

Article

Farm Diversification and Sustainability of Multifunctional Peri-Urban Agriculture: Entrepreneurial Attributes of Advanced Diversification in Japan

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Abstract: Multifunctionality of urban agriculture is essential for the sustainability of both cities and urban farms, especially in Asian mega-cities exhibiting extensive urban sprawl. To maximise the multifunctionality of these farms, entrepreneurial or innovative farm diversification is important. However, there is insufficient research on this issue in developed countries. This study aims to demonstrate the existence of advanced diversified farms characterised by entrepreneurship, skilled farm management and social networks and explore their economic and social sustainability by using data from a survey of 386 farms located close to urban areas in Japan. Gaussian mixture clustering analysis revealed that only about 10% of the sample can be classified as advanced diversified farms and most of the other diversified farms do not exhibit entrepreneurial attributes. Furthermore, regression analysis revealed that advanced diversification has a positive impact not only on the economic viability of farms, but also on their social performance. These findings have significant implications for policies promoting the sustainability of urban agriculture, suggesting that a more balanced promotion of the diversification and entrepreneurial attributes of farms is crucial to building a sustainable relationship between cities and urban agriculture.

Keywords: urban agriculture; multifunctionality; entrepreneurship; farm diversification

1. Introduction

Urban agriculture (UA) has attracted global attention from urban planners and researchers because of its multifunctionality, which is expected to encourage rural development and generate employment [1]. Furthermore, it has been claimed that the social and environmental impacts of UA make a significant contribution to urban sustainability [2,3]. Social impacts include human health benefits (physical and mental), community development and educational benefits. UA is also credited with positive environmental impacts such as greening cities, boosting biodiversity and improving natural resource efficiency.

In Japan, legislation aiming to exploit the multifunctionality of UA was only recently passed in 2015. Here, rapid economic growth from the late 1950s onwards has led to the uneven growth of urban fringe areas, including expansion into large areas of farmland [4,5]. Given that other Asian mega-cities face similar problems around urban sprawl as Japan, understanding how best to exploit

the multifunctionality of agricultural land in peri-urban areas may be an important factor in achieving sustainable urban development in these areas [6].

The general definition of UA offered by the United Nations Food and Agriculture Organisation (FAO) is ‘an industry located within (intra-urban) or on the fringe (peri-urban) of a town, city, or metropolis, which grows and raises, processes and distributes a diversity of agricultural products, using largely human, land and water resources, products and services found in or around that urban area’ [7] (p. 21). Based on this definition, professional UA is distinguished from urban gardening in terms of the importance of commercial objectives to the professional UA operation [8]. Because this study only focuses on commercial urban farming, we adopt the term professional urban agriculture (PUA) as encompassing both urban and peri-urban agriculture.

Historically, professional farmers in Japan tend to be owner-occupiers located in urban or peri-urban areas. Policies promoting PUA often require farmers to exploit the multifunctional nature of their land more effectively, and the benefits of multifunctional peri-urban agriculture have recently been re-evaluated [8,9]. Moreover, commercial farmers in peri-urban areas have a history of diversifying into more customer-oriented enterprises, such as direct marketing, food processing, agri-tourism and education [10,11]. In other words, these farmers have been trying to incorporate the multifunctional externalities of UA into their management strategies through farm diversification activities.

An economic geography approach is helpful for understanding PUA. According to the early models of agriculture proposed by Von Thünen, PUA would offer advantages in terms of lower transportation costs from the farm to the city, so vegetables, fruit, milk and other dairy products are all suitable candidates for PUA [12]. In fact, peri-urban areas in Tokyo were among the most famous production centres for these products before improvements in transport infrastructure and production technology made farms in rural areas more competitive. Urban sprawl during the rapid economic growth from the late 1950s onwards, led to a substantial deterioration in farming conditions in many close-to-urban areas. As a response to these less favourable conditions, many peri-urban farmers adopted farm diversification strategies as an alternative to conventional production. Studies on farm diversification in Western countries have indicated that the shorter the distance between farms and cities, the more farms will diversify their businesses [10,11,13–15].

As a result, most peri-urban farmers in Japan have adopted some form of farm diversification. However, this can be classified into advanced or conventional diversification according to the entrepreneurial attributes of the farmer. Various studies (e.g., Refs. [16,17]) have argued that innovation and entrepreneurship in farmers are both crucial factors in maximising the contribution of farm diversification to economic development. Indeed, some urban farmers exhibit higher levels of entrepreneurship than other farmers and have responded positively to the pressures of urbanisation, such as high taxation, vandalism and low-quality agricultural infrastructure [18]. However, a large number of small family farms remain in urban areas in Japan and this study expects that entrepreneurial behaviour is less likely to be observed in these farms.

Hence, the sustainability of various types of farm enterprise diversification is the most important research question for this study. This is because only advanced diversification is expected to continuously exploit the multifunctional nature of UA. The sustainability of the farm includes not only economic factors but also social (internal and external) and environmental aspects. Therefore, understanding how the characteristics of diversified farms contribute to farm sustainability is essential in the field of urban agriculture both in terms of justifying the continued existence of PUA and for informing future policy.

However, research on these issues in developed countries is rare. Accordingly, this study aims to classify farm diversification strategies in terms of the entrepreneurial nature of farm management and to assess the sustainability of a sample of advanced diversified farms close to urban areas in Japan. For the reasons mentioned earlier, promoting advanced farm diversification in urban and peri-urban areas is a common objective in developed countries. This is a particularly important issue in Asian mega-cities where areas of agricultural land within the metropolitan area pose particular challenges

for policy makers who may wish to encourage the existence of sustainable diversified farms that offer multiple benefits to the local population.

2. Materials and Methods

2.1. Conceptual Framework

2.1.1. Farm Diversification

Pluriactivity is the broadest definition of farm diversification and includes farmers taking off-farm jobs and any unpaid jobs undertaken by the farm family other than those in farm-based enterprises [19]. Other literature focused on diversification into non-traditional farm enterprises and defined structural diversification as activities like tourism (accommodation and recreation) and adding-value (direct marketing and processing) [10]. Similarly, van der Ploeg and Roep [20] introduced the terms ‘deepening’, which means vertical integration of processing and marketing via short supply-chains, and ‘broadening’, i.e., activities connected to agricultural resources such as tourism. In the case of PUA in Japan, marketing via short supply-chains is one of the main diversification strategies (e.g., direct sales to supermarkets or school-meal centres). Generally, this is because these activities are based on customer orientation and the farmers who have short supply-chains directly interact with customers. Accordingly, this study classifies farm diversification as engaging in deepening (e.g., farm gate sales, farmers’ market, sale to retailers, school or cooperatives, mobile sale and processing) or broadening activities (e.g., tourism farm, farming experience farm and pick-your-own farm).

