



Factors Associated with Dynamic Changes in Japanese Agriculture: Farm Discontinuation and Entry Using the Individual 2005 and 2010 Census of Agriculture

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Abstract

Using descriptive and quantitative analyses of farming households drawn from the 2005 and 2010 censuses of agriculture, this study provides reference material for future efforts to support agriculture and agricultural communities. Despite some data limitations for a few municipalities, several significant trends were identified. Discontinued farm households (those that ceased commercial activities between the two Censuses) tended to be in the Hokuriku region. These farms were characterized by aging populations, lack of successors, and a decline in operation size. Further, they tended to rent their farmland and had low rates of environmental conservation practices – both signal indicators of diminished capacity as operators in regional agriculture. Moreover, although no clear trends were identified among entrant farm households (those that

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began commercial agricultural operations during the same period), it is notable that they shared characteristics with discontinued farm households, such as being small scale operations and lacking successors. The current shortage of fiscal budget allocated to agriculture necessitates a narrowing and/or prioritization of support efforts. In this context, these results may enable the development of efficient measures to prevent farm discontinuation and to assist the emergence of entrant farm households.

Keywords: Census of Agriculture, Farm Discontinuation, Entry to Agriculture, Logistic Model

Introduction

According to the “Synthesis Report of the 2010 World Census of Agriculture and Forestry” published by the Ministry of Agriculture, Forestry, and Fisheries in Japan (hereafter: MAFF), as of 1 February 2010, there were 1,631,000 commercial farm households in Japan. Further, demographic aging is a grave situation, as the mean age of major farm workers has now exceeded 65, having risen by 1.9 years since 2005, to 66.1 years. Over 60% of the total farm worker population is 65 or older, and more than half of this group are the so-called old-old elderly (75 or above). The decline in farm households and their aging contributed to the abandonment of cultivation. Since 2005 this has increased by 2.6% (or 10 thousand ha) to 396 thousand hectares.

The increased rate of decline in Japanese agricultural production coupled to agrowing apprehension about the stability of the nation’s food supply and the various functions of rural agricultural areas have spurred governmental action. Specifically, from since 2012, budgets are have been allocated for “comprehensive support service for entrant farmers

(*Shinki syuunou sougou shien jigyou*)” (136 billion yen) with a goal of establishing to establish 20, 000 entrant farmers per year under the age of 40. The core of this program is to ensure benefits for beginning farmers. Other programs include “support service for management establishments (*Keieitai ikusei shien jigyou*)” (6.3 billion yen) that subsidize purchases of agricultural equipment by entrant farmers and community farming organizations, as well as a “support fund for entrant farmers (*Syuunou shien shikin*)” that continued loaning reserves (700 million yen) to approved farmers from the previous year. Additional measures to support both entrant farmers and those central to the region include anew “direct payment program of household income compensation for management stabilization (*Kobetsu shotoku hoshou keiei antei suishin jigyou*)” (7.2 billion yen).

However, a review of these measures reveals the small budget relative to industrial standards and the lack of specific targeting (as with previous policies); both of these issues raise questions about their effectiveness. Regardless of size of budget, the lack of

specific targeting is particularly serious; an effective measure cannot be realized without first understanding something about the structure of Japanese farm households, especially those discontinuing and entering this profession.

The objective of this research is to address this gap by providing information designed to be useful for developing a sustainable and robust agriculture within the extant restricted budget. The first step in this process is to identify the major characteristics of discontinued and entrant farm households. Doing so provides insights into the factors associated with both farm household groups. We link individual data drawn from the 2005 and 2010 censuses to classify farm households into three categories: discontinued, continuing, and entrant. Through descriptive and quantitative analyses, we identify the relative trends of discontinued and entrant farm households. These findings should be of use in future endeavors designed to prevent further farm discontinuation while assisting entrant farm households.

Overview of the Analysis

Literature Review

Despite the recent decline in studies utilizing the census of agriculture, one of the few collaborative achievements is Odagiri's edited volume (2008) analyzing the 2005 census. Other analyses of the 2010 census include a magazine feature article (Editorial

Board of Agriculture and Economics 2011) and internal publications of MAFF (2012). However, both of the latter are framed as reports on structural dynamics with post-tabulation result tables and do not provide detailed analysis of farm discontinuation and entry. The publication most relevant to ours is Sawada's (1999) study of factors of farm discontinuation from the 1990 and 1995 censuses. Sawada, using procedures similar to ours, generated a dataset and found many households discontinued farming at a time of generational change. However, his analysis excluded the Hokkaido region and failed to consider management factors beyond family structure. While differing in approach with this study, a research effort on farm discontinuation using the census of agriculture was presented at the first sectional meeting of the 2012 Farm Management Society of Japan competition (Miyazaki, September 2012). We use four reports from that meeting (Sawada 2012a, Yasutake & Senda 2012, Hosoyama 2012, Watanabe et al. 2012) to help us identify those factors that increased the rate of farm discontinuation: (1) lack of successor; (2) aging farm operators; (3) small-scale operation; (4) single-generation households; and (5) paddy-field operations. While the current study drew valuable insights from this earlier work to aid in determining our measurement model, its findings are limited in geographic region and crop diversity, as well as being limited to descriptive, aggregate analysis.

