shikoku	0.207	0.628	0.330	0.741	1.023 1.438
	7 = Kyushu and Okinawa	0.424	0.607	0.700	0.485	0.766 1.615
4	Age of corporation (years)	0.000	0.009	0.030	0.978	0.017 0.017
5	Agricultural experience of corporation (years)	-	0.003	-	0.637	- 0.005
6	Background of corporation (1= Is a farmer established a corporation only one member/single corporation is the base group)					
	2 = Is a farmer and jointly established a cooperation with other members	0.182	0.263	0.690	0.490	0.334 0.697
	3 = Is a Farmer and has established corporations in collaboration with non-farmers and companies from other industries	-	0.546	-	0.113	- 0.204
	4 = Is a Non-farmer entered agriculture as individuals and established a corporation	0.867		1.590		1.937
	5 = Your company's main business is a separate/different business, but you have entered agriculture as a new business	-	0.504	-	0.178	- 0.309
	6 = Your parent/main company or group company has established a new corporation and entered agriculture	0.680	0.479	1.350	0.320	1.668 0.463
	7 = Others	0.477	0.990	0.990		1.416
		0.138	0.414	0.330	0.739	0.673 0.949
7	Regular employees (persons)	-	0.524	-	0.484	- 0.660
8	Annual sales (1 = Less than 30 million yen is the base group)	0.002	0.004	0.460	0.648	-0.011 0.007
	2 = 30 - 50 million yen	0.289	0.484	0.600	0.550	0.660 1.238
	3 = 50 - 100 million yen	0.493	0.422	1.170	0.243	0.334 1.319
	4 = 100 - 300 million yen	0.517	0.409	1.260	0.207	0.285 1.318
	5 = 300 - 500 million yen	1.883 ***	0.588	3.200	0.001	0.730 3.036
	6 = 500 - 1000 million yen	1.557 **	0.655	2.380	0.017	0.273 2.840
	7 = 1000 - 1500 million yen	-	0.783	-	0.291	- 0.708
	8 = 1500 - 2000 million yen	0.827	0.890	1.060		2.362
	9 = from 2000 million and above	1.406	0.889	1.580	0.114	0.338 3.150
9	Profit margin (1 = 0% (Break-even) is the base group)					
	2 = 1-5%	1.671 *	0.350	-	0.023	- -0.111



