


Article

Factors Influencing the Chance of Inheriting the Family Farming Career among Heirs in the Upper Northern Region of Thailand in the Crisis of Farming Labor Decline

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Abstract: The aging society of farmers and lack of motivation to pursue a farming career among farmers' young heirs could induce a severe labor shortage crisis in the farming sector in Thailand in the near future, especially in the upper northern region, which has been officially declared as the base of the organic agricultural production of the country. The main problem is the decision of farmers' heirs to inherit or not inherit the farming career of their families. The relevant factors and their effects on the decision must be investigated and analyzed. A set of descriptive statistical tools were used to analyze the significance of each factor. A prediction model based on logistic regression was applied to analyze how sensitive of each factor is to the decision to inherit the family farming career. The discovered results could help the federal organization to plan and establish an appropriate strategy in order to cope with the crisis. Here, there are 519 surveyed samples referring to farmers' heirs from five provinces in the upper northern region, which are Chiang Mai, Chiang Rai, Nan, Lamphun, and Mae Hong Son. The data were collected using a questionnaire. The following 10 relevant factors were found to have direct impacts on the decision to inherit the farming career: gender, increased age, marital status, increased yearly income, the chance to obtain advice from the Federal Department of Agricultural Extension, attitudes towards the farming career, an increase in the land size for farming per family, increase in the land size for farming in the rural area, the variety of agricultural products produced by the family, and an increased set of farming equipment and tools possessed by the family. However, an increase in the number of new family members could lead to unwillingness to inherit the farming career. All these factors in both the willing and unwilling groups had a statistical significance at the level of 0.05. Since the sample size of the willing group was considerably larger than the sample size of the unwilling group, a technique of minority oversampling was adopted to alleviate the problem of the imbalanced datasets. The classification accuracy obtained was 77.56. In addition to the federal planning and strategies applied to ease the crisis, the factors discovered in this study can be used as a stimulus for persuading and stimulating the young generation to inherit the farming career or become a skillful as well as knowledgeable professional farmer capable of producing high-quality agricultural products for the upper northern region of Thailand.

Keywords: decline in farming labor; inheritance of the farming career; farmer's heir; motivation



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1. Introduction

Farming has been the root of the food security, occupations, and incomes of human up to the present time. Most importantly, farming is still the main career of people living in rural areas, where poverty prevails at rates as high as 80% of the population [1]. Various emerging and unavoidable problems, such as climate change, the misuse and overuse of chemical farming substances, and economic volatility, challenge the success of the farming career [2]. Aging impacts farmers' health, which directly decreases their proficiency in farming activities in terms of the number of agricultural products and quality [3,4].

Furthermore, this situation occurs in parallel with the decline in, and lack of, farmers' heirs to inherit the farming career, which can deteriorate the farming sector, as the source of world food production [5].

Food nutrition is the most important factor necessary to sustain the quality of life of the population in every country, regardless of its religion, politics, and geography, as pointed out in Tripitaka [6]. However, if a country is rich in arable land that can be farmed to produce its own food without importing food in the form of either raw materials or previously processed food from other countries, the country will be secured from poverty, and the population will be able to devote their abilities to the advancement of the country's prosperity. Thailand is rich in arable land. The report of trade statistics from the Department of Trade Negotiation in the year 2022 [7] indicated that the agricultural production of Thailand ranked fifth in the export list. This implies that the income from agricultural products is very important. Thus, sustaining agricultural growth through continuously improved, relevant technology is essential for Thailand. However, increasing the more qualified labor force in this agricultural or farming sector is even more essential. However, this ideal circumstance is, to date, hindered by the crisis of farming labor decline, as previously mentioned. This critical problem requires a deep investigation of the relevant impact factors.

Thailand is one of the countries where most of rural population have farming as their main career. The current trend of increasing age among farmers and the lack of interest in continuing the farming career among farmers' heirs may soon raise some structural problems in the farming sector of the country [8]. The 12th National Economic and Social Development Plan of Thailand (B.E. 2560–2564) [9] forecasted that Thailand will have more than 20.5 million population aged over 60 years by the year B.E. 2583, which is equivalent to 32.1% of the total population. This change will affect the economic security and society of Thailand, directly impacting the farming sector, which requires approximately 30% of the country's labor force. In contrast, the decline in the farming labor force is continuing, as confirmed by the report of Jansuwan and Zander [8]. The authors reported that only 30% of Thai farmers were aged less than 45 years old in the year B.E. 2551, and this declined to 19% in the year B.E. 2561. The National Statistical Office of Thailand [10] reported that approximately half of the domestic farming labor force are older than 65 years, equivalent to 54% of the population in the farming sector. This survey also indicated that the upper northern region of Thailand is another region encountering this aging situation. The heads of farming households are entering old age (between 46 and 55 years old). Moreover, some of them are already in the elderly age range (between 56 and 65 or more than 65 years old). A lack of farming labor also causes concerns about the ongoing development of the farming sector. When young laborers have a higher education, they will lack motivation to pursue a farming career and fear an insecure income [11]. This means that the laborers entering middle age and old age cannot be replaced by the younger generation. These young laborers prefer to move from the farming sector to the industrial and service sectors, thus affecting the organic production base in the upper northern region of the country [12]. This also has a consequent impact on the safety food processing industry, such as vegetable, fruit, and herb processing [9]. In addition to the labor decline, Thailand has an aging society, which, consequently, also affects the quality as well as the quantity of Thailand's exported agricultural products.

Without a proper plan to resolve the expansion of its aging society, the quality and quantity of the organic products of Thailand could be seriously decreased. Consequently, this circumstance may degrade the quality of life because of the unavailability of good-quality farming products. This implies that the retired farmers or unhealthy, aged farmers must be compensated by their heirs in order to alleviate this crisis. However, the younger generation in the upper northern region of Thailand prefer to choose other careers rather than farming careers [12]. Thus, it is essential to develop a model that can be used to predict whether or not a young heir in the upper northern region of Thailand is willing or unwilling to inherit the family career prior to planning feasible and practical strategic action. The

attributes involved in the prediction process concern the factors of family status, social influence, and the environment relevant to the farming aspect. The prediction model can signify which attributes are important for resolving the crisis and help to develop a federal guideline in order to persuade the farmers' heirs to become the new, young generation of farmers with the knowledge, skill, and potential to produce high-quality farming products.

