

Projection of Thailand's Agricultural Population in 2040

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Abstract

This study aimed to project the agricultural worker population structure in Thailand to 2040. A cohort component method together with originally introduced elements were used to predict the number of total workers, agricultural workers, and non-agricultural workers by age group and sex in 2020, 2030, and 2040. Past-year data are mainly derived from national censuses. The projection results showed that the number of agricultural workers would shrink from 16.85 million to lower than 14.93 million; furthermore, at least 18.14 percent of them will be older than 60 years old. The aging problem is expected to pressure agricultural holders to rely on more machines and employees, resulting in agricultural debt per holders as much as 137 449 Baht. Thai agriculture will face serious instability if such the expensive input usage continues.

Keywords: agriculture, population projection, Thailand

1. Introduction

Thailand has long been recognized as an agriculture-rich country. Thanks to its geographical and climatical suitability, the country has the world's fifth largest harvested rice area (Duangmanee & Fransen, 2013). According to the Office of the National Economic and Social Development Board (NESDB, 2013a), in 2013 agricultural production accounted for 11.30 percent of total domestic products–GDP. However, since 1961 the government has implemented the *National Economic (and Social) Development Plan*, several plans to promote industrial sectors driving the country's development towards an advanced economy (Talukder & Chile, 2013). Aemkulwat (2010) also asserted that although labor force had grown rapidly, workers changed sectors from agriculture to manufacturing and service sectors. This reduced the agricultural proportion of the GDP to 0.09 percent; consequently, it is questionable how many agricultural workers will be left in the future. Population projection, thus, is regarded as an important key to efficient planning for future economic and social challenges.

There are several research articles projecting population size in Thailand. An article of Wongboonsin, Guest, and Prachuabmoh (2005) conducted population projection to 2025 to find implications of demographic dividend–benefit derived from demographic change. Kachanubarn (2010) adapted two sets of projections, from NESDB, and the United Nations' Population Division, to examine elderly health variations according to area of residence. Knodel & Chayovan (2008) forecasted the future well-beings of elderly people in Thailand based on the United Nations projections. Nevertheless, studies that project population size in the agricultural sector are hardly found. Therefore, the main objective of this paper is to predict Thailand's agricultural population structure in year 2040 under a best-case scenario, emphasizing that the real situation will certainly be worse than the projected one. This study focuses on population with Thai nationality. After reviewing past changes in both agricultural and non-agricultural population from 1980 to 2010, trends of each projection element will be analyzed and extrapolated to the future. This paper then discusses consequences of the predicted agricultural population dynamics on society, to introduce how the projection results can be applied to various issues.

2. Agricultural Workers and Non-Agricultural Workers in Thailand from 1980 to 2010

The very first thing to be considered before beginning future projections is to review past year statistics of workers from 1980 to the launch year, 2010 (Thailand National Statistics Office: NSO, 1980; 1990; 2000; 2010b). Figure 1 compares the numbers of agricultural workers and non-agricultural workers according to age group and sex over the past 30 years (left-side, female; right-side, male). A worker refers to a person aged 15 and older who is engaged in economic activities in the year of the survey (NSO, 2010b). An agricultural worker is defined as a worker who is engaged in agricultural works, and a non-agricultural worker works in industries

other than agriculture. In 1980, a clear expanding pyramid is noticed in which agricultural workers accounted for 70.75 percent of total workers. Age group 15-19 had the highest number of agricultural worker at 2.85 million, whereas the number of non-agricultural workers was the highest in age group 20-24 at 1.08 million. Age structures of workers in both sectors largely shifted between 1980 and 2010. A contracting pyramid of worker numbers in 2010 was observed. The number of agricultural workers aged 15-19 dropped to only 0.58 million, causing the age group 40-44 to become the peak of the pyramid; while the peak of non-agricultural workers shifted to 30-34 years old with 1.56 million workers. Moreover, in 2010 agricultural workers accounted for merely 43.63 percent of total workers. This reflects more older workers in the agricultural sector than in the non-agricultural sector. Thereby this paper projects the pyramids of both sectors in 2020, 2030, and 2040, to elaborate the future direction of workers' age structure changes.