Analyses of the census of agriculture on farming entry are scarce. There are a few studies that do not use the census, including Egawa's (2000) that analyzed the relationship between entry and support policies, Hara's (2009) that focused on women's social networking power, Inamoto's (1992) that sorted obstacles to entry, and Sawada's (2011, 2012b) that recommended measures to support franchise-style farm management. Yamashita and Hoshino's study (2012) can also be highlighted as one of few quantitative analyses. However, as these studies are focused on ordinary businesses and individuals (households) that have entered from non-agricultural sectors, the nature of the analyses relies heavily on case studies. This is illustrated by the "Report on the Findings of the 2011 Entrant Farm worker Survey" published by the MAFF in August 2012, that found of the 58,120 farmers who began in 2011, only 2,100 (3.6%) were "newly starting farmers" (who began farming with independently acquired lands and funding).

Much of the existing literature on Japanese farm discontinuation and entry issues are descriptive. Though some draw data from the census of agriculture, the results are limited in region, crop, or attributes of management and lack versatility as a resource for policy design. Thus, the potential policy insights to be gained from our analysis are significant.

Object of Analysis

This study used individual data from the survey of agricultural and forestry management entities in the 2005 and 2010 censuses. Six previous surveys (survey of farm households, non-household agricultural entities, agricultural service entities, forestry households, non-household forestry entities, and forestry service entities) were consolidated, and the survey target was generalized to "agricultural and forestry management entities." Though the reason for this consolidation was a reduction in staffing and budget size, there was the benefit of facilitated understanding and analysis at the operational unit size that was difficult when farm households and farming entities were separately surveyed. Of the 2.01 million farm operation units (excluding forestry) 98.6%, or 1.98 million, were family operations, and organizational operations, such as community-based agriculture, accounted for the remaining 1.4% (1.8% in the 2010 census). Moreover, households in possession of multiple operational units constituted only 0.01% (290 households), even when including forestry. Thus, despite the shift in survey target from households to operational units, agricultural households operated by families (i.e., farm households) remain the basis of Japanese agriculture. Our analytical unit is, therefore, the household; we exclude organizational operations, and do not distinguish between multiple operations held by a single household (a household was

represented by the primary operation), and exclude forestry since there were only 200 operational units in 2005 and 140 in 2010.

Defining the Discontinuation and Entry of Farm Households

This study uses three terms (discontinued farm households, entrant farm households, and continuing farm households) to characterize the status of farm households. Our operational definitions differ from previous uses (e.g., MAFF) in the following ways. First, discontinued farm households are defined as “farm households that were commercial for the 2005 census and no longer commercial for the 2010 census” (Fig. 1). While discontinued households would normally only include households that completely disengaged from agriculture or that became non-commercial homesteads by scaling down or transferring their selling rights to community-based operations, information to differentiate these from farm households that moved outside the survey district and could not be tracked and commercial farm households that did not participate in the 2010 census was unavailable. Hence, here, discontinued farm households include all entities that ceased being commercial (non-commercial farm households) between the two censuses. Commercial farm households were farm households that managed 30a or more of cultivated land or realized at least one half million yen in agricultural product sales. Sawada (1999)

limited his analysis of farm discontinuation to those farm households with at least 2 million yen in sales. However, as we also focus on entrant farm households, the sales threshold was set to secure the maximal number of entrant farm households in the analysis while using a known commercial farm household standard.

Entrant farm households are defined as “households that were not commercial farm households for the 2005 census but that had become commercial farm households for the 2010 census.” Though the term “(newly) starting” is generally used for entries from non-agricultural sectors including new college graduates, we believe non-commercial farm households should also be included among the non-farm household grouping to capture agriculture as an industry and to better facilitate a more complete analysis of its structure. Thus, the use of the term entrant farm households implies new commercial farm households in this study. This includes farm households entering from non-agricultural sectors as well as households that expanded from non-commercial farm households to commercial farm households. As with the discontinued farm households, this includes farm households that withdrew from community-based operations and regained selling rights, farm households whose location before a move into the census district was unknown, and those that began participating in censuses in 2010.

Continuing farm households were “households that were commercial farm households for the 2005 and 2010 censuses.” Households that moved out or in from the census district for which continued farming could be confirmed are included in this group.

Linking the Data

The individual data from the 2005 and 2010 censuses can be linked using identification numbers unique to each farm household (referred to as the operation unit number for the 2005 census and the reference number for the 2010 census). Unfortunately, some municipalities allocated new numbers from those numbers used in the 2005 census for their 2010 census farm households. This led to the inability to link farm households across these two time points. While the cause of this is unclear, it is suspected to be related to the succession issues of people in charge at the municipality merger movement, or the so-called Great Merger of the Heisei Era. There were 39 such municipalities for the 2005 census and 29 for the 2010 census which experienced these shifts; most occurred in Hokkaido, Gunma, and Fukuoka prefectures. While it would be ideal to verify each farm household from these municipalities using the farm operators' name, phone number, or address, and to then classify them as discontinued, continuing, or entrant, it is difficult for census users to gain access to personal/proprietary information. In addition, since those ratios were very low

(less than 3%), we believed they could be disregarded in this analysis. As a result, all farm households from these municipalities were omitted from the analysis as unknown farm households.