The upper northern region of Thailand is ranked second in terms of the number of farmers and size of the farmland in the country. Moreover, the region has been declared as a region of environmentally friendly agricultural extension, organic farms, and farm safety systems. Hence, this region is worth strengthening in terms of the sustainability of farming activities and the local traditional, as well as the cultural practices of the local people. With this realization, this research focusses on identifying the relevant factors in relation to the inheritance of the farming career and causes of the farming labor decline among the local people in the upper northern region of Thailand. Discovering these factors can help to retain the productive farming career in this region. A similar study was conducted by Corsi et al. [13]. They identified the factors affecting the inheritance of farming careers, such as land size and age.

To scientifically investigate the relevant factors and recommend an appropriate guideline, the theory of vocational development of Super [14] and theory of occupational choice of Ginzberg [15] are adopted as the framework of the study. Super's theory signifies the influencing factors involved in career planning, which refer to family relations, personal needs, social effects, and environmental impacts. This theory was applied in our study to select and analyze the independent factors concerning the intention to inherit or not inherit the farming career. On the other hand, Ginzberg's theory emphasizes the periods of occupational choice, consisting of the fantasy period, tentative period, and realistic period. This theory was adapted in our study to partition farmers' heirs into three groups, which included those willing to inherit the farming career, those unwilling to inherit the farming career, and those undecided as to their decision to select any career. Each group was based on the corresponding period of Ginzberg, i.e., the realistic period, fantasy period, and tentative period, respectively.

The investigated problems in this study are the following: (1) what are the factors motivating a farmer's heir in the upper northern region of Thailand to willingly inherit the family farming career? (2) what are the most and least important factors influencing the decision regarding inheritance? (3) What are the appropriate and practical guidelines that can be used to resolve the problem of farming labor decline in the upper northern region of Thailand via the issue of family farming inheritance?

2. Materials and Methods

The questions in the questionnaire were formed by applying the concepts of the theory of vocational development of Super [14] and theory of occupational choice of Ginzberg [15]. In addition, some independent factors were also adopted from previous, similar studies reported in other countries [4,13,16,17]. However, the adoption of factors from other studies was based on the proper context that was deemed most suitable for Thailand's agricultural circumstances.

2.1. Population and Samples

In this study, we focused on each family instead of each household, because one household may have people from different families. Hence, the word "family" is used throughout this paper. There were two phases of selection involved in this study. The first phase concerned the selection of the sample areas. The second phase was the selection of the farmers' heirs in the sample areas. The details of the selection of the sample area are as follows below.

The population explored in this study was farmers' heirs in the upper northern region of Thailand, composed of 8 provinces. The method of multi-stage sampling was used to select the samples. The selection steps consisted of (1) randomly selecting 5 out of

8 provinces, which were Chiang Mai, Chiang Rai, Nan, Lamphun, and Mae Hong Son; (2) randomly selecting 4 districts from each selected province from step 1, totaling 20 selected districts; and (3) randomly selecting 4 sub-districts from each selected district from step 2, totaling 80 sub-districts. From the selected provinces, districts, and sub-districts, there were 39,774 families in total. This population was sampled by purposive sampling [18] to obtain 519 samples for logit regression analysis using the program G*Power 3.1 [19] and descriptive statistical analysis. The details of the analyses will be discussed later. After selecting the sample area, each sample heir was selected as follows below.

In this study, each family refers to a group of people related to each other by family status as a father, a mother, a son, or a daughter. Any adopted son or daughter was also considered as an heir of the family. Only one heir from each family was considered in this research. The selection of an heir is decided by the family with constraints on the heir's age, as he/she must be at least 18 years old and also living with the family while the family head is still alive.

2.2. Tool and Data Collection

The tool used in this research was a questionnaire investigating personal information and attitudes towards the preference to inherit the family farming career. The questionnaire consisted of two sets of open-ended and close-ended questions. The questions were designed to gather the information relevant to each studied variable. In fact, some of these independent factors have been studied before in the context of the agricultural circumstances of other countries. The impact of the gender factor was previously studied in Ghana [20] and in Swaziland [21]. Studies in Poland [22] and in China [23,24] found that marital status is also a significant factor with an impact on this issue. Farm succession in the Republic of Moldova is affected by the number of family members [25]. The source and amount of the family's income are important indicators of change in farm functions [26]. In Ghana, the receipt of federal services in the form of academic advice can help to boost the farming family's productivity and income [27,28]. Having a positive attitude towards the farming career can clearly strengthen the survival of family farms [4]. The reports of the International Fund for Agricultural Development [29] and the study reported in [30–32] reached the same conclusion, stating that the family's land size is one of the most important factors necessary to sustain the succession of family farming. Having a section of arable land in a rural area can encourage the continuation of farming activities [33–36]. Owning enough farming equipment and tools can increase farm productivity [37,38]. In this study, the independent variables were based on the concepts of Super's and Ginzberg's theories. The dependent variable factors were defined according to the concept of Ginzberg's theory. The last column of Table 1 summarizes the references for each previously studied variable factor. The first set consists of both open-ended and closed-ended questions concerning personal information in the following 4 aspects: (1) basic characteristics of gender, age, and marital status, (2) the number of family members and income, (3) social influence in terms of the advice acquired from agricultural extension officers and attitude towards farming careers, and (4) environmental impacts on agricultural factors, including the family's land size, the size of the land located in the rural area, the variety of the family's farming products, and the number of farming tools and equipment. The second set consists of two parts of close-ended questions. The first part is a self-evaluation concerning the farming career. Two groups of heirs, the group willing to inherit the farming career and group unwilling to inherit the farming career, are evaluated. The second part consists of 17 questions measuring the level of attitudes based on a 5-level Likert score [39], where 5 means strongly agree; 4 means agree; 3 means unsure, 2 means disagree; and 1 means strongly disagree.

2.3. Approval of Ethics by the Institutional Review Board (IRB)

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the Institutional Review Board of Chiang Mai University, Thailand (project identification code: CMUREC No. 64/197).