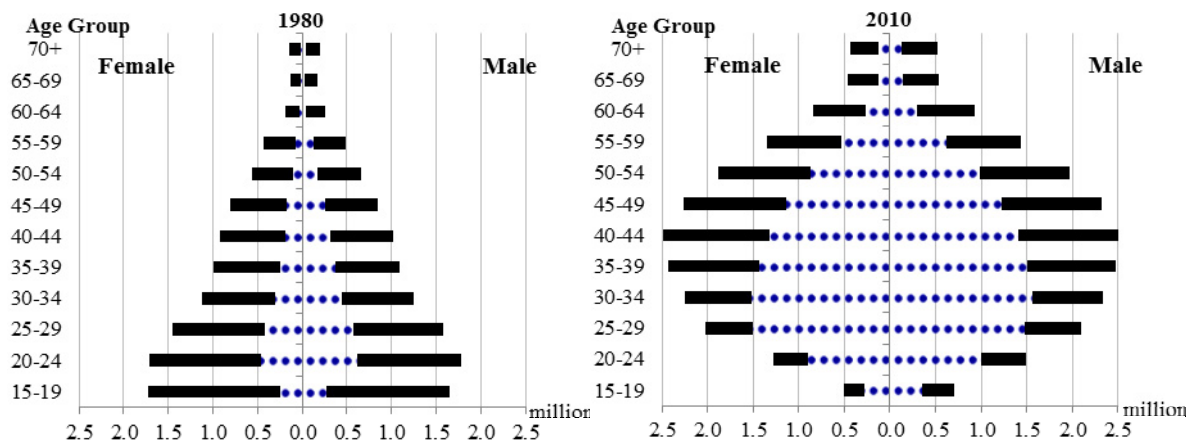


Figure 1. Number of population in 1980 and 2010 by age group, sex, and sector

Note. ■ work in the agricultural sector, ●● work in the non-agricultural sector

3. Methods and Procedure

For the benefit of higher income and better well-being, the agricultural population seeks available jobs in the non-agricultural sector; therefore, the numbers of workers doing agriculture is highly dependent on the non-agricultural sector. This paper predicted the number of agricultural workers indirectly by projecting the number of non-agricultural workers, which was then subtracted from the total number of workers. Data on the whole country's population from 2015 to 2040 were acquired from *Population Projections for Thailand 2010-2040* (NESDB, 2013b). The report applied the cohort component method to four fertility scenarios and expanded life expectancy at birth from 70.4 to 75.3 years for males and from 77.5 to 81.9 for females. This paper uses a scenario in which total fertility rate (TFR) gradually decreases from 1.62 to 1.30 in 2040.

In order to achieve an agricultural worker population structure by age and sex to year 2040, there were several elements to consider. Figure 2 shows the conceptual framework of this study. According to this framework, there are three main steps in this study: projecting the numbers of total workers, projecting the number of non-agricultural workers, and calculating the number of agricultural worker in 2040. Elements taken into account include death rate, survival rate, working population percentage, worker moving rate (in-out of the agricultural sector), and agricultural sector entry rate. These elements are elaborated in the following steps.

