Income inequality in Malaysian livestock sector
(Ketidaksamaan pendapatan dalam sektor penternakan di Malaysia)

Tapsir Serin* and Alias Radam**

Abstract
Livestock farming is one of the sources of rural income in Malaysia. However, opportunities for extra income from non-farm activities are expanding in parallel with economic growth. This study aimed to identify the contribution of each income source to overall income and the level of income inequality in each livestock farmers' economic activity. It also attempted to examine the relationship between the socio-economic parameters and the participation in farm and non-farm activities. Survey questionnaires from 719 livestock operators from the Study of Agriculture Modernization in Malaysia (2005/2006) obtained from the Ministry of Agriculture and Agro-based Industry were used. The relationships were discussed using the descriptive analysis, Gini index measurement and probit estimation. Analysis showed that the portion of non-farm income in total income was relatively small although it contributed to the reduction of income inequality. The focus of improvements should be more to ruminant farmers because of their tendency to be involved in non-farm activities. Intensive system with the appropriate scale of production would ensure better prospects of income. Opportunities for non-farm income were mostly available for educated and experienced farmers, lived longer in specific location as well as the adequacy of farm labour in their livestock enterprise.

Introduction

Agriculture is recognized as a major source of rural income in Malaysia. It is also the third engine of Malaysian economic growth in current government policy. Agriculture Census (2005) showed that agriculture employed 816,763 persons, representing 3.2% of Malaysian population and 8.0% of the total employment in Malaysia in 2005[1]. Of the total agricultural employment, 52.8% were identified as agricultural operators, 37.2% employees and 10% unpaid family labour. A total of 43,747 persons or about 10% of the total agricultural operators were involved in livestock farming. The census suggested that farmer's involvement in economic activities could either be single or multiple activities (DOS 2005). For example, those in livestock farming might also involve in other activities in agriculture as well as non-agriculture.

Non-farm activity plays an increasingly important role in sustainable development in rural areas (FAO 1998). It is an important way to increase overall rural economic activities and employment. In many developing countries, non-farm activity often accounts for as much as 50% of rural

*Economic and Technology Management Research Centre, MARDI Headquarters, Serdang, P.O. Box 12301, 50774 Kuala Lumpur
**Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor
E-mail: tapsir@mardi.gov.my
[1]Malaysia total employment was 10,210,100 persons based on the Labor Force Survey 2005

employment and a similar percentage share of household income (Lanjouw 1999). Average of non-farm share of the total income was about 42% in Africa, 40% in Latin America and 32% in Asia (The World Bank 2000). In the 2005 Malaysian Agriculture Census, 17.19% of the total 520,589 farmers were part-time agricultural operators. This showed that non-farm was also a major source of rural income.

Earnings from non-farm activity not only increase total household income, but also function as a safety net through diversifying income sources. Non-farm income may also prevent rapid or excessive urbanization as well as natural resource degradation through overexploitation. There has been a debate on the role of non-farm income in rural income inequality. Although non-farm income increases total rural income, it can worsen income inequality. However, some other studies suggested that, if the poorer households have a higher participation rate than rich households, non-farm income can reduce rural income inequality (Nong and Xubei 2006).

In Malaysia, the Gini index for measurement of inequality, showed a relatively high value, indicating considerable income inequality. Comparison of Gini index of selected countries is shown in *Table 1*.

In 2008, UNDP studied the increasing trend of Gini index in Peninsular Malaysia as well as in Sabah and Sarawak (*Table 2*). In rural areas, the increase of income inequality might result from the better opportunities in getting non-farm income as a consequence of significant economic development. On the other hand, the increase in income inequality might also indicate the growing incidence of poverty especially in undeveloped countries.