2.4. Data Analysis

The method of analysis consists of two phases. The first phase computes the descriptive statistical values, which are the sample mean, standard deviation, and percentage of each attitude score for the 17 questions. The following intervals are used to interpret the meaning of each computed value: 4.21–5.00 means strongly agree; 3.41–4.20 means agree; 2.61–3.40 means unsure; 1.81–2.60 means disagree; and 1.00–1.80 means strongly disagree. The second phase develops a binary logistic regression analytical model to predict the chance of inheriting the farming career from the family among farmers' heirs. The details of the regression analysis are as follows:

(1) There are 11 independent variables related to the following 4 aspects: (1) personal factors, consisting of gender, age, marital status; (2) family factors, consisting of the number of family members and family's income; (3) social influence factors, consisting of the advice received from the officer of the Department of Agricultural Extension and the attitude towards the farming career; and (4) agricultural environment factors, consisting of the family's arable land size, arable land size in the rural area, the variety of farming products produced by the family, and the number of farming tools and equipment owned by the family. For the dependent variables, the desire to inherit or not inherit the farming career from the family is the main focus. Thus, two dependent variables are defined, which are: (1) the group of heirs willing to inherit their family career, and (2) the group of heirs unwilling to inherit their family career. The variable names, notation of each variable name, types of scaling, and assigned values, as well as the units of measurement, are summarized in Table 1.

Table 1. Summary of the independent and dependent variables, notations, types of scaling, and assigned values and units of measurement used in the analysis in this study. The last column provides the references for the previously studied variable factors and theories.

Variable Factors	Variable Name	Types of Scaling	Assigned Value and Unit of Measurement	References for Previously Studied Variable Factors and Theories	
Independent variables					
Personal factors	Gender	GENDER	Nominal scale	1 = Male 0 = Female	[20,21]
	Age	AGE	Ratio scale	Number of years	[40–43]
	Marital status	STATUS	Nominal scale	1 = Married 0 = Other status	[22–24]
Family factors	Members of the family	FMEM	Ratio scale	Number of members	[25]
	Family income	INC	Ratio scale	Amount earned (Baht/year)	[26]
Social influence factors	Receipt of advice from the officer of the Dept. of Agricultural Extension	ADVICE	Nominal scale	1 = Received 0 = Not received	[27,28]
	Attitude towards the farming career	ATT	Interval scale	Average attitude score computed from all 17 questions	[4]
Agricultural environment factors	Family's land size	AGRIAREA	Ratio scale	Size of the land in "Rai" unit (1 Rai is approximately 0.395 Acres)	[29,30]
	Arable land size in the rural area	AGRIZONE	Ratio scale	Size of the land in "Rai" unit (1 Rai is approximately 0.395 Acres)	[33–36]
	Variety of farming products by the family	VARIETY	Nominal scale	1 = Various products 0 = Single product	[31,32]
Dependent variables	Number of farming tools and equipment owned by the family	MACHINE	Ratio scale	Types of equipment and tools	[37,38]
	Inheritance of the farming career	INHERIT	Nominal scale	1 = Willing to inherit 0 = Unwilling to inherit	[15]

(2) The next step is to develop a model based on the method of binary logistic regression analysis [44] in order to predict the chance of willingness and unwillingness to inherit the family farming career, using the independent variables as the inputs. The defined independent and dependent variable factors were adopted and developed from previous studies, applying Super's theory and Ginzberg's theory, respectively. The details of the references are provided in the last column in Table 1. The conceptual diagram of the prediction model is illustrated in Figure 1. The left block is a list of independent variables, and the right block is a list of dependent variables. The brief method of binary logistic regression analysis is outlined as follows. The analysis is carried out based on the hypothesis that each independent variable factor related to 4 issues, i.e., the personnel issue, family issue, social influence issue, and agricultural environmental issue, affect the willingness to inherit the family farming career, having a statistically significant level of 0.05.