Entrepreneurship is the process through which opportunities to create future goods and services are discovered, evaluated and exploited [21]. According to the Global Entrepreneurship Monitor 2009 Global Report, entrepreneurship encompasses attitudes, activities and aspirations. This study focuses on entrepreneurial attitudes, which refer to the extent to which people perceive their business opportunities, risks, social norms or their own capabilities. This definition is based on the Theory of Planned Behaviour, which posits that farmer psychological profiles can be a useful predictor of their behavior [22]. This study operationalises those attitudes through the concept of entrepreneurial orientation, which reflects the management practices or decision-making styles of farmers who act entrepreneurially [23]. According to farm management studies, entrepreneurship by farmers promotes farm diversification [24–26]. Although farmers tend to establish a number of similar farm businesses, these businesses can still be seen as entrepreneurial because they require ‘contracts with new customers and/or suppliers, new marketing channels and reorganisation of the management in the business’ [27] (p. 242).

Contrary to the preceding discussion, farmer entrepreneurship is not necessarily required for farm diversification in PUA in Japan because farmers who seek business opportunities in urban areas can easily reach potential customers. According to a spatial statistical study in Japan’s Kanto region, small farmers are more likely to diversify their businesses than large ones [28]. This finding implies that entrepreneurship or advanced farm management are not necessary conditions for farm diversification in PUA in Japan. In European countries, although entrepreneurial diversification is seen as a way to promote economic development in rural areas, the EU has not set any policies that define the characteristics of targeted entrepreneurial farms or desirable performance measures [16].

Empirical studies have shown that the success of farm diversification is subject to the internal and external environment of farm management. For instance, the effect of farm diversification on farm viability depends on regional agricultural policies [29]. Other success factors, such as collaboration with stakeholders [30], marketing activities [31] and farm size [32,33], have been suggested as indicators of the success of farm diversification.

The framework for this study is based mainly on the findings of two previous empirical studies. One study defines on-farm entrepreneurial diversification as ‘the creative use by farmers of diverse local assets and attributes rather than ‘imported’ technologies as the basis of alternative activities’ [16] (p. 217). Six factors are identified as on-farm entrepreneurial characteristics: novel redeployment of the

basis of agricultural production, the adoption of a new market orientation, capitalising on endogenous resources, new forms of governance, community involvement/support and management of space and natural resources. Clark [16] conducted a number of case studies and found that locality, informal networks and individual skills and experiences are the characteristics of on-farm entrepreneurial farm diversification. The other study classifies diversification strategies according to the Diversified Farm Business Score (DFBS) and Household Diversification/Innovation Capacity Score (HDICS) [17]. The DFBS measures the feasibility of a diversification strategy, while the HDICS measures the quality of farm management from the perspective of management resources, capabilities, social networks and self-confidence. Accordingly, some farms are classified as innovative diversifiers that engage in wide-ranging social-networking activities.

The characteristics of entrepreneurial [16] and innovative [17] farm diversification overlap. To avoid confusion, this study refers to such activities as advanced diversification. The promotion of advanced diversification is an important objective of PUA policies and to achieve this it is important to understand certain common characteristics of such diversification. Accordingly, three factors are introduced as attributes of advanced diversification. First, entrepreneurial orientation is important in terms of exploiting business opportunities. Second, management capabilities, such as marketing [34,35] and strategic planning [34,36], support advanced diversification and are enhanced by an ability to manage customers, accounts and labour successfully. Third, social networking is an important aspect of advanced diversification and [37] suggests that social networking is an entrepreneurial skill present in diversified farms.

Generally, firms can be classified into different strategic management groups according to the types of management strategies that they pursue [38]. For example, Miles and Snow categorise firms as Prospectors, Analysers, Defenders or Reactors according to the characteristics that they exhibit [39]. However, studies that attempt to classify firms into strategic management groups also face some challenges [40]. First, empirical evidence to support the classification must be presented. This can be achieved by introducing sophisticated statistical methods [41–44]. Second, performance differences between groups should be clearly revealed. Here we adopt a model-based clustering method called Gaussian mixture clustering to determine the number of different groups on the basis of statistical criteria. Then, performance measures for farm diversification in PUA can be included to evaluate the viability of advanced diversification.

2.1.2. Sustainability of Family Farms

The sustainability of firms can be measured in terms of economic, social and environmental performance. Studies on farm sustainability usually categorise social sustainability as internal or external [45,46]. Internal social performance refers to contributions to employees, including work environment, training programmes and motivation. By contrast, external social performance relates to more public issues such as food security, animal welfare, landscape preservation and job creation. A literature review in 2007 showed that stated motivations of farm tourism operators in Western countries are almost economic and social [47]. This is partly because the economic and social benefits of farm diversification were expected in policy and academic contexts. On the other hand, Barbieri [48] investigated the effects of farm diversification on sustainability issues and concluded that diversified farms are more interested in social performance than environmental performance. This means that diversified farmers are not conscious of the environmental benefits of farm diversification.

Based on a literature review, Table 1 presents the motivations of diversified farms classified across the three pillars of sustainability. Most of these studies reveal the importance of economic factors, such as income, resource utilisation and risk reduction [10,27,49–61]. These motives correspond to some of the more common objectives of diversification as reported in strategic management studies [62]. On the other hand, several other opportunistic factors are also revealed. For example, having a good location [10,49] and market opportunities [51,56,58] could be considered as more entrepreneurial goals.

The vast majority of farms in Japan and Western Europe are family farms. In that context, family commitment to the farm business is important when measuring internal social sustainability. Furthermore, the nomination of a successor to the current farmer is crucial to ensure long-term farm continuity. Table 1 also shows that farmers expect farm diversification to promote family commitment [27,51,52,54,55,60] and ensure farm succession [56,57]. Indeed, diversified farms have been found to be more likely to have a nominated farm successor [13]. Although family firms are generally less entrepreneurial than non-family firms [63,64], the promotion of family involvement in a farm business can develop ‘familiness’ [65], a type of resource specific to family firms, which enables them to encourage transgenerational entrepreneurship [66].

Table 1. Farmers’ motivation for farm diversification.

Articles	Country	Type	Methodology (Sample Size)	Motivation for Farm Diversification			
				Economic	Social		Environment
					Internal	External	
[54]	the U.S.	Farm diversification	Factor analysis (292)	additional income, losing government support, market opportunity, other farm successes, resource utilization	family involvement	customer interaction	
[55]	the U.S.	Farm diversification	Factor analysis (638)	additional income, enhanced financial conditions, market opportunity, uncertainty and risk reduction	family involvement	customer interaction	
[56]	the U.S.	Farm diversification	Factor analysis (243)	additional income, enhanced financial condition, market opportunity, resource utilization, uncertainty and risk reduction	family involvement, farm succession	education	
[58]	the U.S.	Farm diversification	Mean difference (383)	additional income, other farm successes, resource utilization	family involvement	education	
[50]	the U.S.	Farm diversification	Principal Component Analysis (112)	additional income, economic survival		community survival, customer interaction, preserve culture	
[10]	the U.K.	Farm diversification	Cross-tabulation (120)	additional income, location, resource utilisation			
[59]	the U.K.	Farm diversification	Cross-tabulation (150)	additional income, enhanced financial condition	family involvement	food supply	
[51]	the U.K.	Farm diversification	Case study (25)	additional income, getting financial support, labour shortage market opportunity, uncertainty and risk	family involvement	education, heritage preservation	
[27]	Sweden	Farm diversification	Factor analysis (309)	enhanced financial condition, resource utilisation	family involvement		
[60]	Norway	Farm diversification	Regression analysis (1607)	additional income, resource utilisation	family involvement		
[52]	Italy	Farm diversification	Factor analysis (226)	additional income, uncertainty and risk reduction	family involvement	heritage preservation (rural and agrifood)	
[49]	New Zealand	Farm diversification	Case study (13)	additional income, location, resource utilisation		consumer interaction	
[57]	the U.S.	Crop diversification (agroforestry)	Factor analysis (729)	economic benefit, tax benefit			environment protection
[53]	Europe	Crop diversification (agroforestry)	Cross-tabulation (183)	resource utilization, getting subsidies		Tradition, Animal welfare	environment protection, Landscape
[61]	Ireland	Crop diversification (organic)	Spatial analysis (597)	enhanced financial condition			environment protection