In this study of livestock farmers, rural household income consists of two major categories: farm income and non-farm income. The farm activities include livestock farming and other farming activities such as crops and aquaculture. The non-farm

Table 1. Average Gini index of income inequality in selected countries (2002–2006)

	Gini index (%)
China	44.7
Hong Kong	43.4
Malaysia	49.2
Papua New Guinea	50.1
Philippines	46.1
Singapore	42.5
Thailand	43.2
USA	40.8

Source: UNDP (2008)

Table 2. Gini index of income inequality and poverty rate in Malaysia (1999–2004)

	1999	2004
Poverty rate (%)		
Sabah	27.3	25.5
Sarawak	10.8	8.0
Peninsular Malaysia	8.1	5.9
Gini index		
Sabah	0.451	0.473
Sarawak	0.452	0.462
Peninsular Malaysia	0.413	0.442

Source: UNDP (2008)

activities include all economic activities in rural areas except the farm activities. The five major sources of non-farm income are wage-paying income, part-time job, entrepreneurship activities such as small businesses, rent, private transfer and other sources.

The livestock subsector in Malaysia is a good example in examining the impact of farm and non-farm activities on rural income. The involvement of rural people in livestock farming in Malaysia is dichotomous in nature (Mokhdzir 1996). There is an obvious demarcation between the ruminant and non-ruminant subsectors in terms of output value, production systems, marketing, and challenges and opportunities. On the other hand, the non-ruminant subsector, which is represented mainly by poultry and pig industries, has emerged from backyard smallholder farming systems into a modern industry, characterized by large scale, high level of integration and highly capital intensity.

The lack of labour, aging farmers, the relatively limited quantity of arable land, and low level of livestock farming technology application resulted in relatively low level of productivity and efficiency especially in ruminant subsector. However, engaging in non-farm activities provides opportunities for extra household income. Besides, productively expending surplus family labour played an increasingly important role in Malaysian livestock community.

This study addressed the issues on farm and non-farm income in the rural area, its socio-economic implications and role in rural income inequality. Output from this study would help to identify the structure of income inequality as well as the contribution from livestock income in the rural area. The results of this study would be useful as policy inputs for further improving national income inequality.

Methodology

Primary data from the Study of Agriculture Modernization in Malaysia, 2005/2006 (SAMM) were used in this study. The raw data were obtained from Ministry of Agriculture and Agro-based Industry. These cross sectional primary data were collected through survey by filling out structured questionnaires, and having interviews with selected rural households who were involved in ruminant livestock farming activities such as cattle, goat, sheep and non-ruminant such as broiler, layer chicken, pigs and village chicken. The data collected covered various variables such as household socio-economic background, farm background, sources and values of income, farm practices as well as aspects of training and extension work done by related agencies. However, only relevant variables were selected for detail analysis.

The survey covered 719 rural households involved in livestock farming from 13 states in Malaysia. Although the sample size was limited, the survey employed stratified sampling procedure on farmers' selection and offered a satisfactory

sample for in-depth study. Furthermore, the report from Malaysian Agriculture Census 2004/2005 was used as a framework. The sample could be used as a rough approximation of the livestock farmer population in this country. Compared to other survey data in livestock subsector, which can merely serve for descriptive analysis, SAMM data have reliable and significant advantages. To our knowledge, the SAMM is the most detailed and professional survey of livestock farmers in Malaysia in recent years.

Descriptive statistics such as the frequency analysis, mean and standard deviation were used to analyse the pattern of income distribution. Income inequality was measured using the Gini index. Following Morduch and Sicular (2002), where incomes are ordered so that $Y_1 \leq Y_2 \leq Y_3 \leq \ldots \leq Y_n$, Gini index is computed as

$$G(Y) = \frac{2}{(n^2\mu)} \sum_{i=1}^{n} \left(i - \frac{n+1}{2} \right) Y_i$$

Where n is the number of observation, μ is the mean of distribution and Y_i is the income of ith household. Gini index is calculated by on-line calculator at Wessa (2008).

According to Nong and Xubei (2006), suppose that $Y_1, Y_2, Y_3 \ldots \leq Y_k$ stand for k components of household income and Y_o the total income, $Y_o = \sum_{k=1}^{k} Y_k$ the Gini index of total income G_o can be decomposed as follows:

$$G_o = \sum_{k=1}^{k} R_k G_k S_k$$

Where S_k stands for the share of the component k in the total income, G_k for the Gini index corresponding to the component k, and R_k for the correlation between the component k and total income. Comparing the Gini index of total income G_o (which includes non-farm income) with that of

farm income only (G_a), will enable us to explore the impacts of non-farm income on inequality. If the value of G_o is inferior to that of G_a, then non-farm income reduces total income inequality, and vice versa.