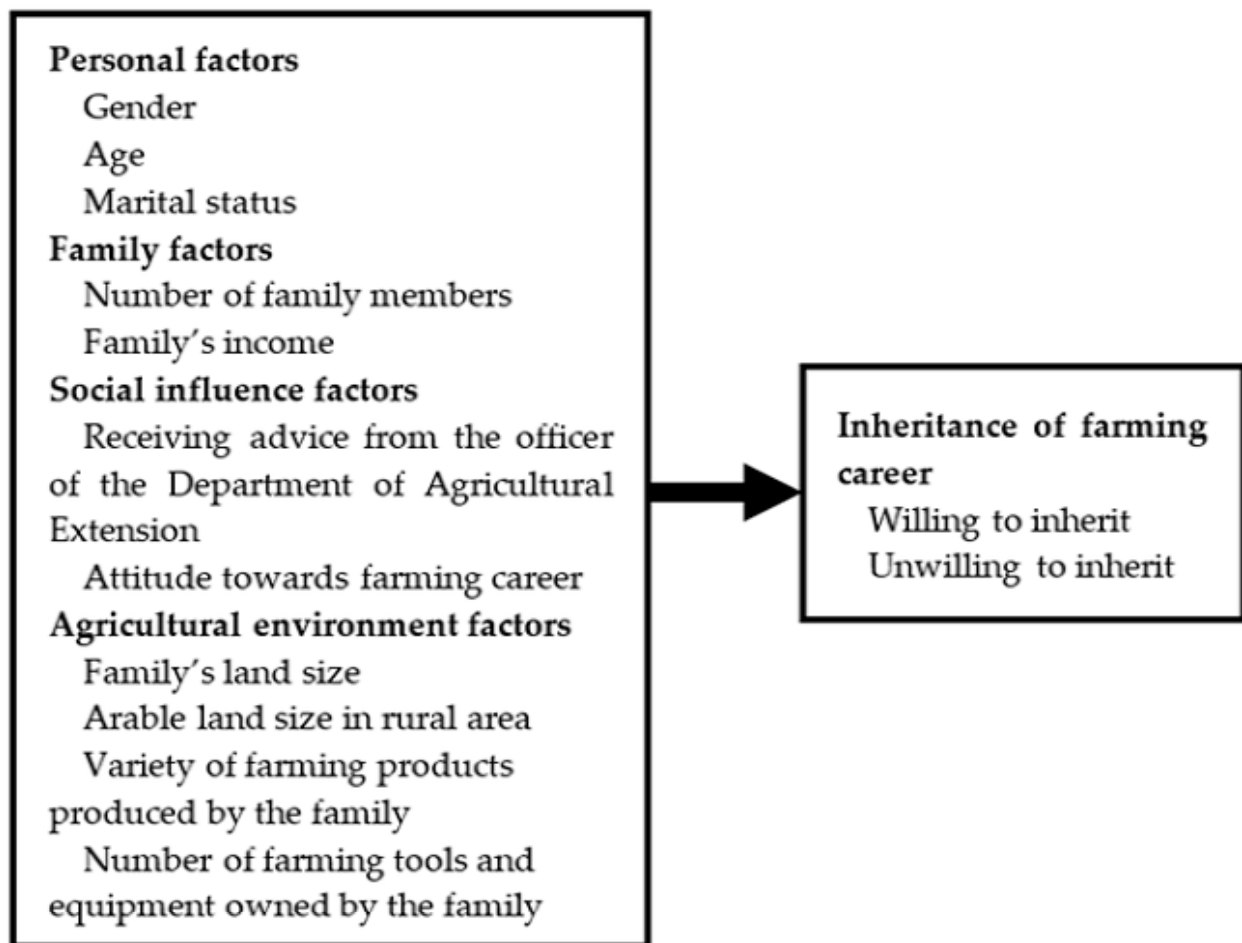


Figure 1. Conceptual diagram of the model for predicting the chance of willingness and unwillingness to inherit the family farming career. The left block contains all the independent factors and the right block contains the dependent factors.

For the computational analysis, each independent variable can be called a feature of a sample. This method can be viewed as a method of classifying the given datasets into two classes according to their features, using a hyperplane in a high-dimensional feature space and a logistic function (or sigmoid function) as a threshold function to determine the class. Logistic function is a differentiable function imitating a threshold function, which is non-differentiable. The output of a logistic function varies from 0 to 1, depending on the input variable. Thus, this function can be interpreted as a probabilistic function. There are two classes in this study, i.e., the class of willingness to inherit the family farming career and class of unwillingness to inherit the family farming career. If the value of the logistic

function is equal to 1 (or rounded up to 1), then the input feature is predicted as belonging to the class of willingness. Otherwise, if the value is 0 (or rounded down to 0), then the input feature is in the class of unwillingness. Based on the observation, a logistic function can be deployed as a probability of the class prediction. Let $P(z)$ denote the probability that input z is in the class of willingness. The value of z is computed from the input feature to the equation of the separating hyperplane between the two classes. To determine the predicted class, the value of z is fed into a threshold function, which is a logistic function in this study. Since there are two classes, clearly, the probability of being in the class of unwillingness is equal to $1-P(z)$. The value of $P(z)$ is defined as a logistic function, as follows:

$$P(z) = \frac{1}{1 + e^{-z}} \quad (1)$$

where $z = \sum_{i=1}^m a_i f_i$. Each f_i is the i^{th} independent feature, such as the income or attitude score of a given issue, and a_i is the regression coefficient of f_i obtained from the separating hyperplane.

(3) Verifying the prediction model. The following four factors are verified: (1) the percentage of the prediction accuracy obtained from the model [45], (2) the regression coefficients, whether each one is 0 or not [46], (3) the relationships among all the independent variables, assessed by the methods of Cox and Snell and Nagelkerke [47], (4) and appropriation of the prediction model by the method of Hosmer and Lemeshow [48].

(4) Eliminating the imbalanced data problem. Generally, social data collection always encounters the problem of imbalanced data, where the number of data in both the majority and minority classes is unequal. This can cause serious inaccuracy in the predicted result, because the value of each regression coefficient, a_i , is computed from a predefined regression error function, which includes the error of the predictions from both the majority class and minority class. Since the error of prediction in the minority class is dominated by the error of prediction in the majority class due to the data size difference, the accuracy of prediction in the minority class is obviously poorer than the accuracy of the majority class. The resampling method has been proven to be a feasible solution to this problem [49]. In this paper, we propose a method that can be used to select additional data from the minority class. In the study, two approaches of minority oversampling and majority under-sampling were tentatively deployed. It was found that the minority oversampling provided a better result. To oversample the additional data from the minority class in this study, the mean and standard deviation of each feature were computed first. Let s_i be the standard deviation of the i^{th} feature computed from all the samples in this class. Select a sample j from the minority class, such that $f_j \in [-s_j, s_j]$ will be an additional sample for resolving the imbalanced data problem. This causes the total number of samples in both classes to increase from 519 to 555 for the further binary logistic regression analysis.

(5) Analyzing how sensitive the change of each independent feature value is to the change in the logistic value in Equation (1) for the class of willingness. If a small change in the value of a feature can induce a larger change in the logistic value, it implies that the corresponding independent variable should be considered first. Only one feature is analyzed at a time. Suppose a feature f_i is analyzed. The value of each other independent feature f_j must be fixed at the average value of f_j from all the samples in the class of willingness. Any nominal feature, such as gender or marital status, is not involved in the analysis, because it has only two values, either 0 or 1, which is not suitable for viewing the speed of change. The results of this analysis are provided and discussed in the next Section.

3. Results

The results of the analysis have two parts. The first part is the statistical summary of the personal data. The second part is the results of the prediction model. The details of each part are summarized as follows.

3.1. Statistics of Personal Data

The study found that most of the samples in the class of unwillingness tend to be female, at 63.71%. Furthermore, the heirs in the class of unwillingness have an average age lower than the average age of the heirs in the class of willingness. Among them, 77.02% are single. In the context of the family factor, both classes have almost equal average numbers of family members, with four members per family. The income of the heirs in the class of unwillingness is slightly higher than the income of the heirs in the class of willingness. In the social dimension, approximately 60.59% of the heirs willing to inherit the farming career have received some prior advice from the officer of the Department of Agricultural Extension. They also have a very positive attitude towards the farming career, at $\bar{x} = 4.33$. For the agricultural environment factor, the families in the class of willingness tend to own their land. In the rural area, the size of the land owned by the families in this class is larger than the size of the land owned by the families in the other class. Remarkably, 57.65% of heirs in the class of willingness live with their families, perform integrated farming, and own various farming equipment and tools. Table 2 and V summarize the qualitative and quantitative data.