Exploiting the multifunctionality of UA is an important external social activity for peri-urban farmers. According to an Urban Agriculture Europe report, in addition to production, UA aims at ‘service functions—such as the landscape features, recreation, education and health’ [67] (p. 19). A review article on multifunctionality in the U.S. reports that social, health and economic impacts are the most frequently documented benefits of agriculture reported in the literature [2]. For example, community gardening projects are often motivated by a desire to improve social development and cohesion, or to save or make money [68]. Participation in UA has been found to indirectly influence health and wellbeing through promoting social involvement [69,70], while in Japan, a similar impact is demonstrated [71]. Other studies have reported the positive effects of UA on the physical and mental health of urban dwellers [72,73]. This study assumes that the multifunctionality of UA can lead to a variety of external social impacts. Table 1 shows that customer interaction [49,50,54,55], education [51,56,58], food supply [59], heritage and tradition preservation [50–53] and community survival [50] are the main social objectives of farm diversification.

In addition, while improving environmental performance is usually considered an important aspect of sustainability, Table 1 indicates that this is a less important motivation for diversified farms. While, some articles include the motivation of environment protection [53,57,61], the sample of those studies are agroforestry farmers [53,57] or organic farmers [61] whose environmental orientation seems different from other studies. On the other hand, almost all of the studies reviewed here were based on a questionnaire survey and could not reveal the potential motivations for the natural environment. Therefore, this study only focuses on the economic and social performance of PUA because these are the main objectives clearly stated by diversified farms in developed countries.

2.2. Analytical Framework

2.2.1. Overview

Figure 1 presents the analytical framework for this study. First, several variables are identified for clustering analysis to identify strategic groups. These are the degree of farm diversification, entrepreneurial orientation, management capabilities and social networking activity. Second, sample farms are classified into strategic groups according to these variables. Third, the characteristics of each strategic group are determined using analysis of variance techniques. Finally, we reveal the effects of advanced diversification on the sustainability (economic and social) of peri-urban farms using regression analysis.

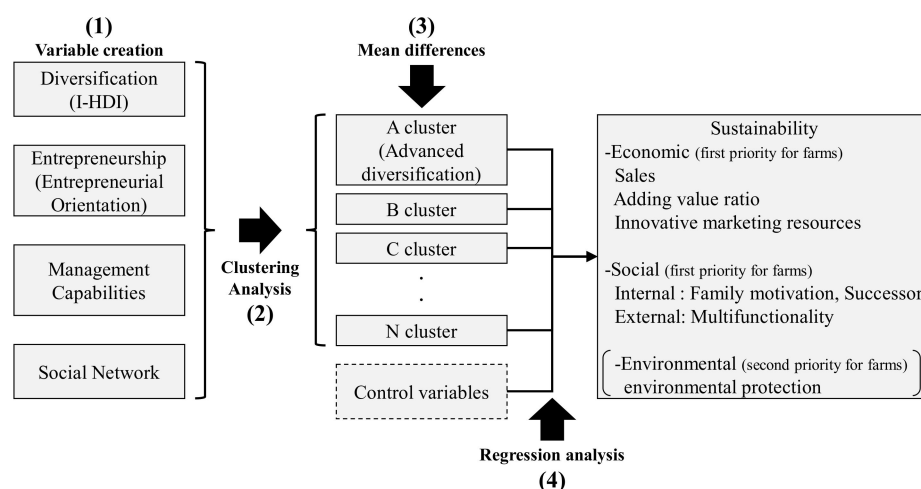


Figure 1. Analytical framework.

2.2.2. Diversification

Following Pope and Prescott [74], who developed farm diversification indices, this study adopts an inverse Herfindahl index (I-HDI). The Herfindahl index can be calculated using the sum of squares of the proportion of sales of each business to total farm sales. Because this index asymptotically approaches zero as the level of farm diversification increases, an inverse Herfindahl index reveals the degree of farm diversification.

Although the Herfindahl index is frequently used in studies of strategic management, it has rarely been applied to farm management studies. Rather, the most popular indicators for farm diversification are the existence of unconventional enterprises [10,27] and the number of enterprises [55,75] on a farm. However, few studies have adopted proportional indices based around volume of sales [29,76] and labour utilised [13,77].

The types of businesses examined in this study are classified as follows. First, sales to the mass market are defined as the conventional business model. Second, farm gate sales (manned or unmanned), mobile sales, farmers' markets and delivery services (on farm gate and/or via web page) are all considered as examples of direct marketing. Third, food preparation (e.g., restaurants and cafes) and processing are also classified as value-adding businesses. Fourth, the public-facing businesses include tourism, farm visits, pick-your-own, and allotment gardening. Finally, we identify short-supply-chain businesses including selling produce to local businesses including several retailers, schools and local events.

2.2.3. Advanced Diversification Measures

First, the entrepreneurial orientation (EO) of individual farmers can be assessed in terms of their innovativeness, risk taking and proactivity [78]. This study includes two questions for each indicator. Based on Covin and Slevin [79], a 5-point Likert scale is used to measure which of the two paired contrasting statements most closely match a farmer's view. Then, EO is measured as the sum of responses to six questions. Few other studies have shown the effects of farmers' EO on farm performance, for example, Grande et al. [80] reported that the EO of farmers improves the performance of their start-up ventures.

In this study, the following six operational capabilities are defined: marketing, customer relationship management, labour management, financial (accounts) management, knowledge management and strategic management. As marketing concepts have shifted in focus from production-oriented to customer-oriented, the concept of 'customer relationship management (CRM)' has gained attention. One definition of CRM is 'a firm's skills and accumulated knowledge to identify attractive customers and prospects, initiate and maintain relationships with attractive customers and leverage these relationships into customer level profits' [81] (p. 117). Thus, CRM capability requires the capacity to utilise management resources to achieve competitive advantage [82]. Knowledge management is also considered an essential management capability for innovation in some strategic management literature [83]. Knowledge management is the process through which an organisation generates, captures, attains, authenticates and practices knowledge in order to maintain and improve its functioning. Such knowledge is embedded in, and carried through, multiple channels including organisational culture and identity, routines, policies and systems, as well as in individual employees [84]. Thus, systems that promote knowledge creation and sharing can support farm sustainability.

