

Age Structure and Change Trend of Tobacco Farmers: A Case Study of Shashi Town, Liuyang City, Hunan Province

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Abstract Taking the tobacco-growing area of Shashi Town, Liuyang City as the object, the number of registered, newly added and resigned tobacco farmers in each year, average age, number and proportion of tobacco farmers of different ages, number and proportion of tobacco farmers born in different eras, as well as planting scale and planting history of flue-cured tobacco in the last 10 years were analyzed statistically. The results showed that the number of tobacco farmers in Shashi Town showed a rapid decline trend from 2012 to 2018, while the average age continuously increased, and the average planting scale rose in a wave like way. From 2019 to 2021, the decline rate of the number of tobacco farmers slowed down, and the average planting scale continuously increased, while the aging of tobacco farmers accelerated. Meantime, the birth years of tobacco farmers were further concentrated in the 1960s, and they were mainly at the age of 50–59. The tobacco industry in Shashi Town of Liuyang City is facing the crisis of aging tobacco farmers and no successor of flue-cured tobacco planting, and it is predicted that the next 5–10 years will continue the change trend from 2019 to 2021.

Key words Tobacco farmers, Number, Birth year, Average age, Planting years, Change trend, Prediction

1 Introduction

The stability of tobacco farmers is the basis for the stable and healthy development of tobacco leaf industry and even tobacco industry. Liuyang is not only an old revolutionary base area and a relatively developed economic area in China, but also a traditional tobacco area with large planting scale, playing a very prominent role in promoting local economic development and rural water conservancy construction^[1–2]. Currently, under the background of China's rapid economic development and continuous industrialization and urbanization, Liuyang, as a county-level city with faster economic development and higher degree of industrialization and urbanization in China, faces greater pressure from a large loss of tobacco farmers and continuous aging of tobacco farmers^[3–4]. It is conducive to taking early countermeasures and guiding the sustainable, stable and healthy development of flue-cured tobacco industry in Liuyang by accurately understanding the aging degree and age structure of Liuyang tobacco farmers, investigating and analyzing the causes, and predicting the future development trend of Liuyang tobacco farmers and tobacco industry^[5].

By referring to the archives of flue-cured tobacco production, purchase and farmers in Shashi Town in the last 10 years, the number of tobacco farmers in each year, average planting scale per household, average age, number and proportion of tobacco farmers of different ages, and number and proportion of tobacco farmers

born in different eras were statistically analyzed. The data of tobacco farmers in 2021 was based on the planting plan applied by tobacco farmers in the year and the files that had purchased fertilizer, and the age of registered, resigned and newly added tobacco farmers in each year was counted according to the chronological age of that year. Meantime, we focused on investigating and verifying the authenticity of flue-cured tobacco planting householders in 2021, investigated and understood the flue-cured tobacco planting history, planting scale and benefits of flue-cured tobacco growers, as well as the reasons for entering or resigning from the flue-cured tobacco planting industry. Combined with the comprehensive analysis of relevant data, the change trend of the number, age and planting scale of tobacco farmers in Shashi Town, Liuyang City in the future was predicted.

2 Age structure and change of tobacco farmers in Shashi Town, Liuyang City in recent 10 years

2.1 Number of tobacco farmers, average planting scale per household and average age of tobacco farmers From 2012 to 2021, the number of tobacco farmers in Shashi Town declined rapidly, from 999 households in 2012 to 409 households in 2021, with a decrease of 59.06% in 10 years. The average age increased by 5.52 years old in the 9 years from 2013 to 2021, with an average increase of 0.61 years old per year. Although the planting scale per household decreased due to policy regulation, it still increased from 1.08 ha in 2012 to 1.93 ha in 2021 (the highest point in history). From 2013 to 2018, the average number of tobacco farmers decreased by 94.16 households per year, while the average age increased by 0.54 years old, and the average planting scale per households increased by 0.05 ha. From 2019 to 2021,

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the number of tobacco farmers decreased by an average of 8.33 households per year, while the average age increased by 0.76 years old, and the average planting scale per household increased by 0.18 ha. From the situation of the last 3 years, the decline rate of the number of tobacco farmers in Shashi Town slowed down, but the aging rate accelerated, and the average planting scale per household increased sharply.

2.2 Number and proportion of tobacco farmers of different ages The proportion of tobacco farmers aged 39 years old and be-

low in the entire team of tobacco farmers decreased from 9.01% in 2012 to 2.93% in 2021, with a decrease of 6.08%. The proportion of tobacco farmers aged 40 – 49 years old decreased from 46.25% in 2012 to 11.98% in 2021, with a decrease of 34.27%. The proportion of tobacco farmers aged 50 – 59 years old increased from 33.53% in 2012 to 66.26% in 2021, with an increase of 32.73%. The proportion of tobacco farmers aged 60 years old and above increased from 11.21% in 2012 to 18.83% in 2021, with an increase of 9.38% (Table 1).