		0.796		2.280		1.481	
	3 = 5-10%	-	***	-	-	-	-
		1.208		0.394	3.070	0.002	1.979
	4 = 10-15%	-		0.443	-	0.165	-
		0.615		1.390	0.165	-	1.484
	5 = 15-20%	-		0.546	-	0.302	-
		0.564		1.030	0.302	-	1.634
	6 = From 20% and above	-		0.867	-	0.182	-
		1.156		1.330	0.182	-	2.856
	7 = Deficit	-		0.369	-	0.136	-
		0.551		1.490	0.136	-	1.275
10	Growth stage (1 = Starting is the base group)						
	2 = Growing	-		0.417	-	0.550	-
		0.249		0.600	0.550	-	1.067
	3 = Mature	-		0.473	-	0.468	-
		0.344		0.730	0.468	-	1.271
	4 = Recession	-		0.557	-	0.626	-
		0.271		0.490	0.626	-	1.363
	5 = 2 nd starting	-		0.492	0.030	0.978	-
		0.014		0.030	0.978	-	0.950
	6 = 2 nd growing	-		0.504	-	0.102	-
		0.825		1.640	0.102	-	1.813
	7 = 2 nd mature	-		0.674	-	0.288	-
		0.716		1.060	0.288	-	2.038
	8 = 2 nd recession	-		(empty)			
	9 = Others	-		0.867	-	0.937	-
		0.068		0.080	0.937	-	1.768
11	Sales target (1 = Remain as the current is the base group)						
	2 = 1.2 times	-		0.334	0.560	0.577	-
		0.186		0.334	0.560	0.577	-
	3 = 1.5 times	-	*	0.374	1.780	0.075	-
		0.665		0.374	1.780	0.075	-
	4 = 1.8 times	-	**	0.738	2.400	0.016	-
		1.774		0.738	2.400	0.016	-
	5 = 2.0 times	-	*	0.445	1.760	0.079	-
		0.782		0.445	1.760	0.079	-
	6 = Above 2.0 times or less than 3 times	-		0.564	1.030	0.301	-
		0.584		0.564	1.030	0.301	-
	7 = From 3 times and above	-	*	0.577	1.830	0.067	-
		1.056		0.577	1.830	0.067	-
	8 = Decreasing	-		1.171	0.270	0.791	-
		0.310		1.171	0.270	0.791	-
	9 = There no target	-		(empty)			-
		0.000		(empty)			-
12	Profit margin target (1 = 0% (Break-even) is the base group)						
	2 = 1-5%	-		0.498	0.540	0.587	-
		0.270		0.498	0.540	0.587	-
	3 = 5-10%	-	*	0.497	1.770	0.077	-
		0.880		0.497	1.770	0.077	-
	4 = 10-15%	-	*	0.540	1.950	0.051	-
		1.056		0.540	1.950	0.051	-
	5 = 15-20%	-		0.589	0.920	0.355	-
		0.544		0.589	0.920	0.355	-
	6 = From 20% and above	-		0.652	1.250	0.211	-
		0.814		0.652	1.250	0.211	-
	7 = There is no target	-		1.008	0.160	0.870	-
		0.164		1.008	0.160	0.870	-
13	Main product (1 = Paddy rice is the base group)						
	2 = Wheat	-		(empty)			-
		0.000		(empty)			-
	3 = Beans and coarse cereals	-		1.128	1.810	0.071	-
		2.037		1.128	1.810	0.071	-
	4 = Open ground vegetable	-		0.403	1.560	0.118	-
		0.629		0.403	1.560	0.118	-
	5 = Facility vegetable	-	*	0.403	1.920	0.055	-
		0.771		0.403	1.920	0.055	-
	6 = Flowers and foliage plants	-		0.624	0.780	0.434	-
		0.488		0.624	0.780	0.434	-



						0.734	
	7 = Fruiter	0.484	0.416	1.160	0.244	-0.331	1.299
	8 = Mushroom	0.887	0.582	1.530	0.127	-0.253	2.027
	9 = Livestock production	-0.752	* 0.430	-1.750	0.081	-1.596	0.092
	10 =Mixed	-0.142	0.357	0.400	0.691	-0.842	0.558
	11 = Others	0.043	0.397	0.110	0.913	-0.735	0.822
14	Self-evaluation in new product and technology development	0.323	*** 0.106	3.050	0.002	0.115	0.531
15	FTA participation	0.056	0.099	0.570	0.570	-0.138	0.251
16	Age of representative	-0.043	0.092	-0.470	0.640	-0.223	0.137
17	High school	-0.114	0.227	-0.500	0.616	-0.559	0.331
18	Vocational school	-0.430	0.334	-1.290	0.198	-1.085	0.225
19	Educational institution	-0.387	0.333	-1.160	0.246	-1.041	0.266
20	Junior college	0.102	0.441	0.230	0.818	-0.762	0.965
21	University	-0.112	0.251	-0.450	0.655	-0.603	0.380
22	Graduate school	-0.128	0.568	-0.220	0.822	-1.241	0.986
23	Other type of education	-0.646	0.722	-0.890	0.371	-2.061	0.770
24	Non-agricultural experience	-0.022	0.063	0.350	0.730	-0.145	0.101
	Constant	-1.576	1.288	-1.220	0.221	-4.100	0.948

Source: Nanseki, 2021; n = 303^a; \$1~109 yen (in 2019 from <https://www.stat-search.boj.or.jp/ssi/cgi-bin/famecgi2>)

Note: ***, **, and *: Statistically significant at 1%, 5%, and 10% respectively; Log likelihood = -151.921; LR Chi2 (73) = 116.2***; Pseudo R2=0.277; correctly classified = 72.9%.

(a) In Probit model 5 observations were not used because these 5 observations belonged to the categories that predicts failure/successful perfectly.