A common method used to quantify management capabilities is to calculate the total spending on particular management practices [85,86]. By contrast, rather than using sales volumes this study uses farmers' own subjective assessments of their capabilities to provide a broader and more nuanced evaluation [87,88]. We sum a series of Likert scale scores based on questions relating to the frequency of management practices associated with the six operational capabilities set out above. Because those capabilities are moderately correlated with each other, the total capability (TC) score, calculated as the sum of each capability score, is used as a clustering variable.

Lastly, farmers' social networks are considered to have a potential impact on farm performance because they can be a source of business opportunities [89,90] and of external management resources such as advice [91–93]. Diversified farms also exchange management information and refer customers to each other [94]. Advanced diversified farms are argued to be better able to exploit informal social networks [16,17,37]. Hence, this study focuses on social network (SN) activity measured using a 5-point scale in questions measuring the frequency of interactions between farmers and individuals or organisations such as farmers, farmers' cooperatives, extension services, suppliers, business partners, consultants, local residents and customers.

2.2.4. Clustering Analysis

This study adopts a model-based clustering method. Conventional clustering methods such as k-mean clustering or hierarchical clustering use a distance function to assign each observation to clusters. On the other hand, Gaussian mixture clustering, which assumes a Gaussian distribution of variables for each component or cluster, assigns each observation to clusters using expectation-maximisation (EM) algorithm optimisation of the likelihood function. As a result, the optimal number of clusters can be selected using the Bayesian Information Criterion (BIC) [95]. In this study, four variables, including the inverse Herfindahl index (I-HDI), EO, TC and SN, are found to be suitable for the classification of diversification strategies. The *r* software application 'Mclust' is used to conduct the Gaussian mixture clustering.

The characteristics of the strategic groups specified above can be understood by comparing mean differences between clusters. To compare more than three groups, analysis of variance is required for continuous variables. In the case of dichotomous variables, a non-parametric approach such as the Kruskal-Wallis test should be used. Using these approaches, examples of advanced diversification can be identified.

2.2.5. Sustainability

In this study, total sales are the focus, as an increase in revenue is often the main objective of farm diversification. However, previous studies indicate that the increase in income in diversified businesses is not always substantial [10,96,97]. Therefore, in order to acknowledge that farm diversification can improve a farm's financial situation in other ways apart from increasing revenues [29,77], our study also includes the value-adding effect that farm diversification can have on products or services. This is estimated through a subjective assessment of the proportion of products that appear to offer additional value as a result of diversification activities.

The definition of farm diversification has shifted over time to give more emphasis to innovative and strategic activities, such as 'the creative use by farmers of diverse local assets and attributes' [16] or 'a movement away from core activities of the farm business by providing goods or services with a basis in a wide understanding of farm resources' [60] (p. 394). Similarly, resource exploitation is another important economic motivation of farm diversification [10,27,49,54,56,60]. To reflect this, we use the number of innovative marketing resources as an indicator of economic performance, because even small family farms need to improve customer relationships and branding strategies as they diversify. Innovative marketing resources can include web pages, social media, product tags, leaflets, farm logos, business cards and direct mail.

The motivation of family members is measured using a 5-point Likert scale as an indicator of internal social performance. In addition, the existence of a nominated farm successor is an important indicator of transgenerational farm performance. Regarding external social performance, the multifunctionalities of UA are measured by summing responses to a series of questions based around a 5-point Likert scale, with questions asking farmers to assess their contribution to society, including offering farm visits, landscape management, interacting with the public, promoting agricultural understanding and supporting the supply of local foods. All of these are highlighted as objectives of multifunctional UA in the Basic Act on Promotion of UA in Japan.

2.2.6. Regression Analysis

Regression analysis is employed in this study to explore the relationship between farm diversification and sustainability, and strategic groups of diversification activities are used as categorical independent variables. In terms of dependent variables, sustainability measures include both continuous and dichotomous variables. First, total sales, added-value ratio, family motivation and multifunctionality are considered as continuous variables. Ordinary least squares regression is used to analyse these variables. Second, the number of innovative marketing resources is calculated as a count variable and analysed using a Poisson regression. Finally, the existence of a successor as a dichotomous variable is analysed using logistic regression.

As farm size and labour are generally correlated, this study only uses farm size as an independent variable to avoid multicollinearity. Farm type, that is vegetable growing or fruit farming, is also included in the analysis. In addition, the cities from which farms are sampled differ in terms of their urban and agricultural policies, so dummy variables for cities are included. Also, peri-urban farms can operate real estate and other businesses in addition to their core farming enterprises. Because such activities are expected to affect farmers' motivation and resource utilisation, we use the ratio of income from real estate businesses to total farm income as a control variable. Finally, farmers' age is used as an indicator of their progress through the farm-family lifecycle.

2.3. Data

The analysis uses data from a survey of 386 farms located close to urban areas in Japan, including Yokohama, Ichikawa and Matsudo, which are in the orbit of central Tokyo. The survey was conducted in 2017–2018 through questionnaires posted to almost all vegetable and fruit farms in those areas (1100 in Yokohama, 300 in Ichikawa and 158 in Matsudo). The proportion of valid responses was 24.7% (22.9% from Yokohama, 28.3% from Ichikawa and 31.0% from Matsudo, respectively).

3. Results

3.1. Description of the Sample Farms

Table 2 presents descriptive statistics for the sample farms. The mean area of farms in the sample is 114 a and the mean labour input is 383 man-days. According to the 2015 Agriculture and Forestry Census, the mean area per farm is 87 a in Yokohama, 112 a in Ichikawa and 109 a in Matsudo. This range suggests that farm size in the sample is likely to be reasonably representative of the population. Second, because the study areas are well-known for the production of pears, grapes and certain vegetables, the proportions of fruit and vegetable farms in the sample were 31% and 59%, respectively. The proportion of real estate businesses among farms is 46.0%, which reflects the fact that sample farms are located in highly urban areas. The mean age of farmers in the sample is almost 63 years old, and the proportion of sampled farmers under 60 years old is 37%, a slightly higher proportion than in census data (under 30% in each city).

Table 2. Descriptive statistics for sample farms.