Table 2. Personal data of the heirs (qualitative data).

Personal Data of Farmers' Heirs	Class of Willingness (n = 308)		Class of Unwillingness (n = 248)		Total (n = 555)	
	Samples	Percentage	Samples	Percentage	Samples	Percentage
Gender						
Male	136	44.30	90	36.29	226	40.72
Female	171	55.70	158	63.71	329	59.28
Marital Status						
Single	129	42.02	191	77.02	320	57.66
Married	161	52.44	48	19.35	209	37.66
Divorced/Separated	16	5.21	9	3.63	25	4.50
Widow/Widower	1	0.33	-	-	1	0.18
Receiving advice from the officer of the Dept. of Agricultural Extension						
Advised	186	60.59	117	47.18	303	54.59
Not Advised	121	39.41	131	52.82	252	45.41
Variety of family's farming products						
Integrated production	177	57.65	113	45.56	290	52.25
Single production	130	42.35	135	54.44	265	47.75

3.2. Results of the Prediction Model and Hypothetical Testing

Based on the logistic regression analysis, the value of each coefficient from the computation is summarized in Table 3. The linear equation of variable z in the logistic function in Equation (1) is formulated as follows:

$$Z = -9.817 + 0.865 \times (\text{GENDER}) + 0.100 \times (\text{AGE}) + 0.893 \times (\text{STATUS}) - 0.191 \times (\text{FMEM}) + 1 \times 10^{-7} \times (\text{INC}) + 0.515 \times (\text{ADVICE}) + 1.429 \times (\text{ATT}) + 0.089 \times (\text{AGRIAREA}) + 0.024 \times (\text{AGRIZONE}) + 0.485 \times (\text{VARIETY}) + 0.152 \times (\text{MACHINE}) \quad (2)$$

The prediction accuracy for the class of willingness is 79.29, while the class of unwillingness is 75.40. The average accuracy is 77.56. Since the size of the samples in the class of unwillingness is smaller than the size of the class of willingness, it induces the problem of imbalanced data, as previously discussed in Section 2. The technique of minority oversampling was applied to help to improve the accuracy. Another possible cause is that the heirs in the class of unwillingness seek other careers rather than farming-related careers. They may move out from their family homes and live in some other areas outside the selected sampling areas, as mentioned in Section 2.

Table 3. Personal data of the heirs (quantitative data).

Personal Data of Farmers' Heirs	Class of Willingness (n = 308)		Class of Unwillingness (n = 248)		Total (n = 555)	
	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
Age (year)	31.45	7.70	24.58	6.61	28.38	8.00
Number of family members (person)	4.32	1.32	4.55	1.34	4.43	1.33
Family income (Baht/year)	166,889.90	165,428.66	192,883.87	330,748.69	178,505.23	253,094.12
Attitude towards the farming career	4.44	0.36	4.19	0.38	4.33	0.39
Family's land size (Rai)	3.01	8.06	0.58	1.78	1.92	6.23
Arable land size in the rural area (Rai)	10.85	15.13	7.66	8.66	9.42	12.74
Family's equipment and tools (number of types)	4.43	1.82	3.94	2.01	4.21	1.92

Note of attitude levels: 4.21–5.00 = strongly agree; 3.41–4.20 = agree; 2.61–3.40 = unsure; 1.81–2.60 = disagree; 1.00–1.80 = strongly disagree.

From the prediction model, there is at least one independent variable having a regression coefficient not equal to 0 at the significance level of 0.05. In other words, there exists at least one independent variable affecting the decision of inheritance at the significance level of 0.05, following the Omnibus tests of model coefficients: $\chi^2 = 216.071$; Sig. = 0.001 [46]. When examining the relationship between the variables and prediction result of the decision to inherit the career by the method of Cox and Snell's R square, we found that it is equal to 0.322, and by Nagelkerke's R square, it is equal to 0.43. This confirms that all 11 independent variables can explain the variation in the decision to inherit the family farming career. However, testing the appropriation of the prediction model by the method of Hosmer and Lemeshow [44,50], we found that there is no statistical significance with Chi-square = 12.395 and Sig. = 0.134. Based on the logistic regression function, there are six independent variables that significantly influence the inheritance of the farming career at the statistical significance level of 0.01, with the other five independent variables at the statistical significance level of 0.05 (as shown in Table 4).

Table 4. Summary of the coefficient of each independent feature and its statistical analysis for the prediction of the probability of being in the class of willingness to inherit the family farming career in the upper northern region of Thailand based on binary logistic regression analysis.

Independent Variables	β	S.E.	Wald	df	Sig.	e^{β}
GENDER	0.865	0.231	14.017	1	0.000 **	2.376
AGE	0.100	0.018	31.682	1	0.000 **	1.105
STATUS	0.893	0.272	10.799	1	0.001 **	2.443
FMEM	−0.191	0.085	5.007	1	0.025 *	0.826
INC	1×10^{-7}	1×10^{-7}	4.258	1	0.039 *	1.000
ADVICE	0.515	0.217	5.643	1	0.018 *	1.674
ATT	1.429	0.294	23.657	1	0.000 **	4.176
AGRIAREA	0.089	0.041	4.648	1	0.031 *	1.094
AGRIZONE	0.024	0.011	5.262	1	0.022 **	1.025
VARIETY	0.485	0.214	5.151	1	0.023 **	1.624

Table 4. Cont.