Table 1 Number of tobacco farmers, average planting scale per household, average age, number and proportion of farmers in different age groups in Shashi Town, Liuyang City from 2012 to 2021

Year	Number of households	Average age years old	Average scale per household//ha	39 years old and below		40 – 49 years old		50 – 59 years old		60 years old and above	
				Number of households	Proportion %	Number of households	Proportion %	Number of households	Proportion %	Number of households	Proportion %
2012	999	49.64	1.08	90	9.01	462	46.25	335	33.53	112	11.21
2013	787	50.09	1.39	58	7.37	340	43.20	306	38.88	83	10.55
2014	843	50.95	1.11	51	6.05	328	38.91	343	40.69	121	14.35
2015	704	51.35	0.99	33	4.69	240	34.09	330	46.87	101	14.35
2016	673	52.03	1.15	30	4.46	187	27.79	350	52.00	106	15.75
2017	533	52.67	1.24	25	4.69	118	22.14	295	55.35	95	17.82
2018	434	52.88	1.40	17	3.92	86	19.81	264	60.83	67	15.44
2019	404	53.63	1.65	14	3.47	66	16.34	261	64.60	63	15.59
2020	421	54.20	1.73	16	3.80	59	14.01	277	65.80	69	16.39
2021	409	55.16	1.93	12	2.93	49	11.98	271	66.25	77	18.83

The main reason for the significant decline in the proportions of tobacco farmers aged 39 years old and below and 40 – 49 years old is that the number of resigned tobacco farmers from these two groups is large, but that of newly added tobacco farmers is small. However, the significant decline in the proportion of tobacco farmers aged 40 – 49 years old is mainly attributed to the fact that in addition to large number of resigned tobacco farmers and small number of newly added tobacco farmers, the proportion of farmers aged 39 years old and below is relatively small in the early stage, so the number of farmers gradually transitioning into the age group of 40 – 49 years old is also relatively small. The reason for the significant increase in the proportion of tobacco farmers aged 50 – 59 years old is not only that this group of tobacco farmers is more stable than other age groups, but also that the tobacco farmers in the age group of 40 – 49 years old occupy a relatively large proportion in the early stage, and a large number of farmers in this group gradually enter the age group of 50 – 59 years old. Compared with the tobacco farmers in the age group of 50 – 59 years old, the proportion of tobacco farmers aged 60 years old and above increases relatively small. The reasons are that when tobacco farmers are around the age of 60 years old, they enter the peak of resigning from flue-cured tobacco planting due to physical decline, only a small number of tobacco farmers persist beyond the age of 65 years old, and a very small number of tobacco farmers continue to grow flue-cured tobacco after the age of 70 years old. Since there is no limit of retirement age for the elderly in rural areas, they will continue to work as long as their health permits; they will quit flue-cured tobacco planting when it is difficult for the body to bear.

They may also quit early when the efficiency of flue-cured tobacco planting is not ideal. Many tobacco farmers, who resigned from flue-cured tobacco planting due to aging and declining physical strength, are employed by large flue-cured tobacco growers to do what they can. But working hours may be reduced from more than 300 d a year to more than 200 or 100 d a year. They will return home to do some housework when they are completely unable to work.

In the last 2 years, due to the improvement of flue-cured tobacco planting efficiency, though it is difficult to attract more young farmers to enter the flue-cured tobacco planting industry, some older tobacco farmers, even if there are difficulties, also insist on planting their own flue-cured tobacco, rather than working for large flue-cured tobacco growers. Therefore, the proportion of tobacco farmers aged 60 years old and above in Shashi Town has increased rapidly in the past 2 years.

3 Number of newly added and resigned tobacco farmers, average age, and number of farmers in each age group in Shashi Town, Liuyang City from 2013 to 2021

3.1 Number of newly added and resigned tobacco farmers From 2013 to 2021, a certain number of tobacco farmers in Shashi Town entered and resigned simultaneously every year, and there were certain proportions of newly added and resigned tobacco farmers of all ages (Table 2). The average age of newly added tobacco farmers was 45.46 – 53.43 years old, and that of resigned tobacco farmers was 50.30 – 55.18 years old. Among the resigned

tobacco farmers in 2021, 10 farmers aged 49 years and below resigned, accounting for 16.39% of the total number of farmers in this age group. There were 10 resigned tobacco farmers aged 60 years old and above, accounting for 12.98% of the total number of tobacco farmers in this age group. There were 22 tobacco farmers aged 50–59 years old, although the number was the largest among all age groups of tobacco farmers, the number of resigned tobacco farmers accounted for 8.12% in this age group, lower

than that of other age groups. It is mainly attributed to the fact that the tobacco farmers aged 49 years old and below may be more likely to resign from flue-cured tobacco planting due to wider employment opportunities, and the tobacco farmers aged 60 years old and above mainly resign from flue-cured tobacco planting due to physical decline or injury and other reasons, while the tobacco farmers aged 50–59 years old are relatively stable.