As a result of this decision rule, 50,102 unknown farm households (those whose data could not be linked) were omitted from the 1,963,424 commercial farm households in the 2005 census, resulting in 1,913,322 households (of which discontinued farm households were 392,532 households and continuing farm households 1,520,790 households). As for the analysis of entrant farm households, 23,815 unknown farm households and 2 households lacking information on the household members were omitted from the 1,631,206 commercial farm households in the 2010 census, resulting in 1,607,389 households (of which entrant farm households were 86,599 households and continuing farm households amounted 1,520,790 households).

Analytical Procedures

Beyond heightened concern about protecting personal information, the public sector reformation to cut labor costs induced a drastic cut (from 4,132 to 2,228) in office staff committed to statistical work in the MAFF. Such effects led to a simplification of the survey, from 391 questions in the 2005 census to 206 questions in the 2010 survey. The process of elimination and consolidation of questions also compromised the continuity of data over

time. While it is possible to link the majority of farm households' individual data over two points in time, such reductions creates serious limitations to variable selection and use in panel studies. Further, even if panel data analysis were to be conducted, it is only possible to compute differences between two time points for those continuing farm households for which the relevant variables are accessible at both time periods. It is not possible to capture the factors of change in the nation's agriculture based solely on this data. For these reason, with the exception of these specific cases, this analysis uses only the 2005 census for the analysis of discontinued farm households and the 2010 census for the analysis of entrant farm households and treats each as cross-sectional data. We gained MAFF's permission to use the data in the "(Notice) on the provision of survey data regarding the census of agriculture" (MAFF July 25, 2011, Toukei 23 No.365).

A cross tabulation was first conducted with data points of discontinued and entrant farm households identified in the data linking process and those of continuing farm households from the respective years in order to capture their operational characteristics. Next, a variable was created labeling discontinued and entrant farm households with 1, and continuing farm households with 0. The factors of discontinuation and entrance to agriculture were identified

through a logistic regression model with this newly created indicator as the dependent variable.

In principal, the use of statistics is not necessary for analysis of data from a complete census, i.e., the population. However, there is meaning in conducting such an analysis when taking into account the omission of farm households for which data could not be linked (as well as the presence of human data entry-related errors). Thus, while we did not run statistical tests for the initial comparison of the two groups in the cross-tabulation, a statistical investigation, using a logistic regression model, was conducted to review its agreement with the descriptive analysis.

Aggregate Analysis

Characteristics of discontinued farm households

Using data from the 2005 census, 393,000 discontinued farm households were compared with 1,521,000 continuing farm households (**Table 1**). To accommodate paper length limitations, we focus on significant differences between these groups and other major factors. Our objective is to identify the household structure and operational conditions of farm households that discontinued farming within the five year period between censuses.

First, geographically, the areas where the ratio of discontinued farm households to

the region's commercial farm households was highest was the Hokuriku region (29.7%), and lowest were the Kanto (17.7%) and Kinki regions (18.0%). Although not shown in the table, by prefecture, the ratios in Saga (42.4%) and Toyama (32.6%) were high. Further when focusing on type of farm household, full-time farm households had a higher rate of discontinued farm households than continuing farm households (27.0% and 21.1%, respectively); conversely, a lower rate of Type 1 part-time farm households generating the majority of their income through agriculture (8.4%, 17.4%). This was ironic in that non-farming income supported the continuation of farming operations.

An analysis of the sociodemographic characteristics of the farm operators indicated the mean age among discontinued farms was 64.8, 3.4 years older than for continuing farm households (61.4 years). Additionally, the proportion of women was 8.8% for discontinued farm households, nearly twice the rate for continuing farm households (4.6%). The mean days of agricultural work for discontinued and continuing farm households were 103 and 142 days, respectively. While 17.0% of farm operators from discontinued farm households selected as their living condition for most of a year that they "normally don't do anything (due to illness or old age)," this was true for only half as many (8.0%) farm operators from continuing farm households. On the basis

of these results, for many discontinued farm households it can be speculated that the farm operator may have been practically retired due to age.

Discontinued farm households averaged 3.8 members, 0.6 fewer than continuing farm households (4.4 members). The difference in number of farm workers was small, but the mean age of household members aged 15 or older was 58.6 years for discontinued farm households and 55.4 for continuing farm households. Further, the ratio of households with children (under 14 years old) was 20.9% for discontinued and 26.5% for continuing farm households, indicating demographic aging among discontinued farm households.

Farm households with a successor present in the residence was 38.2% of discontinued farm households, a large difference from that associated with continuing farm households (46.1%). In contrast, similar differences in the age of resident successors, whether they had a spouse or the presence of successors living elsewhere did not exist.

An examination of management characteristics revealed other differences. First, as a distinguishing management approach, few among either the discontinued or continuing farm households had incorporated (0.4%, 0.2%). The ratio of farm households that operated based on contracts with consumers or produce distributors was

9.1% for discontinued farm households, about 2/3 the rate of continuing farm households at 13.7%. Additionally, for each of the three items dealing with environmental conservation practices (reduction of chemical fertilizers, reduction of agricultural chemicals, and use of compost in soil maintenance), discontinued farm households were about 1/3 less likely to indicate they had made such reductions.