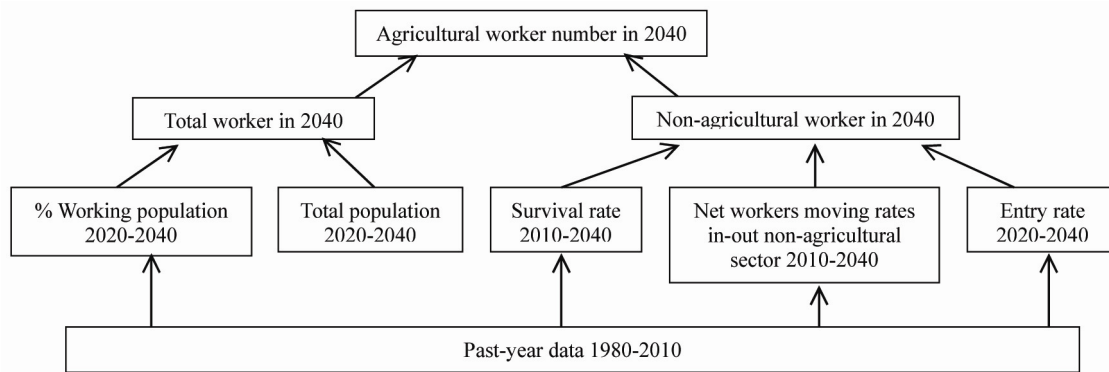


Figure 2. The conceptual framework

3.1 Projecting Total Worker in 2040

This paper examines working population percentage by age group and sex. The percentage comes from number of workers divided by the total population in each age group and sex. The worker number and total population data are provided in Thailand National Population Census decennially—1980, 1990, 2000, and 2010 (NSO, 1980; 1990; 2000; 2010b). Trends of working population percentage in each age group from 1980 to 2010 were analyzed by calculating differences in each interval and average them. Then, percent working population in ten-year interval to year 2040 were extrapolated. Accordingly, total workers by age group and sex from 2015 to 2040 were calculated. This was done by multiplying the working population percentage with estimated total population. The total population data were derived from *Population projections for Thailand 2010-2040* (NESDB, 2013b).

3.2 Projecting Non-Agricultural Worker in 2040

As can be seen from the conceptual framework, the following are further steps needed for finding past trends of workers moving in-out of the non-agricultural sector by age group and sex.

3.2.1 Past-year survival rates from death by age group and sex of the whole population were analyzed. Thailand’s Ministry of Public Health provides annual death rate from 1980 to 2010. Since data of the working population are provided decennially through the National census, the survival rates need to be in 10-year intervals as follows.

$$SVR_i = 1 - (DR_i/1000) \tag{1}$$

; SVR_i is the annual survival rate from death in year i

DR_i is the annual death rate, number of death per thousand of mid-year populations in year i

$${}^{10}_0SVR = (SVR_{year0})(SVR_{year1})(SVR_{year2}) \dots (SVR_{year9}) \tag{2}$$

; ${}^{10}_0SVR$ refers to the ten-year-interval survival rate in a specific age group and sex

Calculate survival rates of each age group and sex from 1980 to 1990, 1990 to 2000, and 2000 to 2010.

3.2.2 Percent net workers moving in-out of the non-agricultural sector by age group and sex are derived from the following formula:

$$\%NM = \frac{NAW_{year10;age\ x+10\ to\ x+15} - SVW_{age\ x\ to\ x+5}}{NAW_{year10;age\ x+10\ to\ x+15}} \tag{3}$$

Where $SVW_{age\ x\ to\ x+5} = (NAW_{year0;age\ x\ to\ x+5})({}^{10}_0SVR)$ (4)

; $\%NM$ defines the percent net workers moving in-out out of the non-agricultural sector

$SVW_{age\ x\ to\ x+5}$ is the number of survived workers who are between x and $x+5$ years old

NAW is the number of non-agricultural worker in a specific age group and sex

3.2.3 Changes in rate of net worker moving in-out of the non-agricultural sector were analyzed over three periods: 1980-1990, 1990-2000, and 2000-2010. Variations in the percentage of each age group were examined to find possible future trends. Then, the percent net workers moving in-out of the non-agricultural sector were

extrapolated to year 2040. As the projection was in five-year intervals, the percentage is to be converted from ten-year interval into an identical pair of five-time intervals. Discounting future value is applied to do so. Given NAW_{year10} is the number of non-agricultural worker in year 10, and NAW_{year0} is that in the start year; a five-year interval rate (5_0MNA) is calculated as follows:

$$NAW_{year10} = NAW_{year0}(1 + {}^5_0MNA)^2 \quad (5)$$

$${}^5_0MNA = \sqrt{\frac{NAW_{year10} - NAW_{year0}}{NAW_{year0}} + 1} - 1 \quad (6)$$