Table 2 Number of newly added and resigned tobacco farmers, average age, and number of farmers in different age groups in Shashi Town, Liuyang City from 2013 to 2021

Year	Number of households	Newly added tobacco farmers							Resigned tobacco farmers						
		Number of households	Proportion %	Average age years old	39 years old and below	40–49 years old	50–59 years old	60 years old and above	Number of households	Proportion %	Average age years old	39 years old and below	40–49 years old	50–59 years old	60 years old and above
2013	787	186	23.63	48.62	23	84	61	18	398	50.57	50.79	40	144	137	77
2014	843	241	28.59	50.23	23	91	86	41	185	21.95	50.58	22	49	86	28
2015	704	68	9.66	48.29	8	30	22	8	207	29.40	52.80	16	58	85	48
2016	673	87	12.93	51.13	9	23	42	13	118	17.53	53.30	9	31	44	34
2017	533	13	2.44	45.46	3	6	3	1	153	28.71	53.65	7	35	70	41
2018	434	28	6.45	48.29	4	9	13	2	127	29.26	55.18	9	13	60	45
2019	404	44	10.89	51.93	5	10	22	7	74	18.32	54.07	4	12	41	17
2020	421	62	14.70	51.45	7	12	37	6	45	10.69	54.27	2	7	26	10
2021	409	30	7.33	53.43	2	3	18	7	42	10.27	54.33	3	7	22	10

3.2 Trend of newly added and resigned tobacco farmers

Although the average age of newly added and resigned tobacco farmers in Shashi Town decreased in some years, the overall growth trend was obvious. In the past 3 years, the average age of newly added tobacco farmers in Shashi Town was greater than 51 years old, and that of resigned tobacco farmers was greater than 54 years old. In addition to the fact that the attractiveness of flue-cured tobacco planting to young farmers has been continuously declining, and that to older farmers is relatively strong, it is also related to the significant decrease in the proportion of relatively young tobacco farmers and the significant increase in the proportion of older tobacco farmers after a large number of young tobacco farmers resign from flue-cured tobacco planting in the early stage. The average age of newly added and resigned tobacco farmers increased simultaneously, which also indicated that the years of newly added tobacco farmers to continue planting flue-cured tobacco in the future would be shortened, and those who resigned from flue-cured tobacco planting would be less likely to re-enter flue-cured tobacco planting due to their older age. To this end, the stability of tobacco farmers in Shashi Town would decline.

3.3 Effects of average age of newly added and resigned tobacco farmers and change rate of tobacco farmers

Except that the average age of newly added tobacco farmers was lower than that of tobacco farmers in 2014, the average age of resigned tobacco farmers was higher than that of tobacco farmers in that year. The changes of tobacco farmers in each year lowered the average age of tobacco farmers in that year to a certain extent, and slowed down the aging process of tobacco farmers. It is speculated that the

growth rate of average age of tobacco farmers in Shashi Town from 2013 to 2018 was significantly lower than that from 2019 to 2021, mainly attributed to large number of newly added and resigned tobacco farmers in Shashi Town from 2013 to 2018 that led to high change rate of tobacco farmers. It also showed that the growth rate of average age of tobacco farmers in Shashi Town during this period was significantly lower than that from 2019 to 2021, which was achieved at the cost of a large number of tobacco farmers resigning from flue-cured tobacco planting and a significant reduction in the number of tobacco farmers. In the past 3 years, the change rate of tobacco farmers in Shashi Town had gradually decreased, and their stability had been improved. But at the same time, it also reduced the pull range of average age variation caused by changes in tobacco farmer team, so that the change of average age of tobacco farmers was more driven by the increase of the age of tobacco farmers who continuously planted flue-cured tobacco.