Of the three key management factors (land, sales, and labor), the area of cultivated land under management (aggregate of paddy fields, orchards, and upland fields) for discontinued farm households averaged 112.7a, roughly 40% less than the continuing farm households' 185.2a. The portion of large-scale farm household operations of 5 hectares or more was 2.1%, less than half (4.7%) that of continuing farm households. However, discontinued farm households rented out more cultivated land (average of 11.6a) than continuing farm households (7.3a). For both groups, land owned as a portion of land the households were cultivating exceeded 100% (indicating they were renting out their land). Discontinued farm households had a higher ratio (129%) than continuing farm households (108.1%). In essence, the issue of surplus cultivated land under possession of non-farm households (including non-commercial farm households), a structural problem for Japan's agriculture, was more pronounced among discontinued farm households.

The trend for annual produce sales was similar to that of cultivated land area. Sales were lower for discontinued farm households (2,008,000 yen) than for continuing farm households (3,556,000 yen); large-scale commercial farm households (10 million yen or more) constituted only 2.1% of discontinued farm households but 6.9% of continuing farm households.

Finally, we investigated hiring practices. Regardless of permanence, discontinued farm households (regular 0.7%, temporary 5.6%) employed farm workers at a lower rate than continuing farm households (1.1%, 11.2%). This indicated the labor force of the family sufficed, or was redundant to farm work in many discontinued farm households.

In reviewing these results, the relative tendencies among discontinued farm households that terminated commercial agricultural work within 5 years included demographic aging, lack of successors, and a diminishing scale of operation. Moreover, discontinued farm households may rent out cultivated land or have low rates of environmental conservation practices, therefore waning in their role as a vital part of regional agriculture.

Characteristics of Entrant Farm Households and Changes in Continuing Farm Households over Time

Next, using data from the 2010 census, we examined the characteristics of the 87,000 entrant farm households in

comparison to the 1,521,000 continuing farm households (**Table 2**). While not directly related to our study objective, we also attempted a descriptive time-series analysis for entrant farm households wherever a comparison with the 2005 census was possible.

Again, we began with the regional characteristics, and found the portion of entrant farm households were highest in Okinawa (14.8%), Hokkaido (10.0%), Kyushu (8.6%), and Kanto (6.0%) and lowest in the Tohoku region (3.0%). While there were no notable differences in the proportionality of operation types for entrant and continuing farms, the ratio of full-time farm households had risen 6.2% (21.1% to 27.3%) for continuing farm households over the span of 5 years (see Table 1).

No differences emerged between entrant and continuing farm households' operator and household situations. The demographic aging of continuing farm households was in fact notable (increase in mean age by 3.2 years, and 5.1% decrease in portion of households with children). However, there was a relatively large difference in the procurement of successors living in the household, with the portion of entrant farm households with successors (32.6%) roughly 10% lower than of continuing farm households (42.1%).

In terms of distinguishing management features, five times as many entrant farm

households had incorporated (1.1%) than continuing farm households (0.2%). This may be an influence of the presence of farm households that made use of institutional funds in entering agriculture or expanding the operation, as corporations often have higher credit lines. However, the rate of environmental conservation practices was slightly lower for entrant farm households than for continuing farm households.

In examining key management factors (land, sales, and labor), we found cultivated land area under management averaged 160.7a for entrant farm households, 31a (16%) smaller than the 191.6a of continuing farm households. The difference was particularly marked for paddy fields, which for entrant farm households were about 20% smaller. In contrast, the trend reversed for sales of agricultural produce – 4,581,000 yen for entrant farm households, or roughly 30% more than continuing farm households (3,580,000 yen). This was influenced by the fact farm households with the nation's two top sales positions (2.5 billion and 1.5 billion yen) were included in the entrant farm households, as the medians (not in the tables) of entrant farm households (668,000 yen) and continuing farm households (991,000 yen) had the opposite trend. Additionally, rice farm households (those households for which rice were the biggest sale) constituted 37.2% of all entrant farm households including those without sales, about 2/3 of continuing farm households (55.2%).

The increase in the ratio of large-scale, continuing farm households from 5 years earlier was 0.6% (8,588 households) for those 5 ha or larger, and 0.3% (4,098 households) for those with 10 million yen or more, indicating little expansion in either case despite high expectations they would play a central role as agricultural operations. Hiring practices also did not differ greatly, with entrant farm households hiring slightly more regular employees than continuing farm households (2.6% vs. 1.9%, respectively).

In general, entrant farm households held many characteristics in common with continuing farm households, including their small-scale and absence of a successor in the residence. As discussed, such farm households were not necessarily completely new entrants from non-agricultural sectors; these results may reflect the prevalence of cases in which the retired generation accomplishes the expansion of their family's operational scale, fulfilling the outward standards of a commercial farm household.

This section described the characteristics of farm households that discontinued or began farming based on survey items found in the census of agriculture. In the following section, we attempt to capture the overall factors of discontinuation and entrance to agriculture by constructing a measurement model based on these results.