Independent Variables	β	S.E.	Wald	df	Sig.	e^{β}
MACHINE	0.152	0.057	7.104	1	0.008 **	1.164
Constant	−9.817	1.447	46.004	1	0.000 **	0.000

* means statistically significance at the level of 0.05; ** means statistically significance at the level of 0.01

Hosmer and Lemeshow Test: Chi-square = 12.395, Sig.= 0.134

Omnibus Tests of Model Coefficients: Model Chi-square = 216.071, Sig.=0.000

Model Summary: −2 Log likelihood = 549.401, Cox and Snell R Square = 0.322 (32.2%), Nagelkerke R Square = 0.430 (43.0%)

The positive regression coefficients indicate that the corresponding variables encourage the decision to inherit the family farming career. Male heirs' tendency to inherit the career is 2.376 times higher than female heirs' tendency. The increase in age can enhance the chance of inheritance by 1.105 times. A married heir has a chance of inheriting the farming career higher than that of an unmarried heir by 2.443 times. The increase in yearly income affects the chance of inheritance by 1.00 times. Receiving advice from an officer of the Department of Agricultural Extension increases the chance of inheritance by 1.674. A higher average attitude score increases the chance of inheritance by 4.176 times. The increase in the family's land size improves the chance of inheritance by 1.094 times. Having a piece of land in the rural area can increase the chance of inheritance by 1.025. Having a variety of farming products enhances the chance of inheritance by 1.624. Finally, owning various farming tools and equipment increases the chance of heirs inheriting the farming career by 1.164 times. The only variable that obviously discourages heirs from inheriting the farming career is the number of family members, as indicated by the negative regression coefficient value of −0.191 (variable FMEM in Table 4). The increase in the number of family members can decrease the chance of inheritance by 17.40. In summary, the top three quantitative independent variables affecting the decision are the family's land size, increased age, and having land in the rural area.

To see how sensitive the change of each independent variable value is to the logistic value change in the class of willingness, we plotted the graph between each variable and its logistic value with respect to the fixed values of the other variables at their mean values. Nine non-nominal independent variables were examined and plotted, as shown in Figure 2. The horizontal axis represents the range of values, and the vertical axis represents the logistic value. A larger logistic value with respect to the value of the variable implies a higher sensitivity. Remarkably, the order of positive sensitivity of the independent variables, sorted from the most sensitive down to the least sensitive, is as follows: the family's land size, increased age, having land in the rural area, the attitude score, owning equipment and tools, and income. This means that having a large land size is the most important factor for making the decision. The only variable having a negative sensitivity is the factor related to the number of family members.

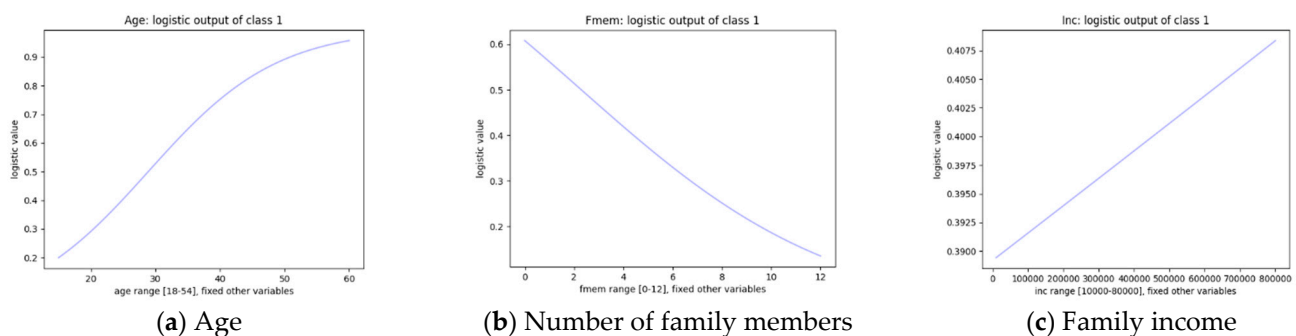


Figure 2. Cont.