To examine the relationship between the socio-economic characteristics and the participation in non-farm activity, the models by Gujarati (2003) as well as Taylor and Yunez-Naude (1999) were used. The expected income of a particular activity is determined by the probability of participating in this activity. Participation was measured using a dummy variable which was equal to 1 if the household participates in the activity and 0 otherwise. It was regressed with the independent variables which were predicted to have effects on non-farm participation. Using probit model, the participation equation is as follows:

$$P_i^* = \alpha Z_i + \epsilon_i \, , \, P_i = 1 \Leftrightarrow P_i^* > 0 \; ; \; P_i = 0 \Leftrightarrow P_i^* \le 0$$

Where P_i^* is a non-observed continuous latent variable and P_i is an observed binary variable with 1 if the household participates in non-farm activity and 0 if does not. Z_i is a vector of independent variables of the participation equation.

Results and discussion
Descriptive analysis
Findings revealed that the 719 respondents earned income from livestock farming while 350 of them also obtained income from other agricultural activities. Their range of total annual income was RM8,100 to RM240,000 with a mean of RM45,904

(*Table 3*). Analysis also showed that the mean of total income was greater than the mean of total farm income with the difference of RM7,043 ($\alpha = 0.01$), indicating the significant contribution of non-farm income.

The majority of all households (26.6%) and households in ruminant sub-sector (31.8%), earned the total annual income between RM10,000 and RM20,000. However, the majority of non-ruminant livestock farmers (20.2%) earned between RM40,000 and RM60,000 (*Table 4*).

The major source of non-farm income based on frequency of participation was wages, followed by entrepreneurship activities, other non-farm income, private transfers and part-time job (*Table 5*). Income from rent was the lowest source which involved only 7.3% of total households. The mean of total income, total farm income and total non-farm income for households with non-farm activities were RM43,441, RM27,718 and RM15,725 respectively. Analysis also revealed that in average, the total farm income was inferior to total income with the difference of RM15,723 ($\alpha = 0.01$). Comparing mean of income for each farm activity showed that livestock farming has given a major contribution to total farm income. Excluding rent as a source of non-farm income, the entrepreneurship activities such as small business seem to contribute the highest non-farm earnings with an average of RM17,290.

A total of 415 households (57.7%) were dependent only on agriculture as the source of income (*Table 6*). Among them,

Table 3. Summary statistics of all households

Annual household income	N	Minimum	Maximum	Mean	Std. Deviation
Total income	719	8,100	240,000	45,903.91	44,174.67
Farm income					
Farm income (livestock)	719	700	240,000	33,219.95	31,822.77
Farm income (other agriculture)	350	300	102,000	11,636.03	11,141.03
Total farm income	719	1,100	240,000	38,860.57	32,540.34

Source: MOA (2006)

Table 4. Frequency distribution of total income (%) according to types of livestock farming

Range of total annual income (RM)	All households (n = 719)	Household in ruminant sub-sector (n = 462)	Household in non-ruminant sub-sector (n = 257)
<10,000	5.56	7.36	2.33
10,000–20,000	26.56	31.82	17.12
20,000–30,000	20.17	22.29	16.34
30,000–40,000	10.15	8.44	13.23
40,000–60,000	15.72	13.20	20.23
60,000–90,000	9.18	8.44	10.51
90,000–120,000	4.87	4.11	6.23
120,000–160,000	4.17	3.25	5.84
>160,000	3.62	1.08	8.17
Total	100	100	100

Source: MOA (2006)