Quantitative Analysis

Discontinuation model

In our discontinuation model, we use as a discrete dependent variable the 2005 census data with a one (1) indicating discontinued farm households and zero (0) continuing farm households to estimate a logistic regression model (logit analysis).

Generally, the selection of independent variables follows from a theoretical model and is then based on the employment of a stepwise procedure based on likelihood or the Wald statistic. However, with a sample as large as the one used in this study, nearly all independent variables emerge as significant. To address this issue, we selected variables for inclusion on the basis of a series of models developed with the aggregate data set that reflected the findings of the previous section and, at the same time, provided good classification and had high goodness of fit. Additionally, through the use of regression diagnostics, we adjusted some measures by using their log (land area, value of sales) to eliminate issues related to heteroscedasticity and eliminated others that demonstrated high levels of multicollinearity.

Estimated results from the model classifying and predicting discontinued and continuing farm households (hereafter: discontinuation model) are shown in the second column of Table 3.

First, one of the model's goodness of fit indices, Nagelkerke's pseudo R^2 coefficient of determination, was only 0.11. However, the classification accuracy rate averaged 79.6% over all. Nonetheless, the accuracy rate drops to 6.1% for the essential classification of discontinued farm households (98.6% for continuing farm households). We address this issue at the end of this section by creating subsamples.

Here, the coefficient indicates the size and direction of the effect of the independent variable on the dependent variable, and the odds ratio, the change in the ratio (probability of becoming a discontinued farm household ÷ probability of becoming a continuing farm household) of the probability of change in the dependent variable resulting from a unit of change in the independent variable. However, as the odds ratio requires an index of the coefficient, there is essentially no problem with an interpretation based only on the coefficient.

First, the coefficients on geography is consistent with the results of the aggregate analysis, as the Hokuriku dummy is positive (i.e., there is a tendency for increases in discontinued farm households in the Hokuriku region), and the Kanto and Kinki dummies are negative. When substituted with the full-time farm household dummy due to an absence of items directly inquiring about non-agricultural income, the coefficient

was positive.

Next, the variables used for the farm operator were the female dummy and retirement dummy, both of which were positive. While the number of days of agricultural work was thought to be an important variable, it was not used due to its high correlation with the retirement dummy, which had more impact, and strengthened the model's goodness of fit and classification accuracy rate. Additionally, no household variables, including age, were significant. The only variable on succession used was the dummy for the presence of a successor in the residence, for which the coefficient was negative.

As for farm management, after combining the three variables on environmental conservation practices to avoid multicollinearity (4-point scale; not at all engaged=0, engaged in all=3), the coefficient was negative. The sales amount (log) and temporary employment dummies were used and were both negative.

While the measurement model for the classification of discontinued farm households was not robust in terms of explanatory power, the coefficient directionality for 10 independent variables, including the three dummies on geography, were consistent with the aggregate analysis. Because of this, the characteristics of households that discontinued farming within 5 years (i.e.,

factors of discontinuation) were, in part, successfully captured. Furthermore, as mentioned at the beginning of this section, it is likely that the low classification accuracy rate for discontinued farm households may be due have reflected more to the skew in the distribution of the dependent variable (number of discontinued: continuing farm households = 1:4) more than reflect on to the adequacy sufficiency of the independent variable. To assess this we created a subsample for the dependent variable (after computing the subsample size from a power analysis), and investigated the overall validity of this model. Running the model described in this section with a random selection of 500 discontinued farm households and 500 continuing farm households (total of 1,000 households) from the population, greatly improved the classification accuracy rate for discontinued farm households (to 65.6%). However, the classification accuracy rate for continuing farm households fell to 66.6% (overall mean of 66.1%).

Entrance model

Next, we constructed a model (hereafter: entrance model) to classify and predict entrant and continuing farm households based on the 2010 census (third column in Table 3). Like the discontinuation model, this was a logistic regression model with a dependent variable coded one (1) for entrant farm households and zero (0) for continuing farm households. As before, results from the aggregate analysis and

the model's goodness of fit, accuracy rate of classification, and correlation coefficients were considered in the process.

Due to the large sample size, the coefficients for all nine independent variables were used in the model were statistically significant. However, as the skew of the dependent variables was even greater than for the discontinued model (Number of entrant: continuing farm households =1:18), the resulting goodness of fit and accuracy rate of the classification were lower. Specifically, the Nagelkerke's pseudo coefficient of determination (R^2) was 0.07, and the overall accuracy of classification was 94.6% (0.5% for entrant farm households). We also created a subsample (500 entrant:500 continuing farm households) for this model to examine its overall validity, and found that the classification accuracy rate for entrant farm households improved drastically to 65.6% (continuing farm households 66.2%, overall mean 64.0%).

First, we reviewed the estimation results of the geographic variables. Of the five regional dummy coefficients, Hokkaido, Kanto, Kyushu, and Okinawa's were positive, and Tohoku's negative. This indicates that, for instance, in Hokkaido, which has a high coefficient and odds ratio, there was a tendency for an increase in entrant farm households. In contrast, none of the items on full-time or farm operator contributed to the model. The

coefficient for the dummy of the presence of a resident successor was negative, as with the discontinued model. Within the management approaches measures, only the incorporation dummy contributed, but with negative value and relatively high odds ratio of 4.11. Finally, for operation scale, the (log of the) cultivated land area under management was used and it had a negative coefficient. Further, since the dummy variable for rice farm households was also negative, it can be deduced that entrant farm households tended to have smaller areas of cultivated land and produced crops other than rice (such as open culture vegetables). Not surprisingly, rice may be avoided by entrant farmers reflecting its drastically lower returns on investment.