3.4 Reasons for tobacco farmers to resign from flue-cured tobacco planting industry

There were many reasons for tobacco farmers to resign from flue-cured tobacco planting. In addition to benefit and age factors, some of them were temporarily resigned for family or personal reasons. In the survey of 42 households of tobacco farmers who resigned from flue-cured tobacco planting in Shashi Town in 2021, 9 of them resigned immaterially by changing their householders. Among the 33 households of tobacco farmers who actually resigned from flue-cured tobacco planting, 20 households resigned from flue-cured tobacco planting because of employment in other industries (including 15 households going out to work, 3 households engaged in other planting and breeding industries, and

2 households engaged in family business), accounting for 60.61% of actually resigned tobacco planting households. Ten households resigned from flue-cured tobacco planting due to family or other reasons (including 4 households that did not contract a suitable field or without a barn, 5 households because of their own or family members' injuries, and 1 household that a family member gave birth to children), accounting for 30.3% of actually resigned tobacco planting households. The other 3 households resigned from flue-cured tobacco planting due to older age and poor health, accounting for only 9.1% of actually resigned tobacco planting households.

4 Flue-cured tobacco planting years of tobacco farmers in Shashi Town in recent 10 years

4.1 Most tobacco farmers have a history of resigning from flue-cured tobacco planting, and the withdrawal of some tobacco farmers from flue-cured tobacco planting have not reduced the scale of local flue-cured tobacco planting There were 167 households of tobacco farmers in Shashi Town who had been planting flue-cured tobacco from 2012 to 2021, and 275 households of tobacco farmers in 2021. After 2012, 108 households of tobacco farmers in Shashi Town replanted flue-cured tobacco within 10 years or after resigning, or entered the flue-cured tobacco planting for the first time. As shown in Table 3, among the 30 newly added households of tobacco farmers in Shashi Town in 2021, 16 of them entered the flue-cured tobacco planting industry for the first time in the last 10 years. In the survey, 9 households were actually added after changing the owners of flue-cured tobacco planting, and only 7 households entered the flue-cured tobacco

planting industry for the first time in the last 10 years. Among these 7 households, 4 households had a history of flue-cured tobacco planting 10 years ago, and only 3 households entered the flue-cured tobacco planting industry completely for the first time. In fact, most of the tobacco farmers who resigned from flue-cured tobacco planting for non-physical reasons may also re-engage in flue-cured tobacco planting; a small number of tobacco farmers had been switching between flue-cured tobacco planting and other industries for many years, entering or resigning from flue-cured tobacco planting many times. At present, most of the tobacco farmers in Shashi Town have a history of resigning from flue-cured tobacco planting. Most of the newly added tobacco farmers all year long have had a history of flue-cured tobacco planting. Farmers with a history of flue-cured tobacco planting have always been the main source of newly added tobacco farmers in Shashi Town in recent years. The withdrawal of some tobacco farmers does not necessarily lead to the decline of flue-cured tobacco planting scale. In some balanced tobacco areas, after some tobacco farmers resign from flue-cured tobacco planting, the vacated barn and land will be claimed by new tobacco farmers, or are subcontracted to old tobacco farmers to expand the scale of flue-cured tobacco planting. In some saturated tobacco areas, when a farmer contracts land first, other farmers may have to resign from flue-cured tobacco planting due to the lack of land transfer. However, in some tobacco areas, after tobacco farmers resign from flue-cured tobacco planting, it may lead to the abandonment of tobacco-based facilities such as curing barn, and the flue-cured tobacco industry is replaced by other industries.

Table 3 Annual number of households continuously planting flue-cured tobacco in Shashi Town from 2012 to 2021 and number of households included in 2021

Number of households	Year										Household
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Continuously planting households	167	189	253	267	285	289	309	332	379	409	
Households included in 2021	275	248	316	323	338	327	330	338	379	409	

4.2 Current team of tobacco farmers has been planting tobacco for many years, which is a precious human resource for flue-cured tobacco planting left after several rounds of selection There were 16, 19, 11, 13, 7, 18, 21, 49, 88 and 167 households that had been planting flue – cured tobacco continuously or discontinuously for 1 – 10 years in Shashi Town, Liuyang City in 2021, respectively. There were 304 households planting flue-cured tobacco continuously or discontinuously for more than 8 years, accounting for 74.33% of the total number of tobacco farmers in 2021. After taking into account the effects of changing the householder halfway or planting flue-cured tobacco in other townships without statistics in the successive planting years, it is speculated that there were more households that had planted flue-cured tobacco continuously or discontinuously for more than 8 years, and the actual proportion in the total number of tobacco farmers in 2021 was even greater. There were small numbers of households planting flue-cured tobacco continuously or discontinuously for less than 3

years, and the actual proportion in the total number of tobacco farmers in 2021 was even smaller. At present, most of the tobacco farmers in Shashi Town have been planting flue-cured tobacco continuously or discontinuously for many years, and they are experienced hardcore tobacco farmers who have persisted in flue-cured tobacco planting after several rounds of elimination. After years of market selection, it has been proved that they are suitable for planting flue-cured tobacco and can also plant high quality tobacco. They are valuable human resources supporting flue-cured tobacco industry in Shashi Town, and need the joint efforts of the government and tobacco companies to maintain carefully.