Variables		Mean	Standard Deviation	Min.	Max.	Descriptions (Unit)
Labour		383	272	0	2050	(Man-day) * Total amount of both family and non-family labour excluding main manager and volunteers in a year.
Land area		114	84	0	480	(a) Total amount of land farmed including tenanted farmland
Farm type	Vegetable	0.59	0.49	0	1	Dummy variable, 1 = 'Vegetable' accounts for two-thirds of total farm sales
	Fruit	0.31	0.46	0	1	Dummy variable, 1 = 'Fruit' accounts for two-thirds of total farm sales
Real Estate Business Rate		46.0	31.9	0	100	(%) the percentage of income from real estate business in the total of farm income
Farmer's age		62.8	11.6	25	80	(years old) Class mark of eight scales ranging from 1 (10–20) to 12 (80–)
Social network		26.4	6.1	8	40	Sum of eight dummy variables below
Break down **	Farmers in other areas	2.92	1.33	1	5	5-Likert scale ranging from 1 (None) to 5 (Once a week)
	Farmers' cooperative	3.16	1.11	1	5	5-Likert scale ranging from 1 (None) to 5 (Once a week)
	Extension services	2.43	1.10	1	5	5-Likert scale ranging from 1 (None) to 5 (Once a week)
	Suppliers	2.94	1.13	1	5	5-Likert scale ranging from 1 (None) to 5 (Once a week)
	Business partners	2.22	1.40	1	5	5-Likert scale ranging from 1 (None) to 5 (Once a week)
	Consultants	1.22	0.63	1	5	5-Likert scale ranging from 1 (None) to 5 (Once a week)
	Local residents	3.41	1.50	1	5	5-Likert scale ranging from 1 (None) to 5 (Once a week)
	Customers	3.12	1.53	1	5	5-Likert scale ranging from 1 (None) to 5 (Once a week)
Economic performance	Sales	696	612	0	3000	(10 thousand yen) Class mark of 12 scales ranging from 1 (None) to 12 (3,000)
	Adding-value ratio	29.0	33.3	0	100	(%) the percentage of production that is given more added value than other farms in the total of product
	Innovative marketing resources	1.12	1.60	0	7	Sum of the seven dummy variables below
	Web page	0.12	0.32	0	1	Dummy variable, 1 = 'Web page' is introduced for farm business
	Leaflet	0.18	0.38	0	1	Dummy variable, 1 = 'Leaflet' is introduced for farm business
	Product tag	0.16	0.37	0	1	Dummy variable, 1 = 'Product tag' is introduced for farm business
	Farm logo	0.14	0.35	0	1	Dummy variable, 1 = 'Farm logo' is introduced for farm business
	Business card	0.25	0.44	0	1	Dummy variable, 1 = 'Business card' is introduced for farm business
	Social Networking Service (SNS)	0.07	0.26	0	1	Dummy variable, 1 = 'SNS' is introduced for farm business
	Direct mail	0.19	0.39	0	1	Dummy variable, 1 = 'Direct mail' is introduced for farm business
Internal social performance	Successor	0.30	0.46	0	1	Dummy variable, 1 = 'Successor' is nominated from family
	Family Motivation ***	3.02	1.05	1	5	5-Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)
External social performance ****	Multifunctionality	14.9	5.1	5	25	Sum of five dummy variables below
	Farm visits	2.53	1.49	1	5	5-Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)
	Landscape management	3.03	1.21	1	5	5-Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)
	Interacting with the public	2.62	1.29	1	5	5-Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)
	Agricultural understanding	2.97	1.26	1	5	5-Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)
	Local food supply	3.73	1.27	1	5	5-Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)

* Man-day means a unit of 1-day's work by one person. Then, 383 man-days in a year mean that an average farm required 383 persons who work only 1 day to run farm businesses. In reality, 383 man-days can be interpreted as two or three persons who work more than 100 days in a year. ** question 'Tick ONE box that best describes how frequently you interact with each person or organisation'. *** question 'Tick ONE box that best describes how strongly you agree or disagree with the following statements about family motivation', statement 'In 5 years, the motivation of family members for farm business management is becoming stronger'. **** question 'Tick ONE box that best describes how strongly you agree or disagree with the following statements about social contributions of your farm'.

In terms of economic sustainability, the average total sales per farm is 6,956,000 yen, and the average added-value ratio is 29.0%. The mean number of innovative marketing resources used is 1.12, which suggests the sample farms are not particularly proactive in introducing such measures. The most popular tools are business cards, whereas social networking services (SNS) are used by only 7% of the sample, which perhaps reflects the average age of farmers. Regarding internal social performance, 30% of the sample have family successors, a ratio in keeping with census data. The mean score for family motivation is 3.02, with a relatively low standard deviation. The average multifunctionality score is 14.9. The highest score is for local food supply and the lowest score is for farming experience (e.g., offering farm visits). These findings indicate that farms experience differences in their ability to undertake the various functions associated with multifunctional UA.

Figure 2 shows the diversified activities of sample farms. Over half of the farms sampled have participated in wholesale markets. Farm-gate sales are the most popular direct marketing business, with delivery services popular for fruit farms. Sales to retailers are the only short supply-chain common to more than 20% of the sample. Fewer than 10% of farms have diversified into processing, farm visits,

tourism farming or pick-your-own, respectively. As a result, the average I-HDI is 1.67 and the average number of enterprises is 2.52.

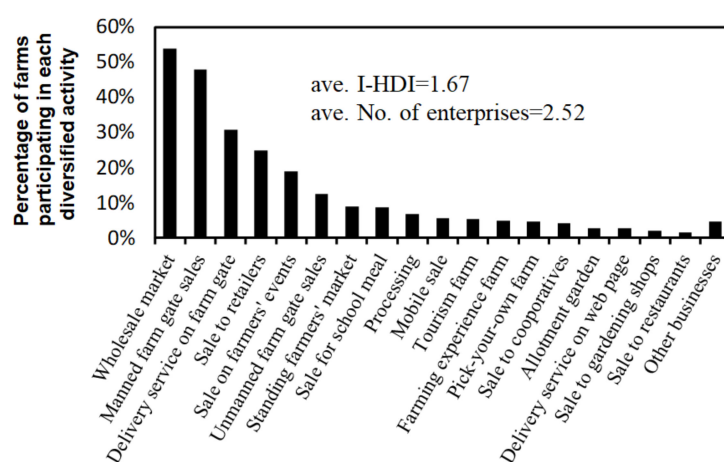


Figure 2. Diversified activities of sample farms.

3.2. Measures for Advanced Diversification

Figure 3 illustrates the mean scores for the six EO indicators. Only the mean score for the first-mover exceeds the reference score of 3, and the mean total EO score is 15.08. This suggests that sample farms are not highly entrepreneurial.

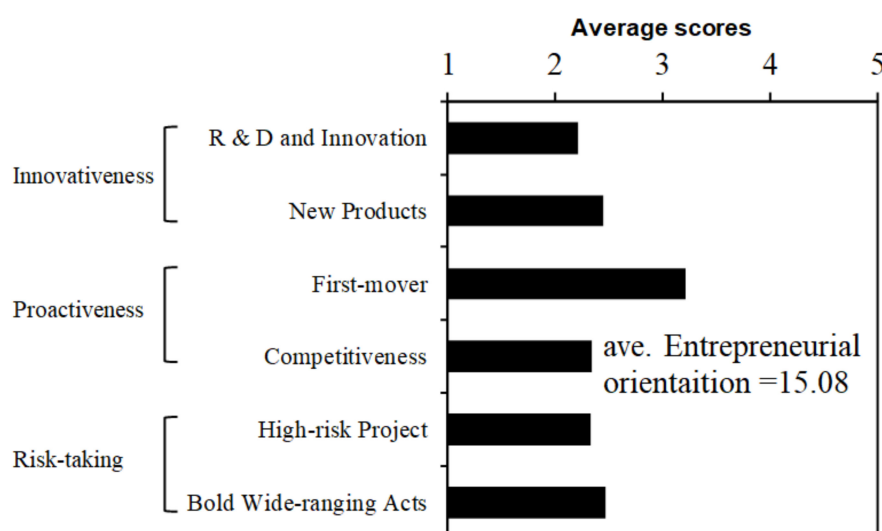


Figure 3. Bar plot of average entrepreneurial orientation indicator scores (≥ 1 to ≤ 5) of the sample.