3.2.4 The future whole country's survival rate from death, to year 2040 was computed. As stated earlier, the future rate utilized the projected population data of NESDB (2013b) for five-year intervals of each age group and sex according to the formula below. This was applicable because only those aged 15 and over were taken into account; thus, there were no effects from fertility. In a specific age group and sex,

$${}^5_0PSVR = \frac{POP_{year5;age\ x+5\ to\ x+10}}{POP_{year0;age\ x\ to\ x+5}} \quad (7)$$

; 5_0PSVR is the future survival rate in five-year interval

POP is the population size according to the supplemental online archive.

3.2.5 Numbers of non-agricultural worker every five years from 2015 to 2040 were estimated. The estimation used the calculated future survival rate and extrapolated percent net worker moving in-out of the non-agricultural sector with the formula below:

$$NAW_{year5;age\ x+5\ to\ x+10} = NAW_{year0;age\ x\ to\ x+5} \times {}^5_0PSVR \times (1 + {}^5_0MNA) \quad (8)$$

3.3 Projecting Non-Agricultural Worker by Age Group and Sex in 2040

There are only two economic sectors in Thailand's economy—namely, the agricultural sector, and the non-agricultural sector. Thus, projected number of agricultural workers equals the projected total number of workers subtracted by the projected number of non-agricultural workers.

4. Results

4.1 Projected Total Workers by Age Group and Sex to 2040

Firstly, the percentages of the working population from 1980 to 2010 are shown in Figure 3. Despite some variations, there was no difference in trends between male and female. Changes in percent working population among the 12 age groups can be categorized in to three types. Vast drops, the first type, are seen in age group 15-19 and 20-24 for both sexes; while slight decreases (second types) are found in the male groups aged 25-59, and female groups aged 25-54. The third pattern is somewhere between remaining constant and gradual increase which are found in males who are 60 years old plus, and females aged 55 and over.