Table 5. Summary statistics of household with non-farm income

Household income	N	Minimum	Maximum	Mean	Std. Deviation
Total income	304	8100	220,000	43,441.29	40,358.75
Farm income					
Farm income (livestock)	304	700	202,500	23,607.63	21,811.85
Farm income (others)	137	300	81,930	9,193.80	8,651.53
Total farm income	304	1,100	202,500	27,717.99	24,087.56
Non-farm income					
Wages	102	350	60,000	13,638.69	11,473.55
Part-time job	44	300	70,000	7,950.45	11,835.45
Entrepreneurship	85	1,000	93,600	17,290.29	13,565.85
Rent	16	240	120,000	17,550.00	14,976.32
Private transfers	45	400	66,000	5,491.11	4,159.83
Others	76	412	96,000	13,708.18	11,557.09
Total non-farm	304	350	120,000	15,724.88	12,444.18

Source: MOA (2006)

Table 6. Summary statistics of households with no participation in non-farm income

Household income	N	Minimum	Maximum	Mean	Std. Deviation
Total income	415	8,100	240,000	47,707.86	36,738.48
Farm income (livestock)	415	1,300	240,000	40,261.26	36,130.62
Farm income (others)	213	300	102,000	13,206.85	11,815.13

Source: MOA (2006)

213 households (51.5%) also involved in other agricultural activities such as rubber and oil palm, fruit and vegetable farming as well as paddy cultivation, other than livestock farming. Analysis showed that for those depending only on agriculture, their average total income, farm income from livestock and farm income from other agricultural activities were RM47,708, RM40,261 and RM13,207 respectively.

It could be concluded that there was an indication of influence from agricultural and non-agricultural activities in income disparity of livestock farmers. This fact will enable us to further analyse the significance of various socioe-conomic factors affecting the commitment in livestock farming as well as participation in non-farm activities.

Characteristics of households

Appendix 1 summarizes the characteristics of households, which may have significant impacts on non-farm participation. The analysis was divided into two categories based on quantitative and qualitative characteristics. The average age of the farmers (as a proxy variable of experience) was 46.7 years with the youngest and eldest at 19 years and 99 years old respectively. There was no significant difference between the average age of farmers who only have agricultural income and farmers who also have non-farm income ($\alpha = 0.05$). However the age of the youngest farmer with non-farm activity was higher than the youngest farmer who depends only on agriculture.

There were households with no children in this sample study. The highest number of children per household was 15. There was no significant difference between these three groups of households in terms of number of children ($\alpha = 0.05$). The majority of households (35%) have lived for 20–30 years in their specific location. The average years of living in their specific location were relatively greater for households involved in non-farm activities with the difference of 3.37 years, compared to households with only agricultural activities ($\alpha = 0.05$).

The majority of households (72.8%) operated their agricultural activity with less than two family labours. The average number of family labour was also similar (1.92) for all household groups. However the maximum number of family labour was higher for households with non-farm activities. Meanwhile, the average number of total farm labour for only agricultural activities was the highest among all household groups. Relative comparison showed that the average total number of labour for only agricultural activities households was statistically higher than for households involved in non-farm activities ($\alpha = 0.1$). The total number of labour has no significant relationship with the type of farm entity with regard to registered or non-registered company.

The sample study consisted of 95.4% male respondents as the head of households (*Appendix 1*). Majority of the respondents surveyed was *Bumiputera* (66.9%) and the percentage of *Bumiputera* was highest (76.6%) for households who were involved in non-farm activities. Analysis also showed that 92.4% of farmers obtained at least secondary education level (i.e. SPM level), 7.6% have tertiary education with at least diploma level and only 5.2% of them have no formal education.

Most of the farmers (64.3%) were operating in ruminant sub-sector. They were either involved in beef cattle, dairy cattle, goat or sheep farming in a few types of production systems. Most of them (82.5%) were owner operators and only 16.8% registered their farm enterprise as company.

Training in agriculture was assumed as an important requisite for successful farming enterprise. In this regard, 60.5% of respondents have attended short courses relating to agriculture. The coverage of extension programme by related government agencies showed a good achievement. About 85.3% of the total farmers received at least advisory services while 51.9% of them operated their farm with government subsidy/incentive. The subsidies/incentives given were in the form of male or female breeders (for ruminant farmers), farm sheds, machinery and grazing area.