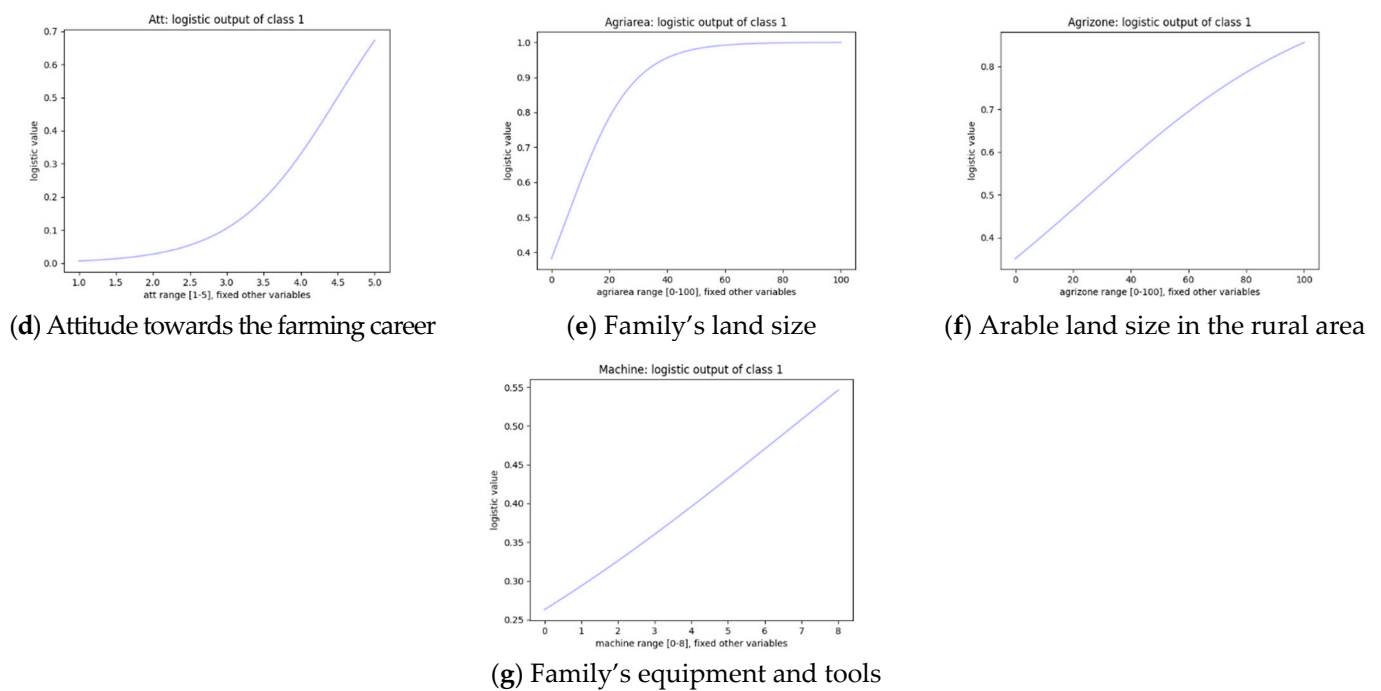


Figure 2. Sensitivity plot between the following independent variables: (a) AGE, (b) FMEM, (c) INC, (d) ATT, (e) AGRIAREA, (f) AGRIZONE, and (g) MACHINE and the corresponding logistic regression output in the class of willingness. The horizontal axis denotes the value range of the independent variable and the vertical axis denotes the logistic value. For example, the top left figure is the plot between the range of ages versus the logistic output by fixing the other variable factors at their mean values.

4. Discussion

The study found that all the independent variables have different degrees of influence on the decision to inherit the family farming career [15]. This section discusses the supportive reason for each variable, as follows.

For the first factor related to the personal data, a male heir has a higher chance of inheriting the farming career than a female heir. This reflects the fact that a farming career is still a hard-working career, especially in the rural area, where access to any agricultural equipment and tools is very limited. Thus, human labor is deployed to compensate for the lack of equipment and tools. The same observation was also reported in other studies conducted in other countries [20,21]. Furthermore, the increase in age enhances the chance of inheriting the farming career. Getting older helps an heir to better contemplate the selection of a farming career, because one can be influenced by gaining the skills infused with knowledge derived from various studies and experiences. The similar observation of this issue in was also reported in other studies conducted in other countries [40,41]. This conclusion also conforms with career development theory [42] and the rationale of how age impacts secure career selection after careful pondering [43]. For the factor of marital status, this study confirms the cultural context of Thai society in the aspect of getting married. When someone is married, the parents usually provide a piece of land as a gift [22] or a bride price [23]. Having a piece of land and money is the most important basic factor for farming [24].

For the factor of family size, the study found that the increase in the number of family members clearly decreases the chance of inheriting the farming career. This is because the land available for farming is reduced, and the arable land size owned by a family becomes smaller. Similar findings were also reported in other countries [25]. Appropriately dividing the land so that it is large enough for farming among each heir cannot be achieved due to the increase in the number of the family's heirs. When the family's yearly income increases,

the chance of inheriting the farming career also increases. This indicates that the source of financial support from the family is essential in order to persuade the offspring to pursue the farming career. Moreover, having sufficiently large funds can make a variety of farming activities possible, a finding similar to the study of other countries reported in [26].

For the factor of social influence, receiving some advice from the officer of the Department of Agricultural Extension enhance the chance of inheriting the farming career. The advice and information received can be adapted and used for planning or deciding on the farming career. Presently, Thailand assigns importance to the aging society of farmers and the lack of heirs' motivation to become a farmer. The Department of Agricultural Extension, Ministry of Agriculture and Cooperatives developed a strategic plan for increasing the number of new-generation farmers [9]. Thus, it is a duty of the officer of this department to encourage and advise farmers' heirs in order to motivate their desire to become a farmer. This duty is also carried out in other countries, as reported in [27,28]. The attitude towards the farming career is another important indicative factor. This attitude can be explained using the theory of planned behavior of Ajzen [51]. The positive attitude influences the intention and indirectly affects human behavior. That is to say, when an heir has a good attitude towards the farming career, he/she will have the chance to gain more interest and to prepare him-/herself for farming. Furthermore, the good attitude is also another option, as an indirectly supportive factor encouraging heirs to enter the farming career [4].

For the agricultural environment factor, the increase in the size of the family's land provides more opportunity for heirs to inherit the farming career. A proper partition of the land into sizes large enough for each heir is also another important factor in order to guarantee and secure the start of the family's farming production [29,30]. In addition, receiving more pieces of land supports the variety of possible farming products, which can enhance the opportunity to earn more income and economical security. This conclusion conforms with the similar finding of Kimhi and Tzur-Ilan [16] in regard to other countries, who stated that possessing a larger land size is the most important approach used by farmers to cope with any change in agricultural risks. However, if most of the family's pieces of land are in the rural area, it can encourage the heirs to continue their families' farming careers. The rationale is based on the fact that land in rural areas is more suitable for farming than the land in urban areas. In particular, the costs of the factors involved, such as the wage, electricity cost, and farming materials, in the rural area are cheaper than the costs in urban areas, as reported in [33,34]. This also involves easy access to natural resources such as reservoirs and plants. The finding is also true in the case of other countries, as reported in the study of Corsi et al. [13], which mentioned that the context of suitable arable land is one of the most important factors related to the inheritance of the family farming career. Rural farming areas are less difficult or lead one to encounter fewer kinds of risks than urban farming areas, such as the expansion of accommodation, business buildings, industries, the poisonous contamination of water, land, and air, as reported in the study in [35,36]. This is to say, owning more pieces of arable land in the rural area can secure the farming careers of heirs. In addition to this advantage, having a variety of mixed farming products and activities, such as various kinds of plants and vegetables, livestock farming, or fisheries, increases the chance of inheriting the farming career, ensures the sustenance of farming in the long term, and secures the economy through several income sources, similar to the findings in [31,32]. All these noteworthy points may create the possibility for an heir to choose the farming career, as determined by the will of the parents, in order to continuously secure their income through various sources. Finally, owning enough and various farming equipment and tools can create the opportunity to inherit the farming career, because the long duration of use may save the maintenance costs, reduce the use of labor in the farming sector, and render the farming activities more convenient, as confirmed by the results from other countries [37,38]. The ability to flexibly use various farming equipment and tools may stimulate more positive attitudes among heirs towards the adoption of farming careers from their families. The previous study by Kostov and

Davidova [17] observed the same fact, supporting the notion of advanced technology use to render new-generation farming more convenient than before.