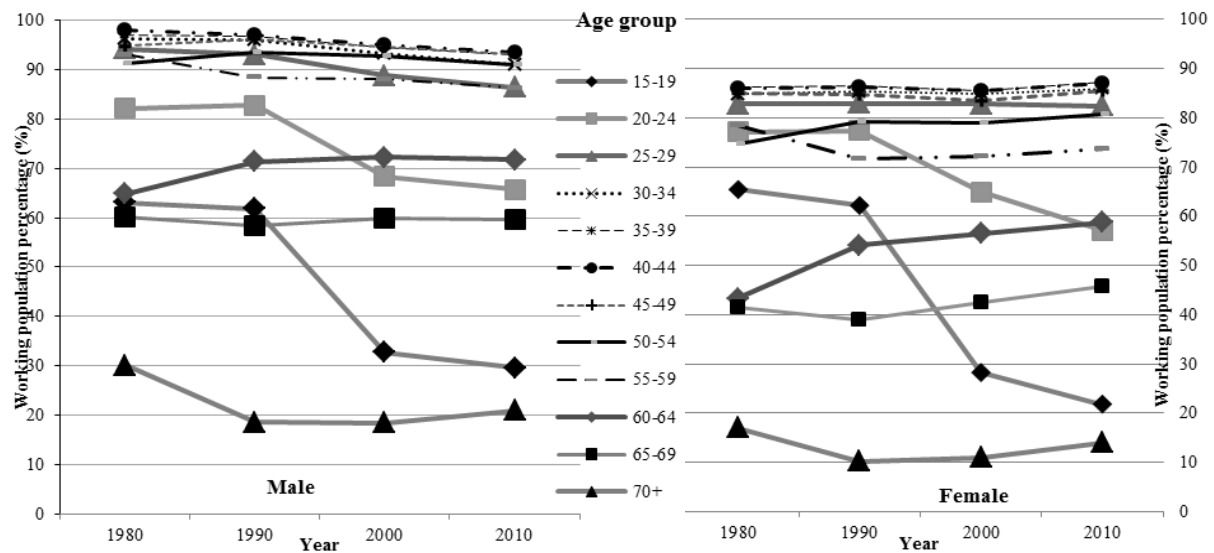


Figure 3. Working population percentage by age group and sex

Considering the average changes in the percentage of working population of each age group from 1980 to 2010 under optimistic conditions, vastly-dropping-type groups (15-24 years old) are to remain constant to 2040. The rest types' age groups of the other types (25 years old and over) are to decline at the same rate as average changes from 1990 to 2010. In 2040, the percentage of the working population aged 15-19 is 29.61 percent for male and 21.82 percent for females. The highest ones in 2040 are of the 45-49 years old male group, at 91.61 percent; and of the 35-39 years old female group, at 88.37 percent.

The extrapolated working population percentages in 2015, 2020, 2025, 2030, 2035, and 2040, were multiplied by the number of the population in each age group and sex acquired from NESDB (2013b), to find the number of total workers by age group and sex. It was found that the number of total workers in 2040 was 35.534 million dropping from 38.641 million in 2010. The number of youngest workers (15-19 years old) diminished from 1.261 in 2010 to 0.841 million in 2040, while the oldest ones doubled from 0.976 to 2.842 million. Males' age group 45-49 had the highest number of workers, whereas the age group 40-44 remains the peak for females. Half of the working population would be older than 45 years old, therefore a huge aging working society in Thailand would be observed in 2040.

4.2 Projected Non-Agricultural Worker by Age Group and Sex to 2040

Past-year survival rates in 10-year intervals along with numbers of non-agricultural workers by age group and sex during 1980-2010 were computed; it is seen that survival rates of almost all age groups and sexes rose over 30 years, presumably due to better welfare and public health. Table 1 uncovers percent net workers moving in-out of the non-agricultural sector from 1980-1990, 1990-2000, and 2000-2010 (Those turning 25-29 and 30-34 years old in 2000 and 2010). Optimistically, the percentage of net workers moving in-out of the non-agricultural sector during 2000-2010 period is extrapolated to 2040 with 30 percent reduction assuming that the non-agricultural sector would grow more slowly than in the past. The extrapolation was also adjusted into five-year intervals using the future value method. You may also consider the following issues:

Table 1. The rate of net workers moving in-out of the non-agricultural sector (%NM) 1980-2010 by age group and sex

Age group year 0	Age group year 10	Male			Female		
		1980-1990	1990-2000	2000-2010	1980-1990	1990-2000	2000-2010
15-19	25-29	2.60	2.01	3.93	2.28	1.41	3.96
20-24	30-34	0.53	0.45	0.84	0.61	0.52	0.81
25-29	35-39	0.31	0.22	0.36	0.35	0.28	0.31
30-34	40-44	0.26	0.14	0.24	0.30	0.20	0.24
35-39	45-49	0.15	0.04	0.13	0.15	0.07	0.13
40-44	50-54	0.11	-0.04	0.02	0.10	-0.02	0.01
45-49	55-59	-0.08	-0.15	-0.10	-0.17	-0.13	-0.08
50-54	60-64	-0.37	-0.45	-0.35	-0.22	-0.33	-0.26
55-59	65-69	-0.61	-0.56	-0.52	-0.54	-0.41	-0.38
60 and over	70 and over	-0.59	-0.59	-0.52	-0.57	-0.57	-0.45

Regarding future workers aged 15-19 that will enter the working sector, and the past trends of their entering rates: proportions of non-agricultural worker aged 15-19 of the total non-agricultural worker—entering rate—in past years were computed. Figure 4 displays entering rates in 1980, 1990, 2000, and 2010. According to the graph, entering rates of females aged 15-19 plunged from 10.84 percent to 2.86 percent, more sharply than those of males, from 8.36 percent to 3.29 percent. Extrapolation is not feasible in this case because it would become negative; therefore, minimum males' rate was set at 2.16 percent in 2040 and minimum female rate was set at 2.04 percent.