Non-farm income as exogenous transfer

Under the hypothesis that non-farm income is an exogenous transfer, the Gini index can be decomposed into three parts: the share of each income component (%), the Gini index of each income component, and the Gini correlation of each income component. Farm income was the largest component of total income (85.4%) (*Table 7*). Income from livestock enterprises itself contributed 72.9% while other agricultural activities contributed a small portion (12.4%). The total non-farm income constitutes 14.6% of total income. The major non-farm income source was

entrepreneurship activities followed by wages and other non-farm income activities.

The Gini index of the distribution of the observed total income, including the contribution from non-farm activity, was 0.454 while that of the distribution of total farm income was 0.511 (*Table 7*). It suggests that, household income would have been 12.6% more unequal in the absence of non-farm activity. It also showed that if households depend only on livestock farming and not in other source of income including other agricultural activity, their income would have been 25.3% more unequal. In other words, the presence of other agriculture and non-farm income reduces the rural income inequality among livestock farmers.

Data also revealed that the distribution of total non-farm income is more unequal than the total farm income. The inequality of income from livestock rearing was moderately unequal with the Gini index of 0.569. This might be due to the type of the livestock farming they were involved in and/or other socio-economics factors. The total non-farm income was also moderately high in inequality, with Gini index of 0.522. However, the distribution of wage paying income and entrepreneurship were more egalitarian, with a Gini index of 0.459 and 0.496 respectively. The contribution of

agriculture to income inequality was very much higher than non-agriculture (*Table 7*). Analysis showed that the contribution of livestock farming, other agricultural activities and agriculture as a whole to inequality was 83.7, 7.0 and 90.9% respectively. As comparison, the contribution of total non-farm activities to inequality was only 9.1%.

Factors affecting non-farm participation
Non-farm income is considered as a potential substitute for farm income or as an addition to total household income. Among the six major types of non-farm sources of income, rent (from non-farm assets) and private transfers are known as non-competing activity in resource use. The participation in wage paying activity is often associated with spatial mobility as members concerned may leave their household and work outside for certain period of time daily. Part-time and entrepreneurship activities are more likely to be a local work within their residential area. In general, the participation in wage paying activity and part-time job is individual decisions while entrepreneurship activities can be a collective decision by the entire household members.

The results in *Appendix 2* suggested the response to non-farm participation referring to selected socio-economic

Table 7. Decomposition of Gini index

	Percentage of total income S_k	Gini index G_k	Gini correlation R_k	Contribution to inequality $(S_k G_k R_k)/G_o$
Total income	100%	0.454	100%	100%
Farm income				
Livestock	72.96%	0.569	91.55%	83.71%
Other farm income	12.44%	0.485	52.97%	7.04%
Total farm income	85.40%	0.511	94.56%	90.93%
Non-farm income				
Wages	4.25%	0.459	37.10%	1.59%
Part time job	1.07%	0.589	36.68%	0.51%
Entrepreneurship	4.49%	0.496	65.17%	3.20%
Rent	0.86%	0.677	41.75%	0.54%
Private transfer	0.75%	0.582	85.03%	0.82%
Others	3.18%	0.699	49.28%	v2.41%
Total non-farm	14.60%	0.522	54.03%	9.07%

factors. It showed that farmers, who were older, lived longer in a specific location, with higher number of family labour, *Bumiputera* and with higher education were more likely to participate in non-farm activities. On the other hand, farmers who were involved in non-ruminant livestock farming, have agricultural qualification, higher income from livestock farming and involvement in other agricultural activities were more unlikely to participate in non-farm activities. It was consistent with the study by Valluru (2002) who found that the off-farm employment decision was generally influenced by their education and experience. The rest of the factors such as number of children, gender, types of livestock entity, involvement in agriculture/ livestock training, extension service and incentives by government were insignificant to determine the tendency of non-farm participation.

Those might be the underlying reasons for significant response of some variables. The older farmers would have more family labour and more familiar of their living location. These factors would enable them to find non-farm opportunities for additional household income. At the same time higher education will facilitate them to get off-farm jobs whether as part-timer or permanent employees. With regard to ethnic group, *Bumiputera* were more responsive to non-farm activities. This was true because the majority of *Bumiputera* in ruminant livestock farming were mostly in small and medium scale. Those who were trained in agriculture were more committed to their farm enterprises. The involvement in other agricultural activities would enable them to supplement their household income. The non-ruminant farmers were also less responsive to non-farm activity as a source of income. This can be understood as non-ruminant livestock farming is an intensive enterprise with higher prospects of income.