5 Number and verification results of tobacco farmers born in different eras in 2012 and 2021 in Shashi Town, Liuyang City

(i) In 2021, tobacco farmers born in the 1960s accounted for the largest proportion of flue-cured tobacco planting, followed by

those born in the 1970s, 1950s, and 1980s. As shown in Table 4, 60 tobacco farmers born in the 1940s who engaged in flue-cured tobacco planting in 2012 had all resigned from flue-cured tobacco planting by 2021; by 2021, 40 of the 278 tobacco farmers born in the 1950s continued to plant flue-cured tobacco, accounting for 14.39% of the number of tobacco farmers in this age group in 2012 and 71.43% of the number of tobacco farmers in this age group in 2021. There were 197, 35 and 3 tobacco farmers born in the 1960s, 1970s and 1980s who were still planting flue-cured tobacco after 10 years, accounting for 38.55%, 31.67% and 10.00% of the total number of tobacco farmers in each age group in 2012, and accounting for 73.78%, 51.47% and 18.75% of the total number of tobacco farmers in each age group in 2021, re-

spectively. In 2012, the number of tobacco farmers born in the 1960s accounted for 51.15% of the total number of tobacco farmers in Shashi Town, and rose to 65.28% in 2021. Although the proportion of tobacco farmers born in the 1980s increased slightly on the basis of low proportion in 2012, only 3 people continued to plant flue-cured tobacco in 2021, accounting for 10% of the number of tobacco farmers born in that year, 4.39% lower than the proportion of tobacco farmers born in the 1950s who continued to plant flue-cured tobacco. The results showed that the stability of tobacco farmers born in the 1960s was significantly higher than that born in the 1970s, and that born in the 1970s was significantly higher than that born in the 1980s.

Table 4 Number and proportion of tobacco farmers born in different eras in 2012 and 2021 in Shashi Town, Liuyang City, as well as number and proportion of recurred tobacco farmers

Year	Total number of tobacco farmers	Tobacco farmers born in the 1950s (40 farmers recurred)			Tobacco farmers born in the 1960s (197 farmers recurred)			Tobacco farmers born in the 1970s (35 farmers recurred)			Tobacco farmers born in the 1980s (3 farmers recurred)			Number of tobacco farmers born in the 1940s	Number of tobacco farmers born in the 1990s
		Number	Proportion %	Proportion of recurred farmers // %	Number	Proportion %	Proportion of recurred farmers // %	Number	Proportion %	Proportion of recurred farmers // %	Number	Proportion %	Proportion of recurred farmers // %		
2012	999	278	27.83	14.39	511	51.15	38.55	120	12.01	31.67	30	3.00	10.00	60	–
2021	409	56	13.69	71.43	267	65.28	73.78	68	16.63	51.47	16	3.91	18.75	–	2

(ii) The actual average age of tobacco farmers was 0.18 years older than the statistics, the number of tobacco farmers born in the 1980s decreased by 5 households, and there was a shortage of farmers born in the 1990s. Of the 409 households of tobacco farmers in Shashi Town in 2021 verified by statistics, 15 households were non-substantial flue-cured tobacco householders. Among the 16 tobacco farmers born in the 1980s, 5 were titulars with their father as the substantive head of household, and there were only 11 tobacco farmers born in the 1980s in Shashi Town. The statistics in 2021 verified that the two tobacco farmers born in the 1990s in Shashi Town were not substantive householders, and there was a shortage of farmers born in the 1990s.

At present, among the substantive householders of flue-cured tobacco planting in Shashi Town, the youngest is a tobacco farmer born in 1987, and there are other two tobacco farmers born in 1986 and 1985, respectively. It was verified that 4 households in Shashi Town, with the oldest tobacco farmers reaching the age of 70 years old in 2021, continued to plant flue-cured tobacco after changing their householders, and 3 of them were under the name of their sons with the father as the substantive head of household. Among the three tobacco farmers who changed their household owners from generation to generation, according to the average age difference of 25 years per household, the statistical age of tobacco farmers in Shashi Town in 2021 decreased by 75 years old compared with the actual age, and the average age decreased by 0.18 years old. According to the statistics, the average age of tobacco farmers in Shashi Town in 2021 increased by 0.96 years over the previous year, and the actual increase was estimated to be 1.14 years after verification. The actual average age increased by more than 1 year old for the first time, which was the fastest growth rate in the last 10 years. Although the planting area of flue-cured tobacco in

Shashi Town increased by 50 ha in 2021 compared with the previous year, there is no physical replacement due to the continuous decline and loss of young farmers' flue-cured tobacco planting willingness, and the strengthening of old farmers' flue-cured tobacco planting willingness, and the crisis of aging tobacco farmers and no successor of tobacco industry in Shashi Town is still accelerating.