The entrance model resulted in a weaker goodness of fit and accuracy rate of classification than the discontinued model. However, the accuracy rate was improved with the model using a subsample. As with the discontinued model, the coefficients and directionality of the nine variables used were consistent with the aggregate results. Overall, the model successfully captured the characteristics of the households that began commercial farming (factors of entry).

We have estimated and interpreted two classification models on discontinuation and entry to agriculture. Both models indicated that while regional factors were a large influence, many common

household and management characteristics, including lack of successors and small scales of operation were also important. Such factors may indicate that the entrant farm households have the potential of discontinuation.

Conclusion

The prolonged economic stagnation and recent globalization of the market increased downward pressure on the price of agricultural produce. In addition, the results of the 2010 census of world agriculture highlight trends such as demographic aging and an insufficient workforce. Taken together, these facts reaffirm the accelerating deterioration of the structure of agriculture in Japan. With the objective of facilitating policy design for the regeneration of rural agricultural communities in the nation, this study identified factors associated with discontinuation and entrance to agriculture. We classified farm households using the 2005 and 2010 census of agriculture into discontinued, continuing, and entrant farm households and then comparatively analyzed them descriptively and quantitatively.

The quantitative analysis compared discontinued to continuing farm households and identified the following factors associated with discontinuation:

1. High frequency in the Hokuriku region, and low frequency in the Kanto and Kinki regions;
2. Have become full-time farm

households because the farm operator died or retired but had no non-agricultural sources of income;

3. Demographic aging in the household, therefore lacking a successor for farm management;

4. Diminished scale of management scale, leaving little space for efforts such as environmental conservation; and.

5. Surplus of cultivated land area under possession or labor force in the family.

In contrast, entrant farm households that newly became commercial farm households had the following relative trends:

1. High frequency in Okinawa and Hokkaido, and low frequency in the Tohoku region;

2. Though there were no outstanding trends of the farm operator and household, many farm households had not yet procured a successor;

3. Many were small-scaled managements but rate of incorporation was high; and

4. Few were rice farmers, and many lacked familial labor force.

Measurement models were constructed for both the discontinuation and entrance farm households based on these findings. In both cases the variables used and the directionality of the estimated coefficients were consistent with the aggregate analysis and successfully captured the overall factors affiliated with discontinuation and entrance.

In viewing the overall analysis results,

it can be said that factors associated with discontinuation of farming, such as the demographic aging of farm operators and the household themselves, were consistent with our expectations and with previous studies. However, factors associated with entrance to agriculture, such as the lack of successors and small scale of operation had an uncanny resemblance to those of discontinuation. This may, in part, be due to the definition of entrant farm households in this study, but also may be indicative of the reality that the majority of entrant farm households in Japan stem from farm households.

This study has identified the factors associated with discontinuation and entry to farming based on the census of agriculture. The limitation of fiscal budgets allocated to agriculture today requires policy measures with a narrow target or clear prioritization. Given this context, the use of these findings –such as a focused effort to prevent discontinuation in the Hokuriku region – will enable the design of efficient measures to prevent discontinuation and to facilitate entrance to agriculture.

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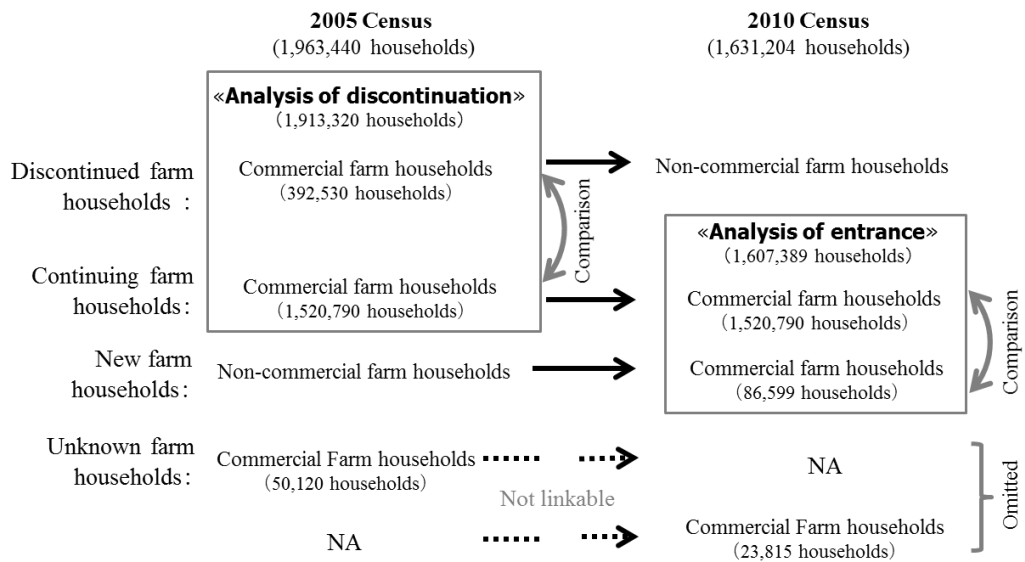