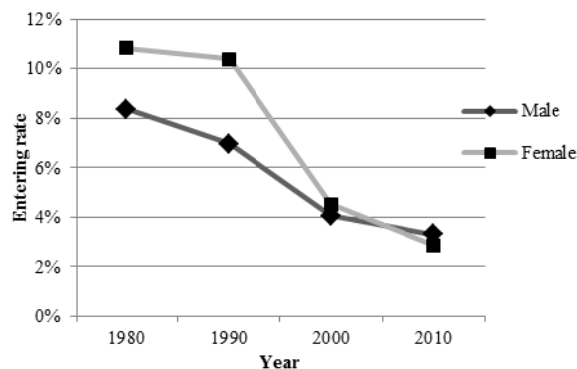


Figure 4. Entering rates of male and female workers

The future number of non-agricultural workers by age group and sex from 2015 to 2040 are derived from the rates of net workers moving in-out of the non-agricultural sector, and the entry rates. The number of non-agricultural workers expands to 22.60 million in 2030 then decreases to 20.59 million in 2040 (from 20.68 in 2010). In 2010 the highest numbers are found in the age group 50-54, 1.44 million for males, and 1.54 million in age group 55-59 for females, shifting from the age group 30-34 for both sexes in the launch year. This builds an apparent contracting pyramid as shown in Figure 5. Non-agricultural workers 50 years old and older account for at least 54.92 percent of total non-agricultural workers.

4.3 Projected Agricultural Worker by Age Group and Sex to 2040

Based on the future total worker and non-agricultural worker projection, the results of agricultural worker forecast under optimal conditions from 2015 to 2040 are demonstrated in Figure 5. According to the figure, in 2040, the total number of agricultural workers declines to 14.93 from 16.85 million in 2010. The age groups with the highest numbers of agricultural workers are 45-49 years old for males and 35-39 years old for females, while those with the smallest numbers are 55-59 years old for both sexes. Since this projection is based on optimal scenario, the expected real situation would be worse; that means numbers of agricultural workers aged 49 and younger must be less than 75.03 percent of the number of total workers. The percentage of aging agricultural workers should be more than 18.14 percent. Overall, there must be lower than 42.03 percent of total workers who will work in the agricultural sector in 2040. This implies that in 2040 Thailand would no longer be an

agriculture-based country. This paper assumes there are no international and domestic conflicts which impact economic and social stability of the country. Only best-case scenario is offered; worst-case or other scenarios are yet to be projected further on.

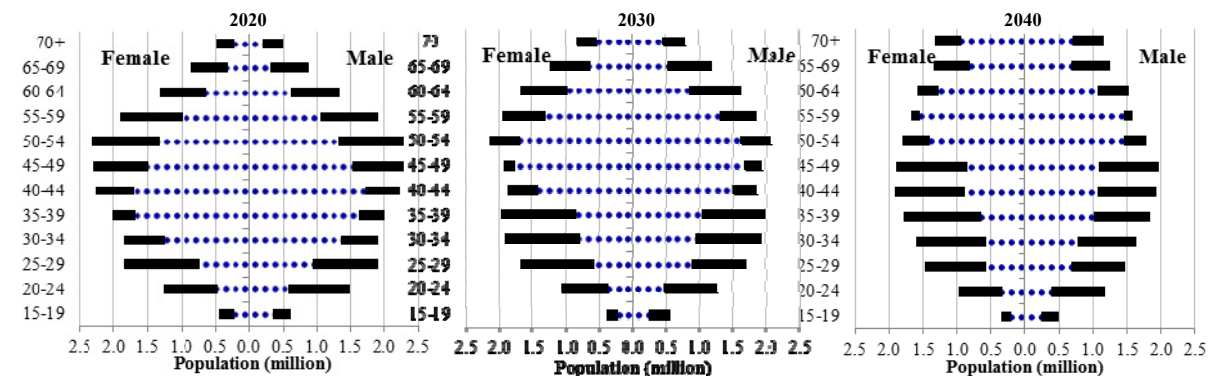


Figure 5. Number of population in 2020, 2030 and 2040 by age group, sex, and sector