6 Development prospects of tobacco farmers in Shashi Town, Liuyang City in the next 5 years

6.1 Elderly tobacco farmers will become the main force of flue-cured tobacco planting in Shashi Town In the past 10 years, the rural labor force born in the 1960s has accounted for the absolute majority of registered tobacco farmers in Shashi Town, and is also the largest group of newly added, resigned and potential tobacco farmers. It is due to the fact that the rural labor force in the 1960s is more hard-working, and most of the rural labor force in the 1960s has elders and grandchildren to take care of. With the increasing age, the access to employment in other industries becomes narrower, and they are willing to return to flue-cured tobacco planting industry when it is not easy to find employment in other industries. The relative increase of flue-cured tobacco planting benefits mainly plays a role in stabilizing registered tobacco farmers, and has limited effect on persuading migrant workers in the 1970s and 1980s to join the tobacco farmer team. For example, construction industry has been the most competitive industry with flue-cured tobacco industry in Shashi Town over the years, and a large number of tobacco farmers who resign from flue-cured tobacco planting will switch to construction industry. The proportion of farmers born in the 1970s and 1980s working in construction industry is significantly higher than that in flue-cured tobacco industry, because the converted daily wage of this type of work is significant-

ly higher than that of flue-cured tobacco planting. In addition, it is a stable income job, and the salary increases according to market changes. For many rural farmers who lack hard work and exercise in the 1980s and 1990s, even if the income from flue-cured tobacco planting is slightly higher than their current work, it is difficult to attract them to switch careers and join the team of tobacco farmers with poor working environment and hard work.

Therefore, it is predicted that in the next 5 years, as the tobacco farmers born in the 1950s gradually resign from flue-cured tobacco planting, the proportion of the tobacco farmers born in the 1950s in the entire team of tobacco farmers will decrease significantly, and the proportion of the tobacco farmers born in the 1950s in the entire team of tobacco farmers will be mainly filled by those born in the 1960s. At the same time, some older and poorer tobacco farmers in the 1960s will be replaced by younger and healthier migrant workers born in the 1960s; the tobacco farmers born in the 1970s and 1980s will also rebound on the basis of their relatively low share in the current tobacco farmer team.

6.2 Aging of tobacco farmers in Shashi Town is accelerated, and the average age of tobacco farmers will reach about 60 years old The age of tobacco farmers is set to be between 30 and 69 years old, with an average age of 45.5 years old. Under the premise that the number of tobacco farmers does not increase or de-

crease at all, the average age of tobacco farmers increases by 1 year old per year. The sustainable replacement state of human resources of flue-cured tobacco production is that after a certain number of old tobacco farmers aged 60 years old and above resign, an equal number of young farmers aged 39 years old and above enter the tobacco farmer team, and the number and average age of tobacco farmers remain unchanged. If only farmers over the age of 69 years old resign from tobacco planting every year and the rest remain, the age of tobacco farmers will be between 31 and 69 years old a year later, with an average age of 50.0 years old, and an increase of 0.5 years old per year. From 2013 to 2018, the average age of tobacco farmers in Shashi Town increased at a rate of 0.54 years old per year, and the number of tobacco farmers decreased significantly. The number of tobacco farmers in Shashi Town only decreased by 5 households from 2019 to 2021, but the average annual growth rate increased to 0.76 years old per year, and the sustainability of human resources of flue-cured tobacco production decreased significantly. According to the birth year and age structure of tobacco farmers in Shashi Town in 2021 (Table 5), it is assumed that only the tobacco farmers aged 70 years old and above would resign from flue-cured tobacco planting in Shashi Town in the next 5 years, and the number and proportion of tobacco farmers in each age group in the next 5 years were deduced (Table 6).