Figure 4 shows the mean scores of indicators for each management capability investigated in the survey. Marketing and labour management seem to be practised frequently but the average scores for account management and strategic management are all below the reference mean of 3. Operational record keeping, operational planning and claims handling are the most common practices, while cost accounting, customer listing and performance analysis are the least common. The average TC score for the sample is 50.48.

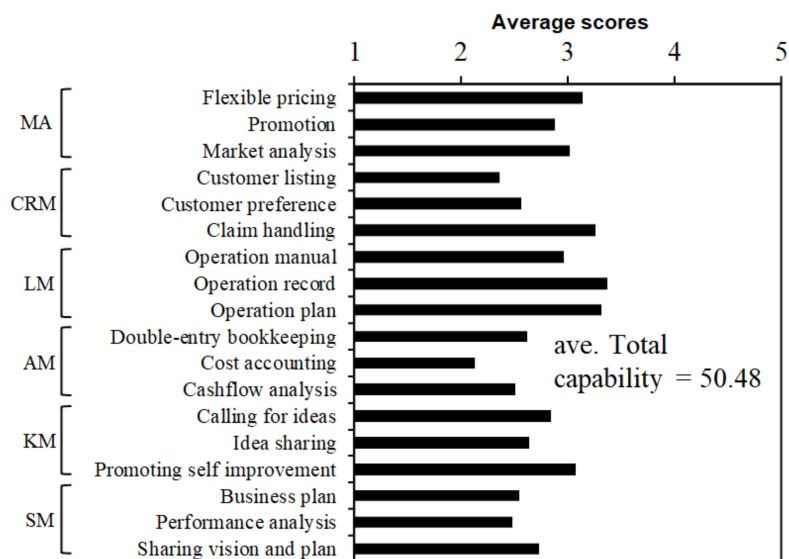


Figure 4. Bar plot of average management capabilities indicator scores (≥ 1 to ≤ 5) of the sample.

Figure 5 illustrates the average scores for the eight SN indicators. The indicators that exceed the reference score of 3 (once every six months) are participation in farmers' cooperatives and interacting with local residents and customers. Interactions with consultants, extension services and business partners are relatively rare. These findings indicate that PUA farmers in this sample are not particularly successful in building broader SNs, although they are well embedded in local communities. The average SN score is 26.57.

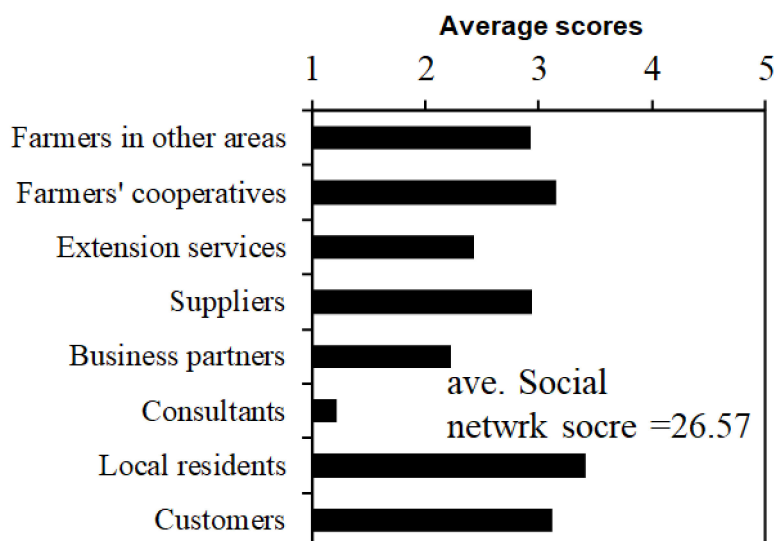


Figure 5. Bar plot of average social network indicator scores (≥ 1 to ≤ 5) of the sample.

3.3. Clustering Analysis

Gaussian finite mixture clustering analysis using I-HDI, EO, TC and SN results indicated that three clusters can be classified based on the criterion: that is, BIC is highest in the three-component (cluster) configuration compared with other configurations based on fewer or more clusters. Table 3 describes each of the three clusters and presents the analysis of variance results. Cluster A exhibits the highest average scores for all four variables. Cluster B had the lowest I-HDI, TC and SN scores. The degree of farm diversification in Cluster B is moderate and its TC and SN scores lie between those of the other two clusters. No difference in EO was found between Clusters B and C. Figure 6 shows the

mean and distribution of variables by clusters. Cluster A rarely includes farms with low EO, TC and SN scores. This indicates that the most difficult problem facing farms is to achieve higher levels of all three advanced characteristics. On the other hand, Cluster B and Cluster C contain both high and low-score farms.

Table 3. Summary of clustering analysis.

Cluster		A	B	C	
Name of Cluster		Advanced Diversification	Conventional Diversification	Conventional Specialisation	F Test
No. of Samples		42 (12.8%)	185 (50.0%)	159 (37.2%)	
Inverse HDI (I-HDI)	(1~)	2.49	1.92	1.06	A > B > C
Total capability (TC)	(15~75)	62.58	50.33	46.51	A > B > C
Entrepreneurial orientation (EO)	(6~30)	19.56	14.09	14.70	A > B, A > C
Social network (SN)	(8~40)	27.22	21.49	19.35	A > B > C

Note: F-tests reveal statistically significant mean differences ($p < 0.05$) between clusters.