5. Conclusions and Suggested Practical Guidelines

This study focuses on the problem of identifying the factors influencing the decision to inherit the family farming career among farmers' heirs in the upper northern region of Thailand. Several interesting, independent positive and negative factors were discovered and confirmed by statistical and computational analyses.

From the prediction model in Equation (2), we conclude the following findings and analytical results: The factors impacting the chance to inherit the farming career are being male, being aged, marital status, earning a higher family income, receiving advice from the officer of the Department of Agricultural Extension, having a good attitude towards the farming career, having a larger land size for farming, having land in the rural area, having the ability to create a variety of farming products, and owning more farming equipment and tools. On the other hand, the negative factor is having more family members. To analyze how sensitive each positive factor is to the inheritance of the farming career, the sensitivity value with respect to the value change of each positive factor versus the logistic outcome of the prediction model, after fixing the values of the other unconcentrated positive factors, was plotted. From the plot, the sensitivity of the positive factors, sorted in a decreasing order, is the following: (1) the family's land size (AGRIAREA), increased age (AGE), having land in the rural area (AGRIZONE), the attitude score (ATT), owning equipment and tools (MACHINE), and income (INC). This indicates that the family's land size (AGRIAREA) is the most important factor in defining the decision to inherit the farming career, and the least important factor is the income (INC).

Based on the discovered factors, the following practical guidelines are suggested to help any federal departments or ministry related to the studied problem to plan an appropriate strategy that can be used to alleviate the decline in the number of new young farmers in the upper northern region of Thailand.

(1) Encouraging the acquisition of, or developing skills in, modern farming. The Ministry of Education and Ministry of Higher Education, Science, Research, and Innovation must collaborate with the Ministry of Agriculture and Cooperatives to develop a curriculum in order to prepare young or working-age heirs to become the new young farmer generation. In particular, the focus should be on the group of young generation farmers entering working age.

(2) Raising the potential of the farming products and market to enable farmers' families to increase their income. The Department of Agricultural Extension or Department of Agriculture should enhance the capability of any family having an heir or heirs to produce higher-value products by emphasizing the acquisition of skills in organic farming and a system of good agricultural practice (GAP), as well as the processing of farming products to gain the advantage of the product price. Furthermore, there should be cooperative work with the Ministry of Commerce to provide easy-access outlets for safe farming products at the community level and to support a logistic system for the transfer of farming products to a large consumer market in the urban area or a shopping mall. This approach could clearly raise the family's income and also motivate an heir to continue the family career.

(3) Developing the skill and knowledge required for the officer of the Department of Agricultural Extension to act as a driving force in order to build a young farmer generation. The department should develop the skills of personal communication and the ability to disseminate modern knowledge and skills, such as the use of innovation, modern machinery, and modern agricultural technology, in order to motivate farmers' heirs to inherit their families' careers.

(4) Presenting the creative dimension of farming, with the application of innovation and modern technology to motivate the young generation to enter the farming career. The Department of Agricultural Extension should suggest a new option to make the farming career more convenient and easier than the conventional practice and to reduce

the investment costs of production. This also includes the improvement of the quality and increase in the quantity of products in order to create a new concept of cozy farming or to avoid loss and economic insecurity for Thai youths.

(5) Supporting access to available arable land for the young generation. To render the suggestion successful, there should be collaboration between the Department of Agricultural Extension and the Land Development Department in order to manage the allocation of land in the rural area to farmers' offspring for farming use. In addition, there should be a procedure for the certification of land rights so that the land can be legally utilized for farming, easy to inherit, and beneficial when applying for certification standards of food safety, such as the standard of organic farming and standard of good agricultural practice (GAP). All these certified standards can also add more value to the farming products.

(6) Promotion of the variety of production for new-generation farmers by the Department of Agricultural Extension. The other local government organizations should play a role in promoting the polyculture system and reducing the monoculture system at the same time. The organization may enhance the skills and knowledge of the young farmer generation to enable them to plan on growing short-term crops, such as vegetables as, well as long-term crops, livestock farming, and fisheries at the same time. This will continuously create a variety of farming products and provide income from several sources so as to minimize the economic risk.

(7) Establishing a fund for new-generation farmers to provide access to farming equipment or farming technology. Automation in agriculture is a new, incoming trend (FAO, 2022). The Ministry of Agriculture and Cooperatives should establish a fund to develop a new generation of farmers. A loan with a low interest rate should be provided to new-generation farmers as an initial fund for the acquisition of farming equipment or various farming technologies necessary to start a cozy farming system and to save on labor costs, which are continuously increasing.

6. Limitations

This study was conducted at a time when the problem of farming labor decline was showing a persistent trend. This situation could decrease the farming production of Thailand in terms of its quality and quantity. Moreover, the lives of the local people in the upper northern region of Thailand are also implicitly affected. During this crisis, some new members of the young generation have left the farming career to seek a better career with a higher income. Therefore, the collected data were imbalanced, because most of the available sources of information from the sampled areas were heirs who were willing and undecided about whether to continue their families' careers. The unwilling group was presumed to have moved out from their families' homes. Another limitation is the continuing pandemic COVID-19. At the time of collecting the data at the beginning of the year 2022, the severity of COVID-19 peaked, and it still prevails. This caused problems in acquiring and accessing the samples in the region. Some of the participants had already relocated to work in other areas. Furthermore, some of them who had temporarily moved out did not intend to come back to their families' homes in order to prevent their aged parents from being exposed to the COVID-19 infection.

7. Future Research

This research considered only the factors directly related to the domains of the heirs' personal attributes and the surrounding circumstances of an individual heir. In fact, according to several theories regarding personal behavior, occupation choice, and happiness in life, other factors beyond the investigated domains in this study must also be taken into consideration in order to reach a completely scientific and accurate conclusion. The following three issues must be investigated in future work: (1) How can one enhance the roles of the family's head so as to inspire and motivate the heir(s) to pursue the farming career? (2) What are the appropriate and realizable federal strategy and policy that can be used to encourage a new of young generation farmers in their careers and to guide them

to success? (3) What is the proper procedure with which to inspire the new generation to enter the farming sector?

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