Table 5 Details of birth year and age structure of tobacco farmers in Shashi Town, Liuyang City in 2021

Year	Number of tobacco farmers	Age years old	Year	Number of tobacco farmers	Age years old	Year	Number of tobacco farmers	Age years old
1952	3	69	1965	31	56	1978	3	43
1953	5	68	1966	35	55	1979	9	42
1954	10	67	1967	30	54	1980	2	41
1955	5	66	1968	29	53	1981	4	40
1956	11	65	1969	19	52	1982	2	39
1957	10	64	1970	16	51	1983	2	38
1958	8	63	1971	9	50	1984	3	37
1959	4	62	1972	6	49	1985	1	36
1960	11	61	1973	11	48	1986	1	35
1961	10	60	1974	7	47	1987	1	34
1962	24	59	1975	6	46	1990	1	31
1963	41	58	1976	1	45	1991	1	30
1964	37	57	1977	4	44			

Table 6 Deduction of number and average age of tobacco farmers, number and proportion of each age group in the next 5 years in Shashi Town, Liuyang City

Year	Number of households	Average age years old	39 years old and below		40 –49 years old		50 –59 years old		60 years old and above	
			Number of households	Proportion %	Number of households	Proportion %	Number of households	Proportion %	Number of households	Proportion %
2021	409	55.16	12	2.93	49	11.98	271	66.25	77	18.83
2022	406	56.05	10	2.46	45	11.08	253	62.32	98	24.14
2023	401	56.94	8	2.00	36	8.98	223	55.61	134	33.42
2024	391	57.83	5	1.28	32	8.18	193	49.36	161	41.18
2025	386	58.72	4	1.04	27	7.00	168	43.52	187	48.45
2026	375	59.61	3	0.80	27	7.20	134	35.73	211	56.27

In view of the fact that in the past 5 years, especially in the last 3 years, the stability of tobacco farmers in Shashi Town has been significantly enhanced, and 379 households in the tobacco farmers' team in 2020 still planted flue-cured tobacco in 2021, accounting for 92.67% of total number of tobacco farmers in Shashi Town in 2021. This deduction has certain reference for the prediction. It is estimated that some tobacco farmers of all ages will increase and resign every year in the next 5 years. Since the improvement of flue-cured tobacco planting benefits has limited effect on extending years of flue-cured tobacco planting for some tobacco farmers, most tobacco farmers will still resign from flue-cured tobacco planting before the age of 65 years old due to irresistible physical decline. By 2026, the age of tobacco farmers in Shashi Town will be more concentrated in about 60 years old, and the number of tobacco farmers aged 60 years old and above may approach or exceed that aged 50–59 years old. Hence, flue-cured tobacco planting may completely become a geriatric economy.

6.3 Number of tobacco farmers continues to decline Since the tobacco farmers in Shashi Town are aging at an accelerated pace, it is difficult to stop the current trend of decreasing registered tobacco farmers year by year even if the flue-cured tobacco planting efficiency is improved to a limited degree. As the main source of newly added tobacco farmers, the migrant workers born in the 1960s gradually resign because they are becoming older and older. Since it is difficult for current efficiency of flue-cured tobacco planting to attract more migrant workers born in the 1970s and 1980s to plant tobacco in hometown, it is predicted that the number of tobacco farmers in Shashi Town will continue to decrease in the future.

6.4 Average planting scale of flue-cured tobacco households will continue to expand, and total planting scale of flue-cured tobacco will remain relatively stable In view of the current trend of balanced production and marketing of flue-cured tobacco planting in China, coupled with the fact that the State Tobacco Monopoly Administration has placed the increase in income of tobacco farmers in a prominent position, it is predicted that flue-cured tobacco planting benefits will continue to increase, and the enthusiasm of tobacco farmers in Shashi Town will be improved. Some tobacco farmers resign from flue-cured tobacco planting or reduce the area of flue-cured tobacco planting due to physical reasons, and the vacant land will be transferred by other qualified tobacco farmers to expand the scale of flue-cured tobacco planting. Meantime, in recent years, a number of large grain production households in Shashi Town have entered flue-cured tobacco planting industry by virtue of their advantages of owning land and venues, and achieved a double harvest of flue-cured tobacco planting and grain production. It also indicates that in a certain period of time in the future, as more large grain production households join flue-cured tobacco planting and become large flue-cured tobacco food growers, the average scale of flue-cured tobacco planting per household in Shashi Town will continue to expand. With the ex-

pansion of average scale of flue-cured tobacco planting per household, the demand for hired workers in flue-cured tobacco planting will increase correspondingly. Although there are problems in the employment of flue-cured tobacco planting, such as difficulty in hiring workers, increasing age of employees and decreasing work efficiency, it is possible to expand employees to the blank area of flue-cured tobacco planting and introduce non-native workers, so as to maintain the stability of flue-cured tobacco planting scale when the number of tobacco farmers declines.