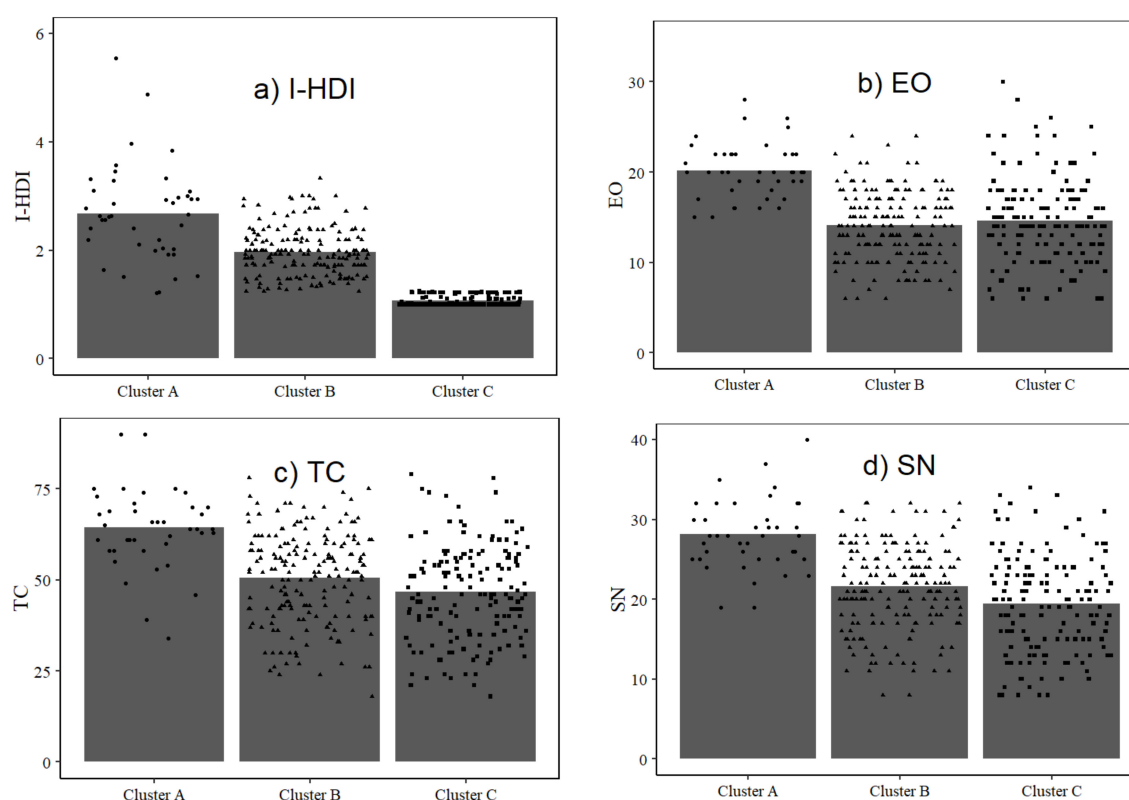


Figure 6. Bar plots of mean of four variables ((a) inversed Herfindahl index, (b) entrepreneurial orientation, (c) total capability and (d) social network) and jitter plots of all sampled farms by clusters (A, B and C).

Accordingly, farms in Cluster A can be interpreted as exhibiting advanced diversification. This cluster accounts for only 12.8% of the sample, which indicates that relatively few PUA farms in the sample can achieve advanced diversification. On the other hand, Cluster B, where farms have achieved moderate levels of diversification, can be interpreted as having achieved more conventional diversification, with farms generally having lower scores than those in Cluster A for EO, TC and SN. The fact that this cluster accounts for 50.0% of the sample suggests that around half of the farms in the sample are not particularly entrepreneurial or innovative. Similarly, Cluster C can be interpreted as displaying more conventional specialisation because farms in this cluster have the lowest scores for all four variables. This analysis also reveals that advanced specialisation is not clustered, and farms

with more advanced characteristics are more likely to adopt strategies based around diversification than specialisation.

Table 4 shows the characteristics of each cluster and the analysis of variance results. Farms that have achieved advanced diversification (A) have a larger labour force than other farms; however, the size of these farms is no different to that of farms in other clusters. The mean age of farmers in advanced diversification farms is comparatively low. In terms of sustainability, cluster A has the highest means for sales, adding value ratio, innovative marketing resources, family motivation and multifunctionality. Little difference was found between the conventional diversification (B) and conventional specialisation (C) clusters for sales, adding value ratio successor and family motivation. On the other hand, the conventional diversification cluster (B) has higher scores in terms of innovative marketing resources and multifunctionalities compared with the conventional specialisation cluster (C). In contrast, the real estate business rate is almost identical in each cluster. This implies that income from non-farm businesses does not affect the extent of farm diversification and the degree of sustainability.

Table 4. Characteristics of each cluster and analysis of variance.

Cluster			A	B	C	F Test
Name of Cluster			Advanced Diversification	Conventional Diversification	Conventional Specialisation	
Labour	(Man-day)		514	390	341	A > B, A > C
Farm size	(a)		142	111	110	
Farm type	Vegetable	(1 = Yes, 0 = No)	0.62	0.46	0.74	C > B
	Fruit	(1 = Yes, 0 = No)	0.19	0.44	0.19	B > A, B > C
Real estate business rate	(0~1)		0.44	0.49	0.43	
Farmer's age	(years old)		58.2	63.0	63.7	C > A
Performance	Sales	(10 ⁴ yen)	992	692	622	A > B, A > C
	Adding value ratio	(%)	53.3	28.2	24.5	A > B, A > C
	Innovative marketing resources	(0~7)	2.67	1.28	0.52	A > B > C
	Successor	(1 = Yes, 0 = No)	0.36	0.32	0.25	
	Family motivation	(1~5)	3.44	2.97	2.97	A > B, A > C
	Multifunctionality	(5~25)	19.7	14.9	13.5	A > B > C

Note: F tests determine the statistical mean differences ($p < 0.10$) between clusters.

3.4. Regression Results

Regression results indicate differences in effects on performance of the three clusters when compared to the reference cluster (excluded from the models). Table 5 reports two models to aid comparison across clusters. The first uses conventional specialisation as the reference cluster and the second uses conventional diversification. In this case, the coefficients of other control variables do not change.

First, compared to conventional specialisation, both advanced diversification and conventional diversification have significant positive effects on total sales, innovative marketing resources, presence of successors and multifunctionality; that is, diversification affects not only economic performance but social performance regardless of how advanced a farm is.

Second, compared to conventional diversification, only advanced diversification has significant positive effects on the added-value ratio, innovative marketing resources, family motivation and multifunctionality. In other words, improved performance in these areas requires a combination of diversification, management capabilities, entrepreneurship and social networks. In terms of the added-value ratio and family motivation, no significant differences were found between conventional diversification and conventional specialisation. However, compared to conventional diversification, advanced diversification does not have a significant effect on sales or successors. This suggests that the act of diversification is important in terms of sales and farm succession, rather than the advanced nature of that diversification.

Table 5. Effects of strategy type on farm sustainability.

		Economic Performance						Internal Social Performance				External Social Performance	
		Sales		Added-Value Ratio		Innovative Marketing Resources		Family Motivation		Successor		Multi-Functionality	
	Intercept	882.62 **	998.43 **	32.53 **	38.24 **	0.66 * (1.94)	1.26 ** (3.54)	3.32 **	3.32 **	−8.18 ** (0.00)	−7.65 ** (0.00)	14.42 **	15.45 **
type	Advanced diversification	249.49 **	133.68	28.16 **	22.45 **	1.47 ** (4.34)	0.86 ** (2.37)	0.41 *	0.40 *	0.76 + (2.13)	0.23 (1.26)	5.08 **	4.05 **
	Conventional diversification	115.81 *		5.71		0.60 ** (1.83)		0.00		0.53 + (1.69)		1.02 +	
	Conventional Specialisation		−115.81 *		−5.71		−0.60 ** (0.55)		0.00		−0.53 + (0.59)		−1.02 +
Farm size		3.28 **		0.02		0.002 ** (1.002)		0.001 *		0.01 ** (1.01)		0.01 **	
Farm type	Vegetable	−208.12 *		−4.13		−0.83 ** (0.44)		−0.29		0.09 (1.09)		−1.58 +	
	Fruit	−296.55 **		−7.66		0.23 (1.25)		−0.10		0.09 (1.10)		−0.63	
City	Yokohama	−174.42 *		−3.30		−0.39 * (0.68)		−0.31 +		−0.29 (0.75)		1.87 *	
	Ichikawa	−151.71		−6.80		−0.11 (0.90)		−0.50 *		−0.53 (0.55)		−0.40	
Real Estate Business Rate		−268.26 **		4.86		−0.06 (0.94)		−0.23		0.53 (1.70)		0.59	
Farmer's age		−2.52		−0.09		−0.01 ** (0.99)		0.00		0.09 ** (1.09)		−0.04 +	
F test (<i>p</i> value)		0.00		0.00				0.00				0.00	
Adjusted R-squared (Nagelkerke)		0.31		0.06		(0.61)		0.05		(0.28)		0.19	