The probit model suggests that the farmers would more likely go for non-farm income if there were reductions of income from livestock farming, assuming all other factors constant. However, the precise quantitative estimation needs the value of all independent variables to compute the change in probability (Gujarati 2003).

Conclusion and recommendation

The major findings of this study are as follows:

a) Agricultural income was the largest component of total household income among all respondents. Income from livestock farming was the major contributor while other agricultural activities contributed a small portion. The non-farm income constituted only 14.6% of total income.

b) The contribution of agriculture to income inequality was very much higher than non-agriculture. The contribution of livestock farming, other farming activities and farming activities as a whole to inequality were 83.7, 7.0 and 90.9% respectively. Although the non-farm income contributed a small percentage of total household income, its presence reduced rural income inequality of livestock farmers.

c) In the responsiveness of households to non-farm activities, older farmers, more years living in specific location, higher numbers of family labour, *Bumiputera* and higher education level indicated positive probability. In turn, farmers with agricultural qualification and involved in non-ruminant livestock farming are more unlikely to participate in non-farm activities.

Income from livestock farming is still important for rural population. Productive and efficient livestock farming can replace non-farm activities to increase income and lead to more equality in farmers' income. Commitment, high productivity and efficiency should be the focus of livestock farmers to reduce their involvement in non-

farm activities. In livestock development programmes, the focus should be more to ruminant subsector because of its association with inefficient use of labour, low revenue and as a result, tendencies to be involved in non-farm activities. Intensive system with appropriate scale of production will ensure better prospects of income and reduce dependency on non-farm activities.

There are actually no restrictions in non-farm activities in rural areas. However, these opportunities appear to be only opened to educated, living longer in specific location and more experienced individuals. Furthermore it also depends on adequacy of farm labour in their livestock enterprise. This seems to contradict government efforts to increase educated farmers in profitable livestock farming. Strategies should be enhanced to attract agricultural qualified persons since they are more committed in livestock farming.

The finding of this study was not the general impression of the role of agriculture in rural income and income equality as a whole, since the focus was only in livestock subsector. More comprehensive sampling which include all subsectors such as crop, livestock, fishery, aquaculture and agro-based industry as well as non-agriculture households, will produce better result in explaining the disparity of rural income.

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Abstrak

Penternakan merupakan salah satu sumber pendapatan luar bandar di Malaysia. Bagaimanapun, peluang pendapatan tambahan daripada aktiviti luar ladang semakin bertambah sejajar dengan pertumbuhan ekonomi. Kajian ini bertujuan untuk mengenal pasti sumbangan sumber pendapatan kepada jumlah pendapatan serta mengenal pasti tahap ketidaksamaan pendapatan dalam aktiviti ekonomi penternak. Kajian ini juga cuba mengaitkan faktor-faktor sosio-ekonomi dengan penyertaan penternak dalam aktiviti dalam dan luar ladang. Sebanyak 719 responden daripada Kajian Pemodenan Pertanian (2005/2006) dari Kementerian Pertanian dan Industri Asas Tani telah dianalisis dalam kajian ini. Analisis deskriptif, pengukuran indeks Gini dan penganggaran probit telah digunakan untuk menerangkan isu-isu tersebut. Analisis menunjukkan bahawa sumbangan pendapatan luar ladang terhadap pendapatan penternak secara relatifnya kecil walaupun ia mempunyai peranan untuk mengurangkan ketidaksamaan pendapatan. Penambahbaikan sektor penternakan secara umumnya perlu lebih ditumpukan kepada sektor ruminan kerana kecenderungan penternak ruminan dalam aktiviti ekonomi luar ladang. Sistem penternakan yang lebih intensif dengan skala pengeluaran yang sesuai dapat menjamin prospek pendapatan yang lebih baik kerana peluang pekerjaan luar ladang kebanyakannya direbut oleh mereka yang mempunyai kelayakan akademik, lebih berpengalaman dan tinggal lebih lama di sesuatu kawasan serta bergantung kepada kecukupan buruh ladang dalam perusahaan ternakan masing-masing.