Note. ■ work in the agricultural sector, ● work in the non-agricultural sector

5. Discussion

Under an idealistic scenario, the population of workers who are engaged in agriculture in 2040 would gradually decline. Even so, the sector will face several challenges impacted by workers' age changing structures. Due to the rising proportion of elderly agricultural workers, the agricultural sector would rely more on other factors such as cropping and cultivating instruments and foreign laborers. All data on agricultural holder numbers, agricultural employee numbers, and agricultural instrument numbers are supplied from the Agricultural Census (NSO, 1994; 2004; 2014) and Survey Report of Agricultural Census (NSO, 1999; 2010a). According to the censuses and survey reports, agricultural holder numbers gradually rose from 5.64 million in 1993 to 5.91 million in 2013; and proportions of the holders who hired agricultural employees increased from 45.9 percent to 51.5 percent respectively. 9.9 percent of them in 2003 were foreign employees, rapidly increasing to 12.2 in 2008, then to 13.9 in 2013. Concurrently, in 2003 there were 1.47 million agricultural holders who reported using four-wheeled tractors, 0.66 million using weed-extracting machines, and 1.02 million using harvesting machines. The numbers reported in 2013 significantly rose to 2.42 million, 1.45 million, and 1.72 million respectively. Despite a hard-to-afford price for low income farmers (approximately 40 thousand Baht, Thai currency, in 2013) the weed-extracting machines were among the agricultural instruments with highest growth in usage, increasing 1.7 times in only ten years.

Hiring more agricultural employees and utilizing more machines enlarges agricultural workers' expenditures resulting in extra liabilities. As reported in the agricultural censuses and survey reports (NSO, 1994; 1999; 2004; 2010; 2014), the number of holders who are in debt due to agricultural activities surged up from 2.41 million in 1993 to 2.78 million in only 20 years. The amount of agriculture-related debt per holder has been increasing dramatically from 34 859 Baht per holder in 1993 to 124 604 Baht per holder, constantly 4487 Baht per year. The relation between changes in agricultural worker's age structure and level of agricultural debt are presented in Figure 6. The figure displays agricultural debt per holder, and percentage of aging agricultural workers; who are aged over 60 years old, to track the structural change of agricultural workers. A perfect linear correlation is seen between the two variables which forms the equation (9):

$$DPH=10632(\%AW)-50517 \quad (9)$$

; *DPH* stands for amount of debt per agricultural holder (Baht)

%AW substitutes aging agricultural worker percentage.

This formula can be applied to forecast future agricultural debt of a holder. Now that aging agricultural workers are projected to be at least 18.14 percent in 2040, the amount of debt per holder in the year should be larger than 137 449 Baht, whereas agricultural households are confronting unpreventable liabilities, left behind by those in modern sectors pleased with stable engaging salaries.

6. Conclusion

In 2040, the population in the non-agricultural sector in Thailand is expected to continue to grow, while the population in agricultural sector is predicted to shrink at least 11.39 percent with further aging characteristics. In response to the agricultural labor shortage of young adults, agricultural households need to depend on more machines and employees. This is because Thai farmers have been accustomed to deciding what to produce corresponding to agricultural market prices and operate quantity-based production. Continuing this strategy will put their financial statuses into danger due to ballooning expenses. Efficient support policies from the government are seriously needed to deal with these challenges, and they must not be by price-incentive as before.

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