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; Innovative marketing resources values in parentheses indicates the incident rate for every unit increase in each independent variable. Successor values in parentheses provide the odds ratio for every unit increase in each independent variable.

Regarding the control variables, farm size has significant positive effects on all sustainability measures other than the added-value ratio, suggesting that farm size is important for both economic and social sustainability. Farms in Yokohama City exhibit a higher tendency to be multifunctional compared with farms in other cities. Most farms in Matsudo City are likely to have certified status (unlike those in the other two cities), and as a result, farmers there are expected to be more highly motivated than others in the sample. This is confirmed in the Yokohama and Ichikawa dummies which are found to have a negative effect on family motivation. The real estate business rate has a lower impact on-farm sustainability. Finally, younger farmers are more likely to use innovative marketing resources and to take a proactive approach to multifunctional agriculture.

4. Discussion

The results of the clustering analysis correspond to the classification of Fadden and Gorman [17], including: innovative diversifiers, potential innovative diversifiers and non-innovators. While 11 of the 37 farms (about 30%) were classified as innovative diversifiers in Fadden and Gorman [17], our results reveal that only 12.8% of the sample can be considered as examples of advanced diversification. These results suggest that farm diversification strategies can be statistically classified regardless of differences in the internal and external farm environment between Japan and Western countries. Moreover, innovative or advanced diversification is only one aspect of farm diversification and less innovative or conventional diversification is more common in PUA (observed in 50% of our sample).

Clark [16] emphasises the importance of entrepreneurial diversification in rural development. Although this study is based on farmers' subjective assessments, the findings clearly demonstrate that advanced diversification strongly contributes to the multifunctionality of urban agriculture. When all other conditions are equal, advanced diversification scores are 4.05 points higher than conventional diversification; that is, the scores associated with the four indicators of advanced diversification (excluding local food supply) are 1 point higher than for other farms. Similarly, indicators suggest that these farms have higher levels of economic and internal social sustainability than their more

conventional counterparts. For example, advanced diversified farms add over 20% more value to their products and adopt one additional innovative marketing tool. The level of motivation of family members for farm business management is also higher in advanced diversified farms.

Thus, in peri-urban areas, entrepreneurial or advanced diversified farms continue to take a more proactive approach to multifunctional agriculture, thereby improving the likelihood of maintaining economic viability compared to conventional farms. The academic contribution of this study is to use statistical analysis to demonstrate the importance of advanced diversification to the economic and social sustainability of farms and to reveal the characteristics of farms who undertake such activities, a subject largely overlooked by previous studies.

This study also deals with the issues identified in previous UA studies. Ilbery [10] suggested that a lack of marketing skills and entrepreneurial attitudes serve as obstacles to farm diversification in the urban fringe. This study has statistically demonstrated that those characteristics are essential for sustainable farm diversification. According to Tables 3 and 4, while there is no statistically significant difference in farm size between advanced and conventional diversification, the total capability score and entrepreneurial orientation scores for advanced diversified farms are 24% and 39% higher respectively than their conventional counterparts.

In Japan, farms in more urban areas can achieve economic sustainability by balancing agriculture and real estate businesses [98]. By contrast, the findings of this study imply that advanced diversification can be effective in achieving farm sustainability regardless of other income sources (effects of real estate business rates on social sustainability are not significant). In Japan, where a declining urban population is inevitable in the near future, the sustainability of PUA itself will be increasingly crucial for urban resilience.

5. Conclusions

The objectives of this study are to clarify the existence of advanced diversified farms and their management characteristics, and the sustainability of advanced diversified farms compared with other types of farms. To collect data, a questionnaire survey was conducted in peri-urban areas around Tokyo. Based on a clustering analysis with variables related to diversification and the advanced nature of the diversification, only around 10% of the sample can be classified as exhibiting advanced diversification, which suggests the limited influence of advanced diversification on local economies in this part of Japan. On the other hand, half of the sample can be interpreted as exhibiting conventional diversification without evidence of a wide range of management capabilities, entrepreneurial attitudes or social networks. Farms achieving advanced diversification are found to have superior economic and social sustainability when compared with other groups.

The policy implications of this study are significant. In Japan, legislation relating to the provision of loans for UA requires urban farms to meet certain certification criteria around multifunctionality. However, this study implies that diversification alone is insufficient for farms to be able to significantly contribute to the supply of social benefits. If policy makers ignore this point, it is possible that economically vulnerable diversified farms run by individuals with limited management capabilities, entrepreneurship or social networks could have negative impacts for local sustainability.

Ultimately, the most important actions required to support farms in urban areas are: providing an environment that supports business start-ups; and promoting the development of innovative and entrepreneurial farmers. According to this study, the low capabilities around the financial and strategic management capabilities in farmers need to be improved. Second, the entrepreneurial orientation of most peri-urban farmers in the sample is extremely low. Thus, provision of entrepreneurial training for farm managers is important. Finally, social networks are also indispensable for entrepreneurs. This study suggests that the existence of networks including extension services, business partners and farmers in other areas should be enhanced by business-matching services or improved access to public services. Such policy support would promote advanced diversified farms in PUA across the world.

The measures described above can play a significant role in helping UA achieve multifunctionality and thus promote urban resilience in the future.

The mechanisms that support the development of advanced diversified farms in PUA could not be fully identified in this study but the synergetic effects between diversification and entrepreneurial attributes, such as entrepreneurship, management capabilities and a social-networking skill, are likely to play an important role in the process of farm development. To clarify the role of these mechanisms, more detailed and long-term case studies are required, and insights from those case studies should be further explored through quantitative analysis. To that end, the indicators used in this study could be referred to as assessment criteria. In addition, future research on the performance of UA should consider the combination of diversified enterprises on urban farms rather than just the degree of diversification, because the synergetic effects of multiple diversified enterprises on farm sustainability may be significant. Finally, this study did not include farm location characteristics as factors that influence the relationship between diversification and farm sustainability. Given that several studies have concluded that location can be an important determinant of farm diversification in PUA, spatial statistical analyses are recommended in future studies.

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