Appendix 1. Characteristics of households

Characteristics of households	All households			Households with non-farm activity			Households with no participation in non-farm activity		
N	719			304			415		
Quantitative variables									
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
Age of the household head	19	99	46.71	21	84	47.26	19	99	46.31
Number of children	0	15	4.62	0	14	4.61	0	15	4.631
Years living in specific location	1	99	26.82	1	99	28.21	1	71	25.8
Number of family labour	1	11	1.921	1	11	2.00	1	7	1.868
Number of farm labour	1	35	3.59	1	17	2.96	1	35	4.048
Qualitative variables (%)									
Gender	Male = 95.4 Female = 4.6			Male = 96.1 Female = 3.9			Male= 94.0 Female = 6.0		
Ethnic group	*Bumiputera* = 68.8 *Non-Bumiputera* = 31.2			*Bumiputera* = 76.6 *Non-Bumiputera* = 23.4			*Bumiputera* = 60.2 *Non-Bumiputera* = 39.8		
Education level	No formal education = 5.2 Primary school = 32.8 Secondary school = 54.4 Tertiary education = 7.6			No formal education = 5.9 Primary school = 29.9 Secondary school = 54.3 Tertiary education = 9.9			No formal education = 2.4 Primary school = 35.9 Secondary school = 54.1 Tertiary education = 7.6		
Agriculture qualification	Yes = 8.5; No = 91.5			Yes = 7.2; No = 92.8			Yes = 9.1; No = 90.9		
Type of livestock farming	Ruminant = 64.3 Non-ruminant = 35.7			Ruminant = 76.3 Non-ruminant = 23.7			Ruminant = 50.7 Non-ruminant = 49.3		
Type of livestock entity	Registered company = 17.5 Owner-operator = 82.5			Registered company = 17.1 Owner-operator = 82.9			Registered company = 16.7 Owner-operator = 83.3		
Training in agriculture	Yes = 39.5; No = 60.5			Yes = 41.2; No = 58.8			Yes = 35.8; No = 64.2		
Extension by government agency	Yes = 85.3; No = 14.7			Yes = 88.2; No = 11.8			Yes = 83.9; No = 16.1		
Government incentive	Yes = 55.1; No = 44.9			Yes = 59.9; No = 40.1			Yes = 47.5; No = 52.5		

Appendix 2. Probability estimation of participation in non-farm activity (probit model)

Dependent variable = response to non-farm participation

Independent variable	Coefficient	Remarks
Constant	−1.417	**
	(−2.703)	
Age of the household head	0.010	*
	(1.818)	
Number of children	0.009	
	(0.673)	
Years living in specific location	0.008	**
	(2.311)	
Number of family labour	0.130	**
	(2.311)	
Number of farm labour	−1.330	
	(−2.102)	
Gender	0.119	
	(0.440)	
Ethnic group	0.237	*
	(1.868)	
Education level	0.319	**
	(3.549)	
Agriculture qualification	−0.324	*
	(−1.761)	
Type of livestock farming (ruminant or non-ruminant)	−0.619	**
	(−4.564)	
Type of livestock entity (registered company or owner operator)	0.013	
	(0.093)	
Training in agriculture	−0.051	
	(−0.425)	
Extension by government agency	−0.067	
	(−0.377)	
Government incentive	−0.048	
	(−0.388)	
Income from livestock farming	-3.6×10^{-5}	**
	(−2.236)	
Involvement in other agriculture activities	−0.449	**
	(−3.896)	
Maximum likelihood in log	−384.304	
Pseudo R^2	0.099	
LR statistic	84.386	
Standard error of regression	0.4667	
Number of observation	719	
% of right prediction	66.34%	

Note: z values are in parentheses. ** Significant at $\alpha = 0.05$. * Significant at $\alpha = 0.1$