6.5 Effect of benefit and technological progress on age structure of tobacco farmers in Shashi Town, Liuyang City This prediction is based on the premise of steady growth of flue-cured tobacco planting benefits in Liuyang in the future. Due to older age structure of tobacco farmers in Shashi Town, the stability of tobacco farmers is fragile. In the case of declining efficiency of flue-cured tobacco planting, a large number of tobacco farmers resign from flue-cured tobacco planting, and the number of tobacco farmers and scale of flue-cured tobacco planting have decreased significantly^[6–7]. If the purchase price and planting efficiency of flue-cured tobacco are greatly increased, there will be more farmers born in the 1970s and 1980s joining flue-cured tobacco planting, so that the age structure of tobacco farmers is likely to be significantly improved. However, different from the dramatic changes in early tobacco production in Liuyang, due to the limitations of the number of rural labor force and capacity of curing barns in Liuyang, the number of tobacco farmers and scale of flue-cured tobacco planting will not increase significantly even if the efficiency of flue-cured tobacco planting increases significantly^[8].

The degree of technological progress and changes in flue-cured tobacco production mode may also have a significant impact on the variation of the number of tobacco farmers, age structure and tobacco planting scale in Shashi Town, Liuyang City. Looking back on the history of flue-cured tobacco planting, Liuyang, like the vast tobacco areas in China, began to use floating seedlings, mechanical tilling, ridging, transportation, and bulk curing barn 20 years ago, resulting in significantly reduced labor intensity of flue-cured tobacco planting, noticeably improved working environment and remarkably reduced amount of labor. The progress of science and technology and changes in production mode significantly improved the production efficiency of flue-cured tobacco, which to some extent led to the overproduction of flue-cured tobacco in China during 2008 and 2014^[9]. Although the change in flue-cured tobacco production mode in Liuyang tobacco area in the recent 10 years is not as large as that in the previous 10 years, it is still changing. In addition to the gradual popularization of float breeding, mechanical tilling, ridging, transportation, and bulk curing barn baking technologies, there are also large-scale promotion of mechanical sowing, mechanical fertilization, mechanical spraying, cigarette holder baking and other technologies, and the employment and labor intensity of flue-cured tobacco planting continue to decrease. Therefore, according to the trend of flue-cured

tobacco production in the last 20 years, it is predicted that if China's flue-cured tobacco production mode in the next 5 – 10 years changes according to the amplitude of the previous 10 years, the decrease in the number of tobacco farmers will not cause a decrease in the scale of flue-cured tobacco planting, and the scale of flue-cured tobacco planting in Liuyang will mainly be determined by flue-cured tobacco planting plan. If China's flue-cured tobacco production mode changes following the amplitude of the last 10 years, the reduction in the labor volume of flue-cured tobacco production may not keep up with the pace of the decrease in the number of tobacco farmers and the aging of farmers. The stable scale of flue-cured tobacco industry in Shashi Town will be under significantly increased pressure^[10].

7 Conclusions and suggestions

Shashi Town is the largest town of tobacco planting in Liuyang, and the annual purchase volume accounts for about 22% of the total purchase volume of Liuyang. The situation of tobacco farmer team also represents the situation in the villages and towns such as Yongan, Chunkou and Longfu, which have a long history of tobacco planting, a large scale of tobacco planting and a relatively stable tobacco industry. The aging of tobacco farmers in Shashi Town (a model of Liuyang) and Liuyang (a representative of China's old tobacco areas) is a common phenomenon in China. Therefore, the investigation and analysis of current situation of tobacco farmers in Shashi Town also has certain reference significance for studying the status of tobacco farmers in other tobacco-growing areas in China.

At present, the aging and large loss of tobacco farmers are the biggest problems in the sustainable development of flue-cured tobacco production in China^[11–12]. To solve this problem, we need to implement the generalized system of preferences. On the basis of greatly improving the planting efficiency of flue-cured tobacco and maintaining a certain number of tobacco farmers, we should relax the selection criteria for professional tobacco farmers and greatly increase the number of professional tobacco farmers; increase efforts to train young tobacco farmers, and take the training of young tobacco farmers as the evaluation index of tobacco stations and technicians, in order to improve the age structure of tobacco farmers. In the long run, it is necessary to accelerate the pace of scientific and technological progress, improve the labor environment of flue-cured tobacco production, reduce the labor intensity of flue-cured tobacco production, and reduce the number of workers employed in flue-cured tobacco production, in order to fundamentally solve the problem of human resources in flue-cured tobacco production and promote the sustainable and healthy development of flue-cured tobacco production in China^[13–15].

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