Fig. 1 Definition of Discontinued and New Farm Households

Table 1 Aggregated Results (Discontinued/Continuing, 2005 Census)

Region (Column ratio)	Discontinued farm households (392,532 households)		Continuing farm households (1,520,790 households)		Distinguishing engagements	Discontinued farm households (392,532 households)		Continuing farm households (1,520,790 households)	
	Households	Ratio	Households	Ratio		Households	Ratio	Households	Ratio
Hokkaido	9,225	21.6	33,439	78.4	Incorporated	1,738	0.4	3,063	0.2
Tohoku	74,661	20.2	295,763	79.8	Contract-based production	35,789	9.1	208,795	13.7
Kanto	54,307	17.7	253,080	82.3	Conservation 1 (Reduction of chemical fertilizers)	87,822	22.4	466,057	30.6
Koshinetsu	36,852	20.6	142,224	79.4	Conservation 2 (reduction of agricultural chemicals)	112,644	28.7	591,612	38.9
Hokuriku	23,712	29.7	56,054	70.3	Conservation 3 (Compost use)	82,224	20.9	477,580	31.4
Tokai	37,227	20.5	144,499	79.5					
Kinki	31,619	18.0	143,568	82.0	Land (a)				
Chugoku	36,913	20.5	143,443	79.5	Cultivated land under management (mean)	112.7		185.2	
Shikoku	22,328	19.6	91,400	80.4	→Paddy-field (mean)	85.9		121.3	
Kyushu	61,424	23.1	204,435	76.9	→Orchard (mean)	35.7		63.3	
Okinawa	4,264	24.9	12,885	75.1	→Upland field (mean)	52.7		99.5	
					5ha or greater	8,259	2.1	72,122	4.7
Operation type					No cultivated land under management (0 ha)	1,419	0.4	2,335	0.2
Full-time farm households	106,149	27.0	321,352	21.1	Rents out cultivated land (mean)	11.6		7.3	
Type 1 part-time farm households (Majority of income from agriculture)	32,946	8.4	264,447	17.4	Abandoned cultivated land (mean)	27.2		27.7	
Type 2 part-time farm households (Agricultural income supplementary)	253,437	64.6	934,991	61.5	Ratio of cultivated land owned (%)	129.2		108.1	
Farm operator					Sales of agricultural produce				
Age (mean)	64.8		61.4		Sales (mean)	200.8		355.6	
Female farm operator	34,534	8.8	70,712	4.6	→Rice as greatest portion	213,427	54.4	824,485	54.2
Days of agricultural work (mean)	103.0		142.3		→Fruits "	24,345	6.2	150,544	9.9
Usually does not do anything	66,865	17.0	121,750	8.0	→Outdoor vegetables "	21,262	5.4	120,628	7.9
					→Indoor vegetables "	8,757	2.2	79,089	5.2
Household					→Other crop "	31,075	7.9	136,685	9.0
Total household members (mean)	3.8		4.4		→Livestock "	10,567	2.7	70,852	4.7
Farm employes (mean)	2.5		2.9		10 million yen or more	8,153	2.1	104,984	6.9
Mean age of members 15 or older	58.6		55.4		No sales (0 yen)	83,099	21.2	138,507	9.1
Presence of members 14 or younger	82,025	20.9	403,742	26.5					
Successor					Farm labor force (People/year)				
Resident successor present	149,938	38.2	700,667	46.1	Presence of permanent employment	2,838	0.7	17,153	1.1
→Age (mean)	37.5		35.4		→total (mean)	3.8		2.7	
→Spouse present	62,152	41.5	292,367	41.7	Presence of temporary employment	21,848	5.6	170,006	11.2
Non resident successor present	41,945	10.7	157,834	10.4	→total (mean)	4.7		5.3	
→Age (mean)	40.3		35.9						

Means were calculated with zeros as missing (i.e. values exclude farm households with zero). Means of days of agricultural work were approximated from a frequency distribution table.

Table 2 Aggregated Results (Entrant/Continuing, 2010 Census)

Region (Column ratio)	Entrant farm households (86,599 households)		Continuing farm households (1520,790 households)		
	Households	Ratio	Households	Ratio	
Hokkaido	3,704	10.0	33,439	90.0	
Tohoku	9,212	3.0	295,763	97.0	
Kanto	16,030	6.0	253,080	94.0	
Koshinetsu	6,496	4.4	142,224	95.6	
Hokuriku	2,229	3.8	56,054	96.2	
Tokai	6,927	4.6	144,499	95.4	
Kinki	7,964	5.3	143,568	94.7	
Chugoku	7,305	4.8	143,443	95.2	
Shikoku	5,313	5.5	91,400	94.5	
Kyushu	19,186	8.6	204,435	91.4	
Okinawa	2,233	14.8	12,885	85.2	
Operation type					
Full-time farm households	26,353	30.4	415,715	27.3	
Type 1 part-time farm households (Majority of income from agriculture)	9,086	10.5	211,301	13.9	
Type 2 part-time farm households (Agricultural income supplementary)	51,160	59.1	893,774	58.8	
Farm operator					
Age (mean)	63.6		64.6		
Female farm operator	6,795	7.8	91,150	6.0	
Days of agricultural work (mean)	142.9		153.5		
Usually does not do anything	7,394	8.5	106,465	7.0	
Household					
Total household members (mean)	3.6		4.0		
Farm employees (mean)	2.4		2.8		
Mean age of members 15 or older	58.0		58.5		
Presence of members 14 or younger	16,606	19.2	324,847	21.4	
Successor					
Resident successor present	28,248	32.6	639,572	42.1	
→Age (mean)	37.4		37.9		
→Spouse present	10,642	37.7	266,975	41.7	
Non resident successor present	15,424	17.8	276,542	18.2	
→Age (mean)	No applicable item		No applicable item		
Distinguishing engagements					
Incorporated		980	1.1	3,249	0.2
Contract-based production		No applicable item			
Conservation 1 (Reduction of chemical fertilizers)		25,339	29.3	538,175	35.4
Conservation 2 (reduction of agricultural chemicals)		29,558	34.1	618,487	40.7
Conservation 3 (Compost use)		21,903	25.3	425,271	28.0
Land (a)					
Cultivated land under management (mean)					
→Paddy-field (mean)		160.7		191.59	
→Orchard (mean)		100.8		126.2	
→Upland field (mean)		52.6		63.7	
Sha or greater		107.6		104.6	
No cultivated land under management (0 a)		4,225	4.9	80,710	5.3
Rents out cultivated land (mean)		773	0.9	3,055	0.2
Abandoned cultivated land (mean)		43.8		45.1	
Ratio of cultivated land owned (%)		30.9		29.7	
		127.8		116.5	
Sales of agricultural produce (10 thousand yen/year)					
Sales (mean)		458.1		358.0	
→Rice as greatest portion		32,188	37.2	839,096	55.2
→Fruits "		8,693	10.0	152,419	10.0
→Outdoor vegetables "		10,002	11.5	130,621	8.6
→Indoor vegetables "		4,276	4.9	75,077	4.9
→Other crop "		10,149	11.7	122,993	8.1
→Livestock "		3,514	4.1	63,060	4.1
10 million yen or more		6,181	7.1	109,082	7.2
No sales (0 yen)		17,777	20.5	137,524	9.0
Farm labor force (People/year)					
Presence of permanent employment		2,294	2.6	28,352	1.9
→total (mean)		3.1		2.2	
Presence of temporary employment		20,207	23.3	384,351	25.3
→total (mean)		4.7		4.9	

Table 3 Logistic Regression Model

Independent Variable	Discontinued model (Discontinued=1)			Entrance model (New=1)		
	Coefficient	Standard error	Odds ratio	Coefficient	Standard error	Odds ratio
Regional dummy 1 (Hokkaido=1)	—	—	—	1.72	0.02	5.58
Regional dummy 2 (Tohoku=1)	—	—	—	-0.24	0.01	0.79
Regional dummy 3 (Kanto=1)	-0.19	0.01	0.83	0.33	0.01	1.38
Regional dummy 4 (Hokuriku=1)	0.54	0.01	1.72	—	—	—
Regional dummy 5 (Kinki=1)	-0.38	0.01	0.68	—	—	—
Regional dummy 6 (Kyushu=1)	—	—	—	0.59	0.01	1.81
Regional dummy 7 (Okinawa=1)	—	—	—	1.03	0.02	2.81
Full-time farm household dummy (full-time=1)	0.39	0.01	1.47	—	—	—
Female farm manager dummy (female=1)	0.44	0.01	1.55	—	—	—
Retired farm manager dummy (don't usually do anything=1)	0.51	0.01	1.66	—	—	—
Resident successor dummy (present=1)	-0.23	0.00	0.79	-0.24	0.01	0.79
Incorporation dummy (incorporated=1)	—	—	—	1.41	0.04	4.11
Degree of engagement in sustainable agriculture (4-point, 0-3)	-0.11	0.00	0.90	—	—	—
Log of cultivated land area under management (a)	—	—	—	-0.51	0.00	0.60
Rice farm household dummy (Rice as largest sale=1)	—	—	—	-0.49	0.01	0.61
Log of agricultural crop sales (10,000 yen)	-0.25	0.00	0.78	—	—	—
Temporary employment dummy (present=1)	-0.26	0.01	0.77	—	—	—
Constant	-0.36	0.01	0.70	-0.46	0.02	0.63
	Sample size	1,913,322			1,607,389	
	Highest coefficient of correlation	0.33			0.39	
	Pseudo coefficient of determination (Nagelkerke R ²)	0.11			0.07	
	Akaike's Information Criteria (AIC)	154917.53			59417.45	
	Classification accuracy rate (Discriminant probability)	79.6%			94.6%	
		(Discontinued 6.1%, Continuing 98.6%)			(Entrants 0.5%, Continuing 99.9%)	

Due to the large sample size, statistical tests for all coefficients were significant at 0.1%. For the same reason, the null hypotheses of the Hosmer and Lemeshow goodness of fit tests are rejected and cannot be used